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Nexus of Financing Constraints and Supply Chain Finance: Evidence from Listed SMEs in China

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Abstract: As opposed to developed markets, financing constraints are a more pressing issue among Small and Medium-Sized Enterprises (SMEs) in emerging markets. We explore the severity of financing constraints on SMEs, and examine the role of supply chain finance (SCF) in alleviating those constraints, with the focus on a large emerging market: China. Using the panel data of SMEs listed on Shenzhen Stock Exchange from 2014 to 2020, we employ robust estimations of panel-corrected standard errors (PCSEs) and robust fixed-effects methods to analyze the issue. Our cash–cash-flow sensitivity model points out that listed SMEs in China show significant cash–cash-flow sensitivity, and financing constraints are prevalent. We document that the development of SCF has a mitigation effect on the financing constraints on the SMEs. Our robustness test with Yohai's MM-estimator is also supportive of the main finding. Our study indicates the importance of supply chain finance development in alleviating the financing constraints on SMEs and, subsequently, supporting their sustainability journey. Overall, our findings have important policy implications for the stakeholders involved in emerging markets, and there are lessons to be learned from the Chinese experience. There is still much to be explored in the nexus of SCF and the financing difficulties of SMEs in China at present, with much of the extant literature concentrating only on specific financing mechanisms. Thus, our study fills the gap by providing a broad and comprehensive analysis of the issue.

Keywords: financing constraints; supply chain finance; SMEs; cash–cash-flow sensitivity; panel-corrected standard errors

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1. Introduction

Small and medium-sized enterprises (SMEs) play a vital role in encouraging economic growth, expanding employment, and increasing tax revenue and technological innovation in emerging markets, such as China. They are of strategic significance for China's economy in maintaining high-quality growth. By 2018, SMEs accounted for 52% of national economic and social development benefits, while large enterprises accounted for 48%. There are about 380,000 industrial enterprises, including 9103 large enterprises and 370,000 SMEs. The assets of large enterprises totaled CNY 113 trillion, while those of SMEs totaled CNY 58.8 trillion (Xue 2021). It is clear that the number of small and medium-sized businesses is substantial. However, the current development of SMEs is facing many difficulties and challenges, and one of the important obstacles is the financing problem. It is difficult to give full credit to the role of SMEs in economic growth. Many of them have been squeezed out by social and financial institutions. According to the data report of the China Financial Research Center, there are some small loan companies whose main financing targets are SMEs. However, the amount of financing they provide does not exceed 5% of the institution's total financing. Borrowing enterprises still face high financing costs, as high as 22% of the total cost of the financing institutions (Xue 2021). As far as China is concerned, many SMEs are found to have no suitable financing platform or environment.

Supply chain finance is developed to help to relieve such financial constraints. It is a supply chain formed by upstream suppliers, core enterprises, and downstream distributors, which are connected to each other as a whole through trade transactions, using pledges, such as the accounts receivable and inventory, formed by deferred or early payment, to obtain financial flows, providing financial support to nodal enterprises upstream and downstream of the core enterprises. This promotes SME financing, and drives the dynamic development of SMEs (Lamoureux 2007; Atkinson 2008; Wuttke et al. 2013). SMEs are often small in scale, and the pledges often fail to meet the approval requirements. Supply chain finance relies on core enterprises with excellent credit qualifications to offer credit to upstream and downstream businesses, while SMEs can depend on real transaction businesses for credit. The supply chain financing mode is a comprehensive financial service mode, which comprehensively evaluates all the types of information resources on the chain, including logistics and the related supply chain management information. It can be said that the emergence of supply chain finance provides a new idea and scheme for the financing of SMEs, which can meet the financing characteristics "short, small, frequent and urgent" of enterprises to a certain extent, and alleviate SME financing constraints (Abbasi et al. 2018; Song 2021; Wuttke et al. 2016; Zhou et al. 2020).

There is still a big gap between the development level of supply chain finance in China and in those developed markets. The main issue is that a relatively high proportion of SMEs still do not join the supply chain financial system, and face the problem of difficult and expensive financing. According to statistics in 2018, 80% of China's SMEs face financing constraints, and their financing demand exceeds the financing supply by about USD 2 trillion. The year 2020 is bound to be difficult for many SMEs, due to the spread of COVID-19 (Ma et al. 2021; Li 2021). In this bad global economic environment, SMEs face greater operational risks, and their financing needs become greater. Therefore, the development of supply chain finance has ushered in a new challenge.

Thus, from the above discussion, our aim is to explore the severity of financing constraints on SMEs, and to examine the role of supply chain finance in alleviating these constraints, with the focus on a large emerging market: China. There is still much to be explored regarding the link between supply chain finance and the financing difficulties of SMEs in China at present, with much of the previous research concentrating only on the examination of specific financing modes and financing mechanisms of supply chain finance (as per our discussion in Section 2.2). Therefore, by considering the financing constraints and supply chain finance of the entire small and medium-sized board of enterprises on Shenzhen Stock Exchange from 2014 to 2020, our study attempts to fill the gap, by providing a broad and comprehensive analysis and, thus, a more complete picture of the issue. Moreover, as per our knowledge, we further contribute to the literature with the first study of its kind to explore the nexus of supply chain finance and financing constraints using a robust estimation process; specifically, the panel-corrected standard errors and robust fixed-effects approaches, together with the MM-estimator process. We believe that these quantitatively robust approaches are able to enhance the reliability of the results and, hence, reduce the need for further investigations into the issue.

Using the cash–cash-flow sensitivity model proposed by Almeida et al. (2004), our findings show that SMEs in China demonstrate significant cash–cash-flow sensitivity, and financing constraints are prevalent. Moreover, our study points out the importance of the development of supply chain finance in alleviating financing constraints on SMEs, and subsequently supporting their sustainability initiatives. Overall, our findings have important implications for SME stakeholders in emerging markets, and there are lessons to be learned from the Chinese experience. From the above discussion, the findings from our study are timely, in that they contribute to the literature during the post-COVID-19 era, in which financing constraints become even more prevalent in emerging economies. While previous research has explored supply chain finance in developed countries, there is a notable lack of studies focusing on the financing challenges and opportunities faced by SMEs in emerging markets. Hence, our study aims to address such a significant knowledge

gap in the existing literature of SMEs operating in large emerging economies, such as China. Last, but not least, our research makes a valuable contribution to the existing literature by specifically focusing on China, a market that presents several distinct differences compared to the developed economies of the West.

The remainder of this paper is organized as follows. Section 2 covers the literature review and hypothesis development. Section 3 deals with the data and method. Section 4 presents the analysis, and discusses the results. Section 5 concludes the paper.

2. Related Literature and Hypothesis Development

Below, we review the literature of financing constraints on SMEs, and their nexus with supply chain finance, with the focus on China. Compared to the West, China has some distinct differences in terms of the financing contraints faced by its SMEs, as well as the current stage of development, and the roles of supply chain finance, in addressing the financing challenges of SMEs. Specifically, lenders and financiers may face greater information asymmetry when evaluating the creditworthiness of SMEs in China. The lack of robust financial data or transparent financial reporting of some Chinese SMEs can make it challenging for lenders to assess their creditworthiness accurately (Shi and An 2016; Zhao et al. 2009). This may lead to greater credit default risk, as well as higher transaction costs of loans to lenders in China, compared to in developed economies in the West (Asgary et al. 2020; Chen and Peng 2011). Meanwhile, as stated earlier, supply chain finance in China, in comparison, is generally less mature and well-established; there are still a high proportion of SMEs that do not join the supply chain financial system, and face the problem of difficult and expensive financing (Ma et al. 2021; Li 2021). In such circumstances, the development of supply chain finance in China is critical in playing a pivotal role in filling the financing void for SMEs.

2.1. Financing Constraints on SMEs in China

The financing difficulty of SMEs is a universal problem in China, and many scholars agree that the reason for the difficulty in financing is that SMEs have low credit, imperfect information, and irregular systems. Lin and Sun (2005) believe that, compared with large enterprises, SMEs have insufficient collateral, opaque information, and high risk borne by credit institutions, causing reluctance among institutions to lend to them. Lu and Xiao (2012) find that false information, deliberate concealment, and other adverse factors seriously affect banks' willingness to lend to SMEs, and banks lack a long-term incentive mechanism for lending to SMEs. Deng (2013) puts forward that, under the background of the reform of state-owned banks in China, the strict risk monitoring and imperfect credit guarantee system in China caused the strict requirements of commercial banks regarding loans to SMEs, which led to the financing difficulties of SMEs. According to Shi and An (2016), compared with large enterprises, SMEs' financial information is incomplete. The phenomenon of selective disclosure and information fraud often occurs, and the internal information of SMEs is often controlled by the founder, which is easy to adulterate. It is precisely because of the high degree of information asymmetry between credit institutions and SMEs that financial institutions take into account the moral hazard and adverse selection that such information asymmetry may bring, and will provide fewer loans, or refuse loans, to SMEs.

Wang (2019) points out that the reason why the traditional credit mode provides SMEs with low financial support is that the transaction costs and risks of providing credit are higher. SMEs have small asset scales and low credit levels, so it is difficult for them to obtain mortgage loans from banks with limited collateral. In contract, large enterprises are significantly better than small and medium-size enterprises in terms of information disclosure and availability, credit rating, collateral, and capital scale. For the banks, the convenience of such enterprise information collection determines that the pre-transaction cost of investigating and collecting information, drafting contracts and negotiating, etc., for large enterprises is relatively lower. Qu (2019) asserts that the financing difficulties of SMEs

are caused by internal reasons, such as their small scale, low credit, and few mortgaged assets. Moreover, compared with large enterprises, the supervision of SMEs by banks after the provision of loans (for example, their evaluating the value of the collateral, tracking and investigating the operating status of the borrowing enterprise on time, and promptly discovering loopholes and potential risks) is much more complicated, resulting in banks incurring greater supervision costs, and thus charging higher financing costs, and granting smaller amounts of financing. Wang (2020) believes that SMEs lack reasonable planning, and the expansion of the production scale is prone to blindness, leading to blind financing. In this way, enterprises will have unreasonable financing strategies and financing needs, resulting in financing difficulties.

From the above discussion, it can be seen that the main forms of SME financing constraints in China are fewer financing opportunities, high financing costs, and a large financing gap. From the perspective of financing opportunities, China's commercial banks generally exhibit the phenomenon of "big customer preference", which will lead to the unfavorable situation of being reluctant to lend, or even refusing to lend, to SMEs. Financing-cost-wise, the fluctuation of the loan interest rate, and a series of expenses, such as evaluation fees, notary fees, and relationship maintenance costs, keeps the financing cost of SMEs high (Lam and Liu 2020). From the perspective of the financing gap, China's existing capital supply and potential financing demand do not match. The financing gap in SMEs is large.

In summary, the causes of SME financing constraints mainly stem from three aspects: enterprises themselves, banks and other financial institutions, and the government.

Based on the above analysis, we propose the first hypothesis, H_1:

H_1. *Financing constraints are prevalent in SMEs in China; this is manifested as significant cash–cash-flow sensitivity.*

2.2. Supply Chain Finance in China

Thus far, scholars have carried out numerous analyses and research on the supply chain finance financing modes of SMEs, which can be divided into three modes: accounts receivable financing, confirmatory warehouse financing, and finance transportation warehouse financing, corresponding to the supply-chain-generated accounts receivable, advance accounts, and movable inventory (Yan and Xu 2007). SMEs at different supply chain nodes can choose from three financing modes, according to their trading range, to improve the incentive for bank lending, and solve the shortage of funds. Lin et al. (2015) study and analyze the three financing modes from the perspectives of the business process, risk point, exhibition point, etc. Based on the research of these three financing modes, Wang (2018) discusses the significance of supply chain financing modes from the perspective of SMEs, banking, logistics enterprises, and promoting value.

From the above discussion, supply chain finance may potentially solve the financing problems of SMEs, which can create favorable conditions for the financing of SMEs. Specifically, the accounts receivable financing mode can realize the future cash flow of the enterprise in advance, increase income, and create profits for the enterprise. The confirming warehouse financing mode can solve the capital problem of the full purchase of goods, and improve the capital turnover capacity of SMEs. The finance transportation warehouse financing mode can revitalize the inventory, release the capital occupied by SMEs, and reduce the financial pressure on enterprises.

The development of supply chain finance may address the financing dilemma of SMEs via the following three main mechanisms: (1) improving the information asymmetry between subjects; (2) reducing the credit default risk in SMEs; and (3) reducing the transaction costs of loans to financial institutions. Zhao et al. (2009), based on the theory of credit rationing, and from the perspective of information asymmetry and profit asymmetry generated in the cooperation between banks and enterprises, believe that supply chain finance could solve the financing dilemma of SMEs to some extent, ease financing restrictions,

and improve credit capacity. Shi and An (2016) also believe that improving enterprise information transmission mechanisms via supply chain finance can fundamentally reduce the information asymmetry between banks and enterprises, and improve credit efficiency.

According to Chen and Peng (2011), supply chain finance may alleviate financing limitations, strengthen the credit system of SME financing systems, and increase the value of the whole industrial chain. Asgary et al. (2020) believe that core enterprises in the supply chain can help SMEs improve their own reputation, so that financial institutions can reduce risks when providing financing credit services, so as to provide more financing for them. Su and Lu (2015) use supply chain finance to simulate the credit model of businesses, financial intermediaries, and third-party logistics providers, demonstrating the significant benefits and importance of supply chain finance in credit risk management. They evaluate the credit risks of all participants in the supply chain finance model, and conclude that supply chain finance can effectively strengthen risk control, so as to safeguard the interests of all participants in supply chain finance, and achieve a win–win situation. Through comparative analysis, Mu (2018) considers that supply chain financing is more conducive to credit ratings than traditional financing methods, and solves the dilemma of SMEs not receiving funds through traditional means.

Zhang and Liu (2012) use the cash–cash-flow sensitivity model to demonstrate whether SMEs have financing constraints, and emphasize the important role of supply chain finance in reducing enterprise financing transaction costs. Hu (2014), in his analysis using a sample of enterprises in the Xi'an equipment manufacturing and biomedicine industries, asserts that supply chain finance can broaden the financing channels of enterprises, speed up financing, and improve the operational efficiency of enterprises through cooperation with core enterprises. Through the study of small technology enterprises, Gu (2016) finds that the main expenditure of these enterprises indicates significant cash flow sensitivity, and that this sensitivity can be alleviated through the supply chain financial system. Wang et al. (2016) construct a multi-party game model, and analyze the strategic choices of all the parties involved in the financing model. The results of the game show that such a financing model helps reduce the credit risk of SMEs, and the transaction costs of loans and, hence, improve the possibility that banks will provide loans to SMEs. Zhou et al. (2017) conduct a grouping regression test on the samples of A-share non-financial listed companies, and verify that supply chain finance has a more significant easing effect on financing constraints on small enterprises with a high growth and intense industry competition.

From the above discussion of the mechanism of supply chain finance to alleviate the financing constraints of SMEs, it can be seen that the multi-angle information acquisition mechanism and reputation chain mechanism of supply chain finance can effectively reduce the frequency of "adverse selection" and "moral hazard", and reduce the information asymmetry between banks and enterprises. A long-term stable enterprise cooperation mechanism, and the closed operation mechanism of credit-granting business can effectively alleviate the transaction costs caused by transaction uncertainty, transaction frequency, and asset specificity, and reduce financing transaction costs. The credit-bundling mechanism of supply chain finance, as stated earlier, can reduce the credit risk of banks, and improve the lending enthusiasm of banks and other financial institutions. At the same time, such a mechanism also plays a screening role, which can "filter" bank credit risks from the source. In short, each of the three mechanisms of supply chain finance can specifically solve existing problems in the financing activities of SMEs, which is conducive to reducing the worries of banks and other financial institutions, creating more favorable conditions for the financing of SMEs, and promoting their further development.

Thus, based on the above reasoning, we propose the second hypothesis, H_2:

H_2. *The development degree of supply chain finance can alleviate the financing constraints on SMEs in China.*

3. Data and Method

3.1. Data Collection

Our data are collected from the WIND, a prominent and reliable financial/economic database in China. The financial data from 2014 to 2020 of listed companies on the Shenzhen Small and Medium-sized Board are selected. In order to ensure accuracy, the following companies are removed from the data: (1) Special Treatment and Particular Transfer (ST/PT) companies; (2) companies with incomplete financial data; and (3) companies that have been listed for less than three years. After the filtering, a final sample of 518 companies over seven years, with a total of 3626 sample observations, and balanced panel data, is identified.

3.2. Model Construction

Almeida et al. (2004) proposed the cash–cash-flow sensitivity model (also known as the ACW model) in 2004 to measure the degree of financing constraints on enterprises. The theoretical basis of the ACW model is that enterprises facing financing constraints are often blocked from external financing channels, and it is difficult to obtain the required funds from outside. To meet future investment needs, companies typically retain some money from current cash flows. At this time, the enterprise will show significant cash–cash-flow sensitivity. However, enterprises without financing constraints do not need to retain part of their capital to meet the capital needs of future investment activities, and the cash–cash-flow sensitivity of the enterprise is weak. Hence, the ACW model is reasonable to measure the degree of financing constraint from the perspective of the enterprise cash-holding level (Almeida et al. 2004). It has been verified and supported in past studies over the years (e.g., Hadlock and Pierce 2010; Acharya et al. 2007; Campello et al. 2010; Michalski et al. 2018; Zhang et al. 2019), showing a strong adaptability and rationality. Therefore, the cash–cash-flow sensitivity model is used in our study to empirically analyze the financing constraints on SMEs.

(1) Basic model

In order to test the first hypothesis, H_1, we construct the following basic model based on the cash–cash-flow sensitivity model proposed by Almeida et al. (2004):

$$\Delta CASH_{i,t} = a_0 + a_1 CF_{i,t} + a_2 SIZE_{i,t} + a_3 TAGR_{i,t} + a_4 \Delta NWC_{i,t} + a_5 \Delta SD_{i,t} + a_6 DEBT_{i,t} + \varepsilon_{i,t} \quad (1)$$

where $\varepsilon_{i,t}$ is the error term; and i, t represent the ith enterprise and the t year, respectively.

Among the parameters to be estimated, a_1 is to measure the severity of the financing difficulties of enterprises; namely, cash and cash-flow sensitivity. A value significantly greater than zero suggests that there is a certain positive correlation between the change in enterprise cash and cash equivalents (ΔCASH) and the cash flow (CF). It indicates that it is difficult for an enterprise to raise funds through external channels, and that it can only withdraw funds from the cash flow generated within the enterprise for future investments, thus suggesting that the enterprise is in financing difficulties.

(2) Extended model

To test the second hypothesis, H_2, we add the measurement of the development degree of supply chain finance (SCF), and the interaction term between the enterprise cash flow and the development degree of supply chain finance (CF × SCF) on the basis of the previous model, and construct the following extended model:

$$\begin{aligned} \Delta CASH_{i,t} = {} & a_0 + a_1 CF_{i,t} + a_2 CF_{i,t} \times SCF_{i,t} + a_3 SCF_{i,t} + a_4 SIZE_{i,t} + a_5 TAGR_{i,t} \\ & + a_6 \Delta NWC_{i,t} + a_7 \Delta SD_{i,t} + a_8 DEBT_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (2)$$

In the extended model, the interaction term between the enterprise cash flow and the development degree of supply chain finance (CF × SCF) is used to reflect the impact of the development of supply chain finance on SME financing constraints (Yan and Liang 2023; Song 2021). If the coefficient of the interaction term (a_2) is significantly negative, it

means that the degree of supply chain finance will affect the sensitivity of businesses to cash flow, implying that supply chain finance development has a significant and positive impact on SME financing. Put simply, the development degree of supply chain finance eases the financing constraints on enterprises.

3.3. Definition and Description of Variables

The change in cash and cash equivalents of a firm (ΔCASH) is chosen as the explained variable in our basic and extended models. It is found that if a firm faces financing constraints, it will tend to hold a certain amount of cash out of its operating cash flow. Conversely, if a firm is able to raise external finance successfully, then the firm's cash holdings will usually remain relatively stable. In other words, the financing constraints faced by a firm will affect its cash holdings (Tang and Moro 2020). Therefore, it is reasonable to measure the financing difficulty of an enterprise by the sensitivity of its cash holdings (changes in cash and cash equivalents) to its operating cash flow.

Three variables of interest are involved: the operating cash flow of enterprises (CF), the development degree of supply chain finance (SCF), and the interaction term of the measurement index of the operating cash flow, and the development degree of supply chain finance (CF × SCF). Among them, the latter two are introduced on the basis of our basic model, to study our second hypothesis.

(1) Operating cash flow (CF)

The CF refers to the net cash flow generated by the current operating activities of the enterprise, divided by the total assets of the current period. Enterprises facing financing constraints often withdraw part of the funds from the current cash flow, to meet the capital needs of future investment activities. The cash–cash-flow sensitivity of the enterprise is therefore more significant at this juncture. In other words, enterprises facing financing constraints will retain more cash flow in the form of cash or cash equivalents in the company for precautionary motives, and the two are positively correlated. In addition, as the operating cash flow is the main source of net income for enterprises, it is of higher quality, and harder to manipulate (Zhu et al. 2020).

(2) The indicator of the development degree of supply chain finance (SCF)

Due to the late start and imperfect development of the concept of supply chain finance in China, there is still no certain indicator with which to measure the development degree of supply chain finance. This is because the accounts receivable financing mode and finance transportation warehouse financing mode of supply chain finance belong to the mortgage loan, which can be summarized as the index of short-term borrowing of enterprises. The confirmatory warehouse financing mode of supply chain finance mainly refers to the bank acceptance bill, which can be summarized as the index of enterprise notes payable (Song 2021; Yang et al. 2019). In view of this, we adopt Yang et al.'s (2019) approach of taking the sum of short-term loans and notes payable as an indicator for measuring the development degree of supply chain finance.

(3) The interaction term between the operating cash flow and the development degree of supply chain finance (CF × SCF)

Pairing the operating cash flow (CF) with the development degree of supply chain finance (SCF) to form an interaction term (CF × SCF) may demonstrate the easing effect of SCF on enterprise financing constraints. If the development degree of supply chain finance can alleviate the financing dilemma of enterprises, then the influence of the operating cash flow of enterprises on cash and cash equivalents will be reduced. In this case, there is a negative correlation between the interaction term and the change in cash and cash equivalents.

Our control variables include the enterprise scale (SIZE), the total assets growth rate (TAGR), changes in the non-cash net working capital (ΔNWC), changes in short-term liabilities (ΔSD), and the liabilities-to-assets ratio (DEBT). SIZE is measured by the total

assets of listed enterprises on the small and medium-sized board at the end of the period. According to Hadlock and Pierce (2010), the enterprise size is a useful predictor of financing constraints. There are two cases for the coefficient of this variable. On the one hand, with the expansion of the scale of the enterprise, the capital reserves of the enterprise will gradually increase, so the enterprise does not need to withdraw cash to increase the holding of cash and cash equivalents. On the other hand, with the expansion of the enterprise scale, the enterprise's demand for funds will gradually increase; at this time, the enterprise needs to withdraw cash to increase the holding of cash and cash equivalents. Thus, the coefficient of SIZE can be positive or negative.

A constrained firm's cash policy should be influenced by the attractiveness of future investment opportunities (Almeida et al. 2004). We use the growth rate of total assets (TAGR), one of the commonly used proxies for the future investment opportunities of enterprises (Kallapur and Trombley 1999). Judging from the coefficient symbol of this variable, when the future investment opportunities of enterprises increase, enterprises tend to increase their holdings of cash and cash equivalents, to cope with future investment needs. Thus, the coefficient of TAGR is expected to be positive.

The non-cash net working capital influences the corporate cash-holding level (Zhang et al. 2019), as it can be a substitute for cash (Opler et al. 1999), or it may compete for the available pool of resources (Fazzari and Petersen 1993). The increase in non-cash net working capital means that the outflow of cash from the enterprise, and the corresponding reduction in the holdings of the enterprise cash and cash equivalents, will be reduced. Thus, the coefficient of ΔNWC is expected to be negative. As for ΔSD, similar to the net working capital, changes in short-term liabilities could be a substitute for cash (Kling et al. 2014); thus, the coefficient of ΔSD is expected to be negative. Finally, the higher the corporate debt level (DEBT), the more funds the enterprise obtains through external financing. Thus, it does not need to withdraw cash to increase the holdings of cash and cash equivalents. The coefficient of DEBT is hence expected to be negative (Ferreira and Vilela 2004).

As there are differences in size and operating conditions between enterprises, we scale all our variables by the total assets of the enterprise, to standardize the treatment. The symbols, names, and calculation methods of each variable are shown in Table 1:

Table 1. Symbols, names, and calculation methods of variables.

	Symbol	Variable	Calculation Method
Dependent Variable	ΔCASH	Change in cash and cash equivalents	$\frac{\text{Net increase in cash and cash equivalents}}{\text{Total assets}}$
Independent Variables	CF	Operating Cash flow	$\frac{\text{Net cash flows from operating activities}}{\text{Total assets}}$
	SCF	Development degree of supply chain finance	$\frac{\text{Short term borrowings} + \text{Notes payable}}{\text{Total assets}}$
	CF × SCF	Interaction term between operating cash flow and development degree of supply chain finance	
Control Variables	SIZE	Enterprise size	$\ln(\text{Total assets})$
	TAGR	Total assets growth rate	$\frac{\text{Total assets}_t - \text{Total assets}_{t-1}}{\text{Total assets}_t}$
	ΔNWC	Change in non-cash net working capital	$\frac{(\text{Current assets} - \text{Current liabilities} - \text{Cash})_t - (\text{Current assets} - \text{Current liabilities} - \text{Cash})_{t-1}}{\text{Total assets}_t}$
	ΔSD	Change in short-term liabilities	$\frac{\text{Current liabilities}_t - \text{Current liabilities}_{t-1}}{\text{Total assets}_t}$
	DEBT	Liabilities-to-assets ratio	$\frac{\text{Total liabilities}}{\text{Total assets}}$

4. Analysis and Findings

4.1. Descriptive Statistics and Correlation Test

The descriptive statistics in Table 2 show that the mean value of the explained variable, the proportion of change in cash and cash equivalents to total assets (ΔCASH), is 1.146%. Overall, there are significant differences in the amount of cash held by different SMEs. Its minimum value is −39.488%, and its maximum value is 33.871%. As for the variables of interest, the average operating cash flow (CF) of SMEs is 4.995%, the standard deviation is 6.675%, and the standard-deviation–mean ratio is not large, at about 1.3. This shows that the change in the cash flow of the sample companies is small, but some SMEs have a negative cash flow. The mean value of the development degree of supply chain finance (SCF) is about 16.43%, and the standard deviation is 11.862%. The standard-deviation–mean ratio is also not large, at about 1.38. This shows that the supply chain finance of the enterprises is relatively stable. However, it is worth noting that the minimum value of the SCF index is 0, and there is a large gap to the maximum value, indicating that the development degree of supply chain finance among different enterprises is not balanced. For the other control variables, there is also an obvious gap between the maximum and minimum values, but their standard deviations are all within a reasonable range.

Table 2. Descriptive statistics.

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
ΔCASH	3626	0.01146	0.07796	−0.39488	0.33871
CF	3626	0.04995	0.06675	−0.31265	0.51553
SCF	3626	0.16430	0.11862	0.00000	0.76806
SIZE	3626	22.14429	1.03684	19.39899	26.69427
TAGR	3626	0.10804	0.19981	−2.00683	0.98729
ΔNWC	3626	0.06209	0.18735	−1.60270	0.73019
ΔSD	3626	0.04063	0.11733	−1.28704	0.78767
DEBT	3626	0.43930	0.17810	0.06337	2.68091

The correlation analysis results between the variables in the basic and the extended model are shown in Table 3:

Table 3. Correlation test results of variables.

	ΔCASH	CF	SCF	SIZE	TAGR	ΔNWC	ΔSD	DEBT
ΔCASH	1.000							
CF	0.204 ***	1.000						
SCF	−0.048 ***	−0.162 ***	1.000					
SIZE	0.019	−0.064 ***	0.130 ***	1.000				
TAGR	0.377 ***	0.006	−0.106 ***	0.142 ***	1.000			
ΔNWC	−0.068 ***	−0.082 ***	−0.552 ***	−0.262 ***	0.059 ***	1.000		
ΔSD	0.145 ***	−0.078 ***	0.103 ***	0.166 ***	0.679 ***	−0.139 ***	1.000	
DEBT	−0.041 ***	−0.137 ***	0.627 ***	0.381 ***	−0.072 ***	−0.666 ***	0.187 ***	1.000

Note: *, ** and *** in the table are significant at the level of 10%, 5%, and 1% respectively.

The correlation analysis results show that the correlation coefficient between the dependent variable ΔCASH and the independent variable CF is positive (0.204) and significant at the 1% level, indicating that our first hypothesis has a certain rationality. In addition, the correlation coefficient between the independent variables is small, and the absolute value of all the correlation coefficients is less than 0.7, which is usually the threshold value for indicating multicollinearity. We also performed the variance inflation factor (VIF), and the test results show that the VIF values of all variables are much lower than 10. Therefore, the problem of multicollinearity can be ruled out.

4.2. Estimation Process

Our estimation process leans on Cameron and Trivedi (2010) and Baum (2013). In order to choose between the different panel models, we first need to test for the presence of unobserved/individual specific effects. Fixed effects are tested via a Fischer (F) test, while random effects are explored via a Breusch–Pagan Lagrange multiplier (LM) test (Park 2011). Following Park (2011), the F-test settles whether fixed effects or simple pooled OLS better fits our panel data, whereas the LM test contrasts the random effects with the pooled OLS. The *p*-values of both our F test and LM test are below 0.01, indicating that both the fixed and random effects are preferred to the pooled OLS. We then performed the Hausman test, and obtained a probability value of 0.006, indicating that the preferred model is the fixed effects (FEs) model. We run the FEs model as the baseline model, and the results are shown in Table 4 (for the basic model) and Table 5 (for the extended model), respectively. However, panel data structures often contain non-spherical errors (Podestà 2016). We therefore performed the respective tests to check for heteroscedasticity, serial correlation, and cross-sectional dependence. As shown in both Table 4 (basic model) and Table 5 (extended model), the modified Wald test has the *p*-value of 0.0000, validating the presence of heteroscedasticity. Likewise, the Wooldridge test shows the *p*-value of 0.0467 in the basic model, and 0.0471 in the extended model, indicating the presence of serial correlation. We also performed the Pesaran CD test to deduce whether the errors are correlated across the companies in our sample. The test outcome has the *p*-value of 0.0221 in the basic model, and 0.0289 in the extended model, indicating that the errors exhibit cross-sectional dependency in the data. We also applied the 2SLS regression model to examine the possibility of endogeneity in the model. After obtaining the 2SLS estimates, we applied the Durbin–Wu–Hausman test to determine whether our variables of interest, i.e., the operating cash flow of enterprises (CF) and the development degree of supply chain finance (SCF) are truly endogenous. The results show that the *p*-values of the test are greater than 0.05 and, thus, the null hypothesis that our variables of interest are exogenous is accepted. Therefore, the problem of endogeneity can be ruled out.

Table 4. Regression results of the fixed effects, robust fixed effects, and panel-corrected standard errors: basic model.

Variable	Fixed Effects	Fixed Effects with Robust Standard Errors	PCSEs
CF	0.197 ***	0.197 ***	0.086 ***
	(0.0184)	(0.0180)	(0.0045)
SIZE	−0.003 **	−0.003 *	−0.006 ***
	(0.0012)	(0.0016)	(0.0010)
TAGR	0.208 ***	0.208 ***	0.074 ***
	(0.0078)	(0.0083)	(0.0019)
ΔNWC	−0.057 ***	−0.057 ***	−0.008 ***
	(0.0090)	(0.0085)	(0.0010)
ΔSD	−0.142 ***	−0.142 ***	−0.098 ***
	(0.0138)	(0.0141)	(0.0019)
DEBT	−0.006	−0.006	0.007 *
	(0.0062)	(0.0091)	(0.0039)
constant	0.060 **	0.060 **	0.017 ***
	(0.0267)	(0.0263)	(0.0036)
R-squared	0.214	0.214	0.178
Observations (N × T)	3626	3626	3626
Tests for heteroscedasticity, serial correlation, and cross-sectional dependence			
Modified Wald test		χ^2 (518) = 2883.20 Prob = 0.0000	
Wooldridge test		Prob = 0.0467	
Pesaran CD test		Prob = 0.0221	

Note: *, ** and *** in the table are significant at the level of 10%, 5%, and 1% respectively; values in parentheses are standard errors.

Table 5. Regression results of fixed effects, robust fixed effects, and panel-corrected standard errors: extended model.

Variable	Fixed Effects	Fixed Effects with Robust Standard Errors	PCSEs
CF	0.298 ***	0.298 ***	0.088 ***
	(0.0291)	(0.0286)	(0.0044)
SCF	0.025 *	0.025 *	0.006 **
	(0.0144)	(0.0142)	(0.0028)
CF × SCF	−0.636 ***	−0.636 ***	−0.207 ***
	(0.1334)	(0.1330)	(0.0184)
SIZE	−0.003 **	−0.003 *	−0.006 ***
	(0.0012)	(0.0017)	(0.0009)
TAGR	0.209 ***	0.209 ***	0.075 ***
	(0.0083)	(0.0086)	(0.0019)
ΔNWC	−0.057 ***	−0.057 ***	−0.008 ***
	(0.0087)	(0.0081)	(0.0005)
ΔSD	−0.144 ***	−0.144 ***	−0.085 ***
	(0.0141)	(0.0144)	(0.0020)
DEBT	−0.006	−0.006	0.008
	(0.0098)	(0.0121)	(0.0053)
constant	0.057 **	0.057 **	0.016 ***
	(0.0268)	(0.0259)	(0.0035)
R-squared	0.219	0.219	0.153
Observations (N × T)	3626	3626	3626
Tests for heteroscedasticity, serial correlation, and cross-sectional dependence			
Modified Wald test		χ^2 (518) = 2423.82 Prob = 0.0000	
Wooldridge test		Prob = 0.0471	
Pesaran CD test		Prob = 0.0289	

Note: *, ** and *** in the table are significant at the level of 10%, 5%, and 1% respectively; values in parentheses are standard errors.

Since our baseline FEs model contains non-spherical errors, it is unfavorable to make a comment on the parameters in this model. For this reason, we addressed the issue by adopting robust models. Firstly, we performed the FEs model with robust standard errors (hereafter known as robust FEs, which is also known as Rogers standard errors), where the robustness refers to the heteroscedasticity and serial correlation. We take note that most common panel data estimators are unable to simultaneously handle both the serial correlation and the cross-sectional dependence (Reed and Ye 2011). We thus employed Beck and Katz's (1995) panel-corrected standard errors (PCSEs) estimator. The PCSEs standard error estimate is robust not only to heteroscedasticity, but is also robust against possible cross-sectional dependence and serial correlation (Bailey and Katz 2011; Hoechle 2007; Torres-Reyna 2007). Another reason for employing the PCSEs is that our sample of 518 companies over seven years is congruent with the description by Bailey and Katz (2011) that the PCSEs is a proper estimator, and is suitable with balanced panel data where the cross-sectional observation (N) is greater than the time period observation (T): N > T (Bailey and Katz 2011; Jönsson 2005; Marques and Fuinhas 2012).

4.3. Findings

In Table 4, based on the regression results of the basic model, it can be seen that the coefficient between the operating cash flow (CF) of SMEs and the change in cash and cash equivalents of enterprises (ΔCASH) is positive (0.197) in the robust FEs regression, which is in line with our expectations, and statistically significant at the level of 1%. Likewise, the finding is also significant in the PCSEs regression, albeit with the smaller coefficient value of 0.086. In general, we find that the standard error of all the variables in the PCSEs regression

is much smaller compared to that in the robust FEs regression, and the smaller standard error thus enhances the statistical significance level of the variables in the PCSEs regression. The findings hence imply an improved inference of the PCSEs estimation (which is robust against the cross-sectional dependence), over the robust FEs estimation.

Findings from both the robust FEs and PCSEs regressions imply that China's SMEs have significant cash-to-cash-flow sensitivity, and that there is a widespread phenomenon of financing constraints; that is, our first hypothesis, H_1, is supported. Specifically, taking both the robust FEs and PCSEs estimations, the coefficient of the CF variable in the basic model is between 0.086 (from PCSEs) and 0.197 (from robust FE), which means that every unit increase in the operating cash flow indicates an average of a 0.086 to 0.197 unit increase in the sensitivity of cash holdings among the SMEs in China.

In Table 5, according to the regression results of the extended model, the coefficients of the CF variable in both the robust FEs and PCSEs regressions are significantly positive (0.298 and 0.088, respectively) at the level of 1%, and are comparable with the results in the basic model, further verifying H_1. Meanwhile, the coefficients of the interaction term (CF $\times$ SCF) are negative (-0.636 and -0.207 in robust FEs and PCSEs, respectively), are in line with our expectations, and are significant at the 1% level. The findings imply that, with the development degree of supply chain finance, the financing constraint dilemma of China's SMEs has been alleviated; that is, the development degree of supply chain finance is able to ease the problem of financing constraints for SMEs in China. Thus, hypothesis H_2 is supported. Specifically, the coefficients of -0.207 (PCSEs) and -0.636 (robust FE) indicate that every unit increase in the development degree of supply chain finance reduces the financing constraints faced by SMEs in China by an average of a 0.207 to 0.636 unit.

In addition, the robust FEs and PCSEs regression results of several control variables in both the basic and the extended model are comparable, and the coefficient signs are consistent with expectations. For example, the growth rate of the corporate total assets (TAGR) is significantly positively correlated at the level of 1%, indicating that, with the increase of corporate assets, cash holdings and cash equivalents will also increase, as we expected. The coefficients of the non-cash working capital (ΔNWC) in the robust FEs and PCSEs regressions are significantly negative at the 1% level, indicating that an increase in daily operating expenses will reduce the amount of cash held by enterprises. Similarly, the change rate of current liabilities (ΔSD) is significantly negative at the 1% level. Current liabilities, as a short-term financing method for enterprises, can be regarded as an alternative to daily cash holding by enterprises. If enterprises acquire more current liabilities, they will retain less cash and its equivalents.

4.4. Robustness Test

Outliers represent a persistent concern in empirical finance research, as their existence may potentially lead to biased coefficient estimates in least-square regressions (Edgeworth 1887; Adams et al. 2019). Specifically, the financing constraints models of investment–cash-flow sensitivity or cash–cash-flow sensitivity may be prone to outliers, and the estimation results could be driven by a few influential observations in the sample (Allayannis and Mozumdar 2004). In order to check if our findings are robust to potential outliers in our sample, including both univariate and multivariate outliers, we adopt the MM-estimator, as described in Yohai (1987), in our fixed effects regression. This outlier-robust estimator can be particularly helpful in the fixed effects panel data, as suggested by Bramati and Croux (2007). MM-estimators can provide coefficient estimates with less bias than OLS when datasets contain outliers and coefficient estimates that are similar to those provided by OLS in datasets without outliers (Adams et al. 2019). In recent years, it seems that a consensus has emerged to recommend the MM-estimator as the best-suited estimation method, with obvious advantages over the data winsorization and trimming methods (Adams et al. 2019), as it combines a high resistance to outliers and a high efficiency in regression models (Verardi and Croux 2009). The findings of our fixed effects with the MM-estimator are presented in Table 6. The coefficients of the CF variable in the basic

model, as well as the CF variable and the CF × SCF interaction term in the extended model, remain statistically significant at the 1% level. Specifically, the coefficient signs of the three variables of interest (CF, SCF, and CF × SCF) with the MM-estimator remain similar to the ones reported in the robust FEs and PCSEs regressions, meaning that their statistical significance levels also mostly remain the same. Overall, we conclude that the estimated coefficients for our variables and covariates with the MM-estimator do not exhibit any significant change, in terms of statistical significance and economic importance. There are also no drastic changes in the magnitudes and signs of the coefficient estimates of interest. In short, the robustness test implies that there is no serious outlier problem in our data and, thus, supports the findings of our earlier robust FEs and PCSEs estimations.

Table 6. Robustness test regression results—FEs with MM-estimator.

Variable	Basic Model	Extended Model
CF	0.232 ***	0.337 ***
	(0.0251)	(0.0355)
SCF		0.031 *
		(0.0166)
CF × SCF		−0.596 ***
		(0.1275)
SIZE	−0.002 *	−0.002 *
	(0.0011)	(0.0011)
TAGR	0.328 ***	0.332 ***
	(0.0132)	(0.0116)
ΔNWC	−0.083 ***	−0.079 ***
	(0.0152)	(0.0144)
ΔSD	−0.172 ***	−0.163 ***
	(0.0161)	(0.0169)
DEBT	−0.011	−0.010
	(0.0135)	(0.0125)
constant	0.072 **	0.077 **
	(0.0348)	(0.0360)
R-squared	0.095	0.088
Observations (N × T)	3626	3626

Note: *, ** and *** in the table are significant at the level of 10%, 5%, and 1% respectively; values in parentheses are standard errors.

5. Conclusions

With the large scale and rapid development of SMEs in China, the market demand for financing is increasing, and the problem of financing constraints is becoming increasingly prominent. In China, it is asserted that the emergence of supply chain finance provides the necessary scheme for the financing of SMEs, which can meet the financing characteristics of enterprises, and alleviate their financing constraints. With much of the previous research focusing only on specific financing mechanisms, there is still much to be discovered about the relationship between supply chain finance and the current financing issues of SMEs in China. In this sense, our paper investigates the role of supply chain finance development in alleviating the financing constraints of SMEs in a broader and more comprehensive way. Specifically, we employ a panel dataset of 518 listed companies on the Shenzhen Small and Medium-sized Board from 2014 to 2020 for this purpose. Using the cash–cash-flow sensitivity model, our paper shows that financing constraints are found to be significant in SMEs in China. With the sum of short-term borrowings and notes payable of enterprises taken as a measure of the development degree of supply chain finance, and an interaction term (CF × SCF) between the operating cash flow of enterprises and the degree of supply chain finance as an indication of the alleviation effect of supply chain finance on the financing constraints of enterprises, our analysis subsequently reveals that the development of supply chain finance has a significant mitigating effect on the financing constraints of enterprises.

Our findings have important implications for the stakeholders involved in the emerging markets, and there are lessons to be learned from the Chinese experience. With the positive role of supply chain finance in promoting the development of SMEs, our findings imply that enterprises, financial institutions, and governments in emerging economies should collaborate, and cooperatively promote the sustainable development and enhancement of supply chain finance in SMEs. Specifically, with the still-immature development of supply chain finance in China, as well as many other emerging economies, SMEs should enhance their cooperative reputation, establish mutual trust and close and stable relationships with core enterprises, and send signals of sound operation to the outside world. Moreover, financial institutions may increase their credit support by making full use of the credit spillover generated by the supply chain as a whole, updating the credit assessment system, and designing targeted financial products, so as to achieve the best allocation of credit funds, and fill the funding gap in SMEs, under the premise of effective risk control.

Policy-makers in emerging economies should step up their efforts to monitor the information disclosure of SMEs, with high standards and strict requirements, to promote the improvement of information asymmetry in the market. They should also actively observe market development trends, and introduce relevant support and preferential policies to help supply chain finance to develop better and faster, encourage more market participants to join the supply chain finance market, expand the scale of the supply chain finance market, and accelerate innovation in supply chain finance products. Further, government departments should pay greater attention, speed up construction, and actively guide and write legislation in order to build a good ecology that supports supply chain finance development. With the development of fintech, the authorities may play a leading role, and join hands with financial technology enterprises and banks, and other financial institutions, to establish a supply chain information platform infrastructure using blockchain technology and other technological means, and commit to integrating resources and information to help address information asymmetry and adverse selection risks and, thus, the financing needs of SMEs.

Future studies may explore supply chain finance beyond its mitigating effect on the financing constraints of SMEs; i.e., its roles and effects on the sustainable growth and innovation of SMEs in China. For comparison purposes, similar studies may also be extended to other emerging markets, and valuable lessons can be drawn from the findings.

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