

HOW DOES FINTECH DEVELOPMENT AFFECT FINANCING CONSTRAINTS OF SMES? EVIDENCE FROM CHINA

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ABSTRACT

Small and medium-sized enterprises (SMEs) play an indispensable role in China's economy through making huge contributions to GDP, national employment, financial innovation and government taxation. However, SMEs in China have long faced financing constraints due to their inherent problems, such as financial information asymmetry, immature governance mechanisms, and lack of collateral under the traditional financial system, which have hindered their long-term development. In recent years, financial technology (Fintech) has entered a rapid development track, especially in China, providing new ideas and methods for solving the financing difficulties of SMEs from a technical perspective. In order to examine this, this paper measures the degree of financing constraints through the cash flow sensitivity of cash model and explores how the Fintech development affects financing constraints of SMEs in China and how this impact further communicated to the performance and the risks of SMEs by adopting two-way fixed effects models. The results show that Fintech could alleviate the financing constraints of SMEs. Furthermore, the mediating role of ownership is identified, presenting a better mitigating effect of Fintech on the financing constraints for private SMEs. In addition, both the performance and the risks of SMEs showed the upward single-sided U-shaped relationship with the increase of the Fintech development index, which indicates that Fintech could amplify performance while magnifying the risks of SMEs. The findings of this paper offer an important implication for China that regulatory authorities should consider and balance the financing constraint mitigation effect and risk amplification effect of Fintech.

Keywords: *–Fintech, financing constraints, two-way FE model, cash flow sensitivity of cash model*

1. INTRODUCTION

The issue of financing constraints for SMEs has always been one of the hot spots of concern to the social and academic circles. In China, SMEs account for 99% of the total number of enterprises, creating nearly 60% of GDP, paying 50% of taxes, and providing 80% of jobs nationwide, which demonstrates an essential role of SMEs on promoting China's economic development (Lv, 2015; Xiao & Li, 2016). However, in recent years, the downward pressure on China's

economy has made the problem of financing constraints of SMEs more serious. The financing constraints would hinder SMEs from optimizing their investments and growing their businesses and thereby provide negative feedback on the economy (Liang & Zhang, 2018). Therefore, it is necessary to find an effective solution to alleviate the financing constraints of SMEs.

The existing literature explores solutions to SME financing constraints, mainly focusing on the role of traditional financial institutions by providing targeted loans for SMEs or enhancing the competitiveness of the banking industry to reduce the external financing costs (Yu et al, 2019; Xu & Li, 2019). However, the reality shows that traditional financial institutions have a very limited mitigation effect on the financing constraints of SMEs due to the discrimination of ownership (Dai & Cheng, 2014). The financing difficulty of SMEs is also caused by the intrinsic characteristics of SMEs (such as high business risk, high fraud risk, low-value collateral, information asymmetry, etc.) and the macro market environment (such as immature credit system, high requirements for bank risk control, limitation in venture capital, etc.) in China.

With the rapid development of information technology, the emergence of Fintech has brought the dawn of solving the problem of financing difficulties for SMEs. From a theoretical point of view, Fintech is an effective approach to mitigate the financing constraints of SMEs. The mitigating mechanism could be illustrated by three paths. First, Fintech could broaden the financing channels, such as P2P lending, crowdfunding, and customized financing options (Liu & Zhao, 2019; Abbasi, Kaleemullah, et al, 2021). Second, Fintech could reduce financing costs by adopting virtual banks and artificial intelligence to cut down the costs of operation (Wang, 2015; Li, 2015). Third, Fintech could improve financing efficiency by quickly matching the demands of financing and investing through technologies like big data analysis, cloud computing, artificial intelligence (Zhuang & Wang, 2019).

Unfortunately, there is almost no empirical study on the impact of Fintech on financing constraints of SMEs. This is because Fintech has just emerged in recent years thereby the relevant data of Fintech development is rare and hard to obtain. To fill up this research gap, this article explores how the development of Fintech is associated with the financing constraints of SMEs by using a unique Fintech development data from Ant Financial, one of the Chinese top Fintech companies, and the sample collected from 655 Chinese listed SMEs for the period 2011-2015. The reasons why the 2011-2015 data were used are as follows. First, it is very meaningful to investigate the early-stage research of Fintech in China, providing a research perspective on the early development of Fintech and making marginal contributions to the academic study. The origin of China's Fintech can be traced back to 2011, marked by the event of Alipay and Tenpay obtaining payment licenses, which led to the flourishing of P2P lending and other Fintech companies. However, in 2014, some Fintech companies, especially P2P lending companies, began to experience a series of failures and caused severe social and economic impacts, which attracted the attention of Chinese regulators. Second, the data used in this research are derived from a specialized research project conducted by a professional research team, which is composed of the Digital Finance Research Center at Peking University and China's top one Fintech company, Ant Financial Group. This ensures the high quality and reliability of the provided data. Finally, it also addresses the difficulty in obtaining early-stage development data of China's fintech industry. This article also studies the mediating role of ownership on the relationship between Fintech and financing constraints based on the cash flow sensitivity model above by group regression with two sub-groups for private SMEs and state-owned SMEs. Further, this article explores how Fintech influences the performance and the risks of SMEs.

The contributions of this article are as follows. First, it fills up the research gap on Fintech and financing constraints of SMEs by resolving the unavailability of Fintech development data. Second, it contributes to the literature on the mediating role of ownership on the relation be-

tween Fintech and financing constraints. Third, it also contributes to an emerging literature on the impact of Fintech on the performance and the risks of SMEs, which is seldom studied by scholars. Finally, this research provides policy recommendations based on the research conclusions.

2. LITERATURE REVIEW AND HYPOTHESIS GENERATION

2.1. FINANCING CONSTRAINTS AND SMES

The financing constraints of small and medium-sized enterprises are one of the key factors that restrict the development of enterprises, and it is also the hotspot of social and academic research. Scholars have explored the concept and measurement of financing constraints.

Regarding the concept of financing constraints, there is currently no uniform definition at home and abroad. [Modigliani & Miller \(1959\)](#) first mentioned the definition of non-financing constraints in MM theory, that is, in the perfect market, internal and external financing can be completely replaced, and corporate financing decisions do not affect corporate value. Further, [Carpenter et al \(1988\)](#) found that in the imperfect capital market, due to information asymmetry and agency conflicts, the external financing cost of the company will be significantly higher than the internal financing cost. This would make the company more difficult to get external capital and become more relied on its internal capital, which forms the financing constraints and hinders the development of the company ([Healy & Palepu, 2001](#); [Grossman & Hart, 1983](#)).

In terms of financing constraint measurement, there are currently two methods. The first is using a single indicator or a constraint index to measure financing constraints. Typical representatives are: dividend payout ratio, KZ index, WW index, SA index and Q index ([Chae & Lee, 2009](#); [Kaplan & Zingales, 2000](#); [Hennessy et al, 2007](#); [White & Wu, 2006](#); [Carreira & Silva, 2010](#)). The second is using the cash flow sensitivity model to observe the use of internal funds to determine whether the company has the financing constraint problem. The typical models are Investment-cash flow sensitivity model ([Fazzari et al, 1988](#)) and cash-cash flow sensitivity model ([Weisbach et al, 2004](#)).

The researchers have discussed the applicability of the above two measurement methods. The use of a single indicator may not fully measure the degree of corporate financing constraints, meanwhile since most SMEs are less likely to issue dividends which might make this indicator not suitable for measuring financing constraints ([Espallier & Guariglia, 2015](#); [Li & Luo, 2015](#)); the method by constructing constraint index usually requires strict premise assumptions (such as capital markets in developed countries), and its practicability for Chinese companies remains to be tested ([He & Ye, 2017](#); [Li & Xu, 2015](#)).

As for the cash flow sensitivity models, they also have some limitations. The cash flow sensitivity of cash could only help judge whether the company is facing financing constraints problem but cannot analyze the impact of financing constraints on corporate investment behavior and its profitability ([Qiao & Chen, 2017](#); [Li et al, 2014](#)). The cash flow model of investment also has certain limitations that are caused by the problem of principal-agent or loose financing policy ([Kaplan & Zingales, 1997](#); [Kaplan & Zingales, 2000](#)).

There are widespread financing constraints problems in small and medium-sized enterprises ([Liang & Zhang, 2018](#)). Compared with large enterprises, the intrinsic characteristics of SMEs, such as poor business performance, high operational risk, imperfect information disclosure, and poor shareholder background have made these companies not favored by investors in the capital market ([Smalbone et al, 1995](#); [Guo & Xu, 2012](#)), which leads to the inferior position in external financing and the high financing costs ([Xiao & Chen, 2017](#); [Cassar & Holmes, 2014](#)). Fintech can ease the financing constraints of SMEs by alleviating concentration and informa-

tion asymmetry in the financial sector. (Chen et al, 2023).

The financing constraints could hinder the development of the SMEs. It could affect corporate investment behavior because of the lack of capital. Due to the long-term and high-risk characteristics of R&D investment, the value of investment projects of SMEs is highly uncertain (Cai et al, 2015). Since intellectual capital generated by R&D investment is an intangible asset, its collateral value is often underestimated (Huang et al, 2006; Kamien & Schwartz, 1978; Bougheas, 2004). This makes the SMEs in a worse position to get debt financing from financial institutions compared with large companies that hold PP&Es.

Furthermore, poor information disclosure has caused investors to distrust SMEs. The SMEs usually use their investment projects as business secrets and be very cautious in disclosing R&D information to prevent plagiarism, which exacerbates the information asymmetry between companies and fund providers (Li, 2016). Other than that, since the Chinese national credit system is not yet completely built, the operation situations and authenticity of financials of some SMEs are difficult to check, which increases the transaction cost of capital suppliers and hinders corporate financing (Zhu et al, 2018; Ye et al, 2017).

2. 2. FINTECH: THE SAVIOR OF SME FINANCING CONSTRAINTS?

Fintech, also known as Fintech, refers to the technologies used innovatively to better provide more convenient and low-cost financial products and services. Scholars have explored the definition, role, applications and measurement methods of Fintech (Jourdan et al, 2023).

According to the Financial Stability Board (FSB), Fintech mainly refers to a cutting-edge technology based on big data, blockchain, cloud computing, artificial intelligence, etc., which has a significant positive impact on financial markets and financial services business supply. Arner et al. (2015) pointed out that Fintech is a modern financing technology, and it is an efficient solution for enabling finance based on technology. Aghion et al (2004) suggest that technological advances will greatly reduce transaction costs and improve information asymmetry, drive changes in the financial structure, and significantly improve the efficiency of the financial system. Alt & Puschmann (2012) believes that the emergence of Fintech is mainly due to the occurrence of the financial crisis, innovation in information technology and changes in consumer behavior.

With regard to the role of Fintech, Fintech could enhance the ability of financial services relying on the advantages of digital technology (Yin et al, 2019); it could break the limitations of traditional financial services, enhance the accessibility of financial services, and promote financial services transferring to the tail customer group (Li & Zhang, 2018); it can also effectively alleviate information asymmetry by using big data analysis, blockchain and other technologies to enhance financial risk identification capabilities, thereby effectively controlling lending risks, reducing market transaction costs, and improving financial service efficiency (Liu et al, 2018).

Other scholars have studied the application of Fintech in the field of regulation, and the concept of “regulatory sandbox” is very eye-catching (Liu & Liu, 2019; Li, 2018). The “Regulatory Sandbox” provides a “reduced version” of the real market and a “loose version” of the regulatory environment, encouraging FinTech start-ups to boldly innovate products, services, business models and delivery mechanisms while protecting consumers’ rights (Zetzsche et al, 2018). Sun (2017) argued that Fintech development will spawn a “regulatory sandbox” and transform the regulatory model. Chang-Hsien & Peng (2017) pointed out that the essence of “supervised sandbox” is to provide a safe testing environment to better protect the interests of consumers.

The measurement of the development of Fintech is an academic problem. Most scholars have used some variables or Fintech related industrial index systems to proxy the development of

Fintech due to the complicated evaluation dimension of Fintech development and the difficulty in obtaining relevant data. For instance, [Zhu & Gao \(2018\)](#) used the “scale of third-party Internet payment services” as a proxy variable to measure the development of Internet finance. [Guo & Shen \(2015\)](#) used the word extraction method and search engine to obtain keywords related to Fintech, extracted the core keywords that can represent Fintech through factor analysis, and constructed a Fintech development index based on the analysis results. The index system includes five dimensions: payment clearing, loan financing, wealth management, channel business and technical support. Other scholars also measured Fintech development in the perspectives of financial services availability, financial exclusion, or tried to build index systems to measure Fintech development ([Beck et al, 2007](#); [Sun & Li, 2011](#); [Sarma & Pais, 2011](#)).

2. 3. THE EFFECT OF FINTECH ON FINANCING CONSTRAINTS

Few studies explore the effect of Fintech on easing financing constraints. From a theoretical point of view, Fintech is an effective approach to mitigate the financing constraints of SMEs. This might be the savior for mitigating financing constraints of SMEs. The mitigating mechanism could be illustrated by three paths.

First, Fintech could broaden the financing channels. Due to the poor credit quality, the SMEs are often rejected by some traditional large financial institutions for the financing application. While banks are more willing to lend funds to large companies with abundant collaterals ([Wang, 2003](#); [Guo, 2013](#); [Lv, 2015](#)). Fintech could provide various financing services, such as P2P lending, crowdfunding and customized financing options, which successfully breaks the limitations of traditional financial services ([Liu & Zhao, 2019](#); [Abbasi et al., 2021](#)).

Second, Fintech could reduce financing costs. Traditional financial institutions often conduct strict credit reviews of SMEs, resulting in substantial review fees. These financial institutions usually raise interest rates on debt financing to get compensation for suffering a higher risk ([Wang, 2015](#)). Also, the business outlets and labor services on which financial services provided by traditional financial institutions are more costly than virtual banks ([Li, 2015](#)).

The emergence of Fintech companies has changed the delivery mode of traditional financial services and therefore has significantly reduced the operating costs. For example, SMEs can implement credit loans through the Internet, using artificial intelligence and intelligent algorithms to conduct credit reviews efficiently and automatically, resulting in significant cost reductions for labor and other services ([Anstead & Nick, 2008](#)). According to data released by Ant Financial, the cost of cloud computing is only one-tenth of the cost of traditional IT services ([Song, 2017](#)). Besides, applying big data technology to risk analysis and early warning systems could give full play to the risk control function of Fintech, which effectively reduces information asymmetry, financial risk, transaction costs, and the external financing costs of SMEs.

Third, Fintech could improve financing efficiency. Compared with traditional finance, Fintech firms can quickly and timely and efficiently mine and collect customer credit data through big data, cloud computing, blockchain, artificial intelligence and other technologies to fully understand the business conditions and credit of SMEs. Based on the above data, it provides customized financing products or financing combinations based on the actual situation of the enterprise, thereby improving the optimal allocation of borrowing funds and financial service quality ([Wang & Zhao, 2019](#); [Zhuang & Wang, 2019](#); [Boustani, 2020](#)).

To summarize, there are few studies on the relationship between Fintech and financing constraints of SMEs. From the theoretical analysis, Fintech could alleviate the financing constraints of SMEs by broadening financing channels, reducing financing costs, and improving financing efficiency. Few empirical studies were conducted because of the unavailability of Fintech de-

velopment data.

Based on the analysis above, the Hypothesis 1 is proposed as follows.

H1: *The development of Fintech could alleviate the financing constraints of small and medium-sized enterprises.*

2. 4. OWNERSHIP AS A MODERATING VARIABLE

Financing constraints are influenced by the nature of ownership (Yu et al, 2019; Xu & Li, 2019). China's special institutional background and financial market environment make the Chinese government still play a major role in resource allocation. In the traditional financial market, the nature of the actual controller and the background of political relations are crucial for enterprises to obtain financing support. Private SMEs often face serious "discrimination of ownership" in the financing process (Liang & Zhang, 2018).

This article believes that the development of Fintech has a better mitigating effect on the financing constraints of non-state-owned SMEs, compared with state-owned SMEs. The reasons are as follows.

First, the problem of information asymmetry in private SMEs is more serious than that of state-owned SMEs. Compared with state-owned SMEs, private SMEs have low financial status and information transparency, and their credibility is relatively poor. Fintech could mine and collect customer credit data in a timely, rapid and efficient manner, and reduce the information asymmetry especially for private SMEs (Liang & Zhang, 2018).

Second, private SMEs have lower requirements for financing demand than state-owned SMEs. Fintech is competitive in providing flexible and convenient financing services with a small number of funds. While the credit funds provided by traditional financial institutions are usually large, and these funds are difficult to lend to private SMEs because these institutions have strict requirements on the firm size, profitability and value of collaterals (Yu & Pan, 2008).

Third, private SMEs face serious "discrimination of ownership", which makes it difficult to obtain financial support in traditional financial markets. Meanwhile, this also enhances their willingness to seek alternative financial supports through online finance and Fintech channels. Therefore, the mitigation effect of Fintech on financing constraints for private SMEs should be more obvious than state-owned SMEs (Dai & Cheng, 2014; Najaf et al, 2024).

In summary, the problem of "ownership discrimination" caused by China's special political system has made private SMEs face more serious financing constraints, but it has made it more flexible in financial choices. Therefore, we have reason to believe that, compared with small and medium-sized enterprises with the political background or controlled by the Chinese government, the mitigation effect of Fintech on the financing constraints of private SMEs is more significant. Hypothesis 2 is generated as follows.

H2: *Compared with state-owned SMEs, the development of Fintech has a better mitigating effect on the financing constraints of non-state-owned SMEs.*

2. 5. THE EFFECT OF FINTECH ON PERFORMANCE AND RISK OF SMES

Based on the mitigation effect of Fintech on corporate financing constraints in theory, this article further explores the impact of Fintech on corporate performance and corporate risk of SMEs. The existing literature has seldom studied the influence of Fintech on corporate performance or corporate risk.

However, the relationship between financing constraints and corporate performance has been explored, which shows a negative sign. This is because the financing constraints have made the firm less capable to invest in good investment projects due to the limit of the capital. Campello

et al (2011) found that the decrease in the compensation of R&D personnel harm corporate performance. Fintech alleviates firms' financing constraints and reduces firms' financing costs (Chen & Yoon, 2021). Lyu et al (2023) found that Fintech has a significant mitigation effect on corporate financing constraints, and the coverage capability of Fintech has a stronger mitigation effect compared to the depth of use. Ruohan & Bing (2023) found that Fintech makes corporate investments more efficient and that this beneficial impact is long-term; as fintech develops, it plays a greater role in increasing corporate investment efficiency.

Fintech might be a great catalyst for promoting business performance. From the perspective of theoretical analysis, Fintech could alleviate the financing constraints of SMEs, which could improve the financing capacity of enterprises, promote business activities and corporate R&D investment, and thus improve corporate performance (Wachira, 2016). Therefore, this article argues that the development of Fintech could increase the performance of SMEs.

According to Metcalfe's law of network economics, the accumulation of social idle capital based on Fintech will grow quadratic with the increase in the number of users participating in the entire Fintech system (Hendler & Golbeck, 2008; Gao et al, 2017; Hai et al, 2022). The development of Fintech will make the accumulation of idle capital in the society show an arithmetic progression and bring a large amount of low-cost external funds to SMEs. This accelerating increase in the supply of external capital could significantly reduce the financing costs of SMEs by an accelerating way with the development of Fintech. When SMEs have enough accelerating low-cost external capital, they will increase investment and expand their scales, thereby improving their performance. Because of the strong network externalities in the development of Fintech, this article proposed Hypothesis 3 as follows.

H3: *The effect of Fintech on the business performance of SMEs is marginal increasing, that is, there is a U-shaped relationship between the development of Fintech and the performance of SMEs.*

Due to the poor data availability of Fintech, there is little empirical research in the existing literature to explore the relationship between Fintech development and corporate risk. However, some scholars have conducted empirical research on the relationship between Internet finance and corporate risk (Guo et al, 2023).

The typical findings are as follows. Zhu & Chen (2016) found that Internet finance could increase the efficiency of the resources allocation and reduce the concentration of the risk, however, they also found that Internet finance could make the risk of traditional financial institutions more secluded, meanwhile, the risk of operation and information technology would be more outstanding. Wang et al (2017) looked at the relationship between Internet finance and risk of the banking system and found that the relationship between them is like the reverse "U" trend. Peng et al (2016) studied the relationship between Internet finance development and the risk of the banking system and found the opposite evidence that the relationship is like the "U" trend. They explained that, in the early stage, the Internet finance could reduce the management fee of banks and reduce the risk, however, when it enters to the mature stage, the Internet finance would raise the cost of capital to gain more profits, therefore it increases the risk of the banking system. Yang (2017) argues that applications like big data mining could enhance the risk control capacity of the finance industry and provide a positive utility to the development of real economy. It is also investigated that fintech effectively facilitates the banking sector's credit supply to SMEs (Sheng, 2021) and contributes to the improvement of private enterprises' financing situation by enhancing the risk control in bank loans (Lv & Xiong, 2022). Sampat et al (2024) focuses on understanding FinTech developers' perspective of the dark side of FinTech by conducting a qualitative enquiry research. Hu et al (2024) conducted empirical research and the results support the theoretical outcome that the synergy between Fintech and traditional finance

has indeed effectively reduced commercial banks' risk-taking.

This article believes that the relationship between Fintech development and the risks of SMEs is quadratic and like the shape of reverse "U". In the early stage of Fintech development, due to the lack of industry norms, Fintech would increase the risk of SMEs; However, in the mature stage, due to the cumulative effect and network effect, the large amount of valuable data could be used as an effective tool to provide risk control services by Fintech companies and thereby reduce the risks of SMEs. Based on the analysis above, Hypothesis 4 was proposed as follows.

H4: *The relationship between Fintech and corporate risk is quadratic, like the shape of the reverse "U".*

3. RESEARCH DESIGN

3. 1. SAMPLE AND DATA

This article takes China's listed small-and-medium size companies from 2011 to 2015 as research samples and screens them according to the following criteria: (1) excluding financial and insurance listed companies because they are out of the purpose of financing constraints for SMEs; (2) excluding companies with abnormal total assets or total revenue during the study period; (3) excluding companies with missing data. We finally got 655 companies. All the firm-specific data comes from the CSMAR database and the Fintech development data is from a report by Peking University Digital Finance Research Center and Ant Financial Research Group.

The data collection and processing procedures are: download the corresponding variable data from the database - calculate the value of the variable that cannot be acquired directly in Excel - organize the panel data and include it in the csv file - import the csv file into Stata then conduct the do file.

In order to alleviate the influence of extreme values on the research conclusions, this article performs 1% winsorization on continuous variables. To overcome the potential endogenous problems, the control variables followed by previous scholars would be included.

3. 2. DEFINITION AND MEASUREMENT OF VARIABLES

3. 2. 1. DEPENDENT VARIABLES

The dependent variables involve three aspects: one is the change of cash holdings, the second is corporate performance (ROA), and the third is the corporate risk.

First, this article uses the cash flow sensitivity of cash to observe whether the change of the cash holdings of SMEs significantly depends on their operating cash flows so as to find out whether the SMEs have financing constraints (Qiao & Chen, 2017; Li et al, 2014). Further, the interaction term between Fintech and cash flows is introduced to study the mitigation effect of Fintech development on financing constraints. The change of cash holdings (ΔCash) is calculated by

$$\frac{\text{Cash Holding}_t - \text{Cash Holding}_{t-1}}{\text{Total Assets}_t}$$

Second, ROA is used as a proxy variable for corporate performance to study the relationship between corporate performance and Fintech (Hendler & Golbeck, 2008; Gao et al, 2017). The ROA calculation method is

$$ROA_t = \frac{\text{Net Income}_t}{\text{Total Asset}_t}$$

Finally, the three-year standard deviation of ROA ($\sigma(\text{ROA})$) is used as a proxy variable for corporate risk to study the relationship between Fintech and corporate risk (Pi et al, 2018; Wang et al, 2018). The $\sigma(\text{ROA})$ is calculated by

$$\sigma(\text{ROA}) = \sqrt{\frac{\sum_{i=1}^{N=3} (\text{ROA}_i - \overline{\text{ROA}})^2}{N-1}}$$

3. 2. 2. KEY REGRESSORS

(1) Fintech development index (FDI)

In July 2016, the Digital Finance Research Center of Peking University announced the China Digital Inclusive Financial Index (Qiu et al, 2018), which used the underlying data of Ant Financial's trading account. It portrays the level of China's Fintech development from multiple dimensions. Ant Financial is one of the most influential Fintech companies in China. The most widely used third-party payment application Alipay and the world's largest money fund Yu'eobao are the most well-known products of Ant Financial. The company has put lots of capital to research the application of big data analysis, AI, blockchain, etc, and holds plenty of Fintech-related investment projects.

Table 3.1 shows the dimensions and indicators of the Fintech development index. The indicator system consists of three dimensions, coverage of Fintech services, depth of use and digital support services. The weight of each dimension and indicator is calculated by AHP (Qiu et al, 2018).

Table 3.1. Fintech development Index

First Dimension	Second Dimension	Specific Indicators
Coverage breadth	Account coverage	The number of Alipay accounts per 10,000 people
		The ratio of users who tied bank cards to the corresponding Alipay account
		The average number of bank cards per Alipay account
Use depth	Payment service	Number of payments per capita
		Amount of payments per capita
		Number of high-frequency active users who made more than 50 payments over a year
	Credit loan service-Individuals	Number of users who have consumer loans per 10,000 Alipay adult users
		Number of loans per capita
		Loan amount per capita
	Credit loan service-SMEs	Number of users with SME loans per 10,000 Alipay adult users
		Number of loans per SME operator
		Number of loans per SME operator
	Insurance service	Number of users who purchase insurance per 10,000 Alipay users
		Number of insurance orders per capita
		Insurance amount per capita
	Investment service	Number of people who purchase investment products per 10,000 Alipay users
		Number of investment orders per capita
		Investment amount per capita
	Credit information service	The number of people who use credit-based living services per 10,000 Alipay users (including finance, accommodation, travel, social, etc.)
		The number of times a natural person's credit history is called
Digital support service level	Convenience	The proportion of mobile payment orders relative to all payment orders
		The proportion of mobile payment amount relative to all payment amount
	Financial service cost	Average lending rate of SME operators
		Average loan interest rate of individuals

Source: the Digital Finance Research Center of Peking University, Organized by authors

(2) Cash Flow (CF)

Cash flow is another key regressor in this research. The coefficient of the cash flow stands for the cash flow sensitivity which could provide evidence of the existence of the financing constraints. Refer to Xiao & Liu (2019), the operating cash flow was used in the regression model instead of using the EBITDA scaled by total assets (Weisbach et al, 2004). Since the Chinese capital market is not mature, some problems like window-dressing, financial fraud still exist. This article would take operating cash flow as the proxy for cash flow because the operating cash flow is more difficult for manipulating than the EBITDA. The operating cash flow calculation method is Operating Cash Flow=Net Income + Non-Cash Expenses – Changes in Operating Working Capital. It could be checked through finance database from the audited cash flow sheet.

(3) State Ownership (Ownership)

This article would use 5% state-owned shares to total shares as the criteria for distinguishing whether it is a state-owned enterprise (SOE). The reasons are as follows: (1) The China Securities Law considers shareholders holding more than 5% of shares to be the major shareholders. The law believes that the major shareholder has a certain influence on the company's business decisions; (2) SMEs with a state holding more than 5% can be regarded as having a certain government background, and the firm is likely to receive preferential policies, such as government subsidies, priority loan qualifications, etc. The state ownership is calculated by

$$\frac{\text{The Number of State-owned share}_i}{\text{Total number of shares}_i}$$

3. 2. 3. CONTROL VARIABLES

In terms of corporate characteristics, the article controls the following variables, including net working capital, short-term debt, capital expend, business growth, leverage, firm size, etc.

Meanwhile, the individual effect and the time effect are also controlled by using the two-way fixed effect model. The reasons why the control variables are selected and why the two-way fixed effect model is determined would be discussed in the section 3.3 Regression Model Setting.

Table 3.2 was designed to show the definition and measurements of variables.

Table 3.2. Definition of Variables

Variable Mean	Symbol	Definition
Delta Cash Holdings	ΔCash	The change of the cash holdings/total assets
Performance	ROA	return on asset
Corporate Risk	$\sigma(\text{ROA})$	Three-year standard deviation of ROA
Fintech Development Index	FDI	the higher the value, the better the development of Fintech
Cash Flow	CF	operating cash flow/total assets
Ownership	Ownership	state-owned shares/total shares
Delta Net Working Capital	ΔNWC	The change of the net working capitals/total assets
Delta Short-term Debt	ΔSD	The change of the short-term debts/total assets
Capital Expenditure	Expend	capital expenditures/total assets
Business Growth	Growth	one-year growth rate of total assets
Leverage	Leverage	total liabilities/total assets
Firm Size	TA	total assets

Source: Organized by authors

3. 3. EMPIRICAL MODELS

The Hausman test was conducted to help determine whether to choose a fixed effect model (FE model) or a random effects model (RE model). The test results show that the p-value is 0.000, so the null hypothesis H_0 is rejected, that is, the fixed effect model should be used. Due to the length of space, this article does not report the results of the Hausman test. Controlling the individual effect might not be enough for this research because the time effect cannot be ignored especially for the research related to finance. This neglect could lead to biased estimations (Liu et al, 2011).

Based on the analysis above, this article would adopt the two-way FE model which fully considers the individual effects and time effects so as to get more accurate estimations.

In terms of model selection, this article would use the cash flow sensitivity of cash model to analyze the status of corporate financing constraints as the applicability of the cash-cash flow sensitivity model has been confirmed in Chinese academic research (Zou & Ling, 2018; Liang & Zhang, 2018; Yao et al, 2017). The cash-cash flow sensitivity model believes that the company which has financing constraints problem would significantly rely on its internal capital for its expenditures and therefore reveals a significant positive cash flow sensitivity of cash (Weisbach et al, 2004).

The reason why this article does not adopt the investment-cash flow sensitivity model is that the model has certain limitations, which are concerned with agent problem and financial distress (Kaplan & Zingales, 1997; Kaplan & Zingales, 2000). The non-linear relationship between financing constraints and cash flow sensitivity of investment was found, which made it not an ideal method for observing the alleviating effect of Fintech on financing constraints.

Further, researches also found some fallacies of cash flow sensitivity of investment. For instance, the agent problem could lead to high cash flow sensitivity when the firm is of low financing constraints. Evidence shows low cash flow sensitivity of investment when the firm is facing financial distress, which totally conflicts with the actual situation of high financing constraints.

In order to test hypothesis 1 and study whether Fintech could alleviate the financing constraints of SMEs in China, model (1) was proposed as follows. The model follows the cash flow sensitivity of cash analysis framework proposed by Weisbach et al (2004), and introduces the Fintech development index (FDI false) and the interaction term between cash flows and Fintech development index ($CF \times FDI$ false), referring to Khurana et al (2005).

$$\begin{aligned} \Delta Cash_{it} = & \alpha_0 + \alpha_1 CF_{it} + \alpha_2 FDI_{it} + \alpha_3 CF_{it} \times FDI_{it} + \alpha_4 \Delta NWC_{it} + \alpha_5 \Delta SD_{it} \\ & + \alpha_6 Expend_{it} + \delta_i + \varepsilon_{it} \end{aligned} \quad (1)$$

In model (1), i stands for the sequence of the company, t stands for the time. The coefficient of the interaction term (α_3) is expected to be significantly negative, which indicates that Fintech development could alleviate financing constraints of SMEs in China. As the cash flow sensitivity of cash theory states, the use of the cash should rely on internal capital. Therefore, the coefficient of cash flow (α_1) should be significantly positive. In terms of the coefficient of the Fintech development index (α_2), it could be zero since no theory supports that Fintech could directly influence the use of the cash holdings. It could also be positive because the development of Fintech could bring more funds which also increases the use of the cash holdings.

The control variables are included in model (1) based on the literature of Weisbach et al (2004). The coefficients of delta net working capital and delta short-term debt (α_4 and α_5) are expected to be positive because the increase of net working capital and short-term debt would increase the cash holdings of the firm. The coefficient of capital expenditure (α_6) should be negative

because the capital expenditure would decrease the cash holdings. The firm size is controlled by the log of total assets for the cash-related variables, such as cash holdings, cash flows, net working capital, short-term debt, capital expenditures. Therefore, it is not necessary to include the log of total assets as the control variable. The δ_i stands for the year dummy variables.

To test hypothesis 2, group regression was conducted. The variable called ownership was introduced to divide the sample into two groups, based on whether the ownership is greater than a certain level. Due to the sample limit¹, this article would take 5% ownership as a group basis. According to the group basis, the group that is of less than 5% ownership is defined as the non-state-owned enterprise group (or Private SMEs group), and the other is defined as the state-owned enterprise group (or State-owned SMEs group).

Based on the analysis above, this article would use the model (1) for group regression to compare the size of the coefficient (α_3) of the interaction term ($CF_{it} \times FDI_{it}$). If hypothesis 2 is established, the absolute value of the coefficient of the non-state-owned enterprise group should be greater than the absolute value of the coefficient of the state-owned enterprise group.

Model (3) was proposed to test Hypothesis 3 and examines the non-linear relationship between Fintech development and the performance of SMEs.

$$ROA_{it} = \delta_0 + \delta_1 FDI_{it} + \delta_2 FDI_{it}^2 + \delta_3 Growth_{it} + \delta_4 Leverage_{it} + \delta_5 LnTA_{it} + \delta_6 ROA_{i,t-1} + \delta_i + \varepsilon_{it} \quad (3)$$

Model (3) includes growth, leverage, the log of total assets and the lag one phase of ROA as the control variables given the reason that they would influence the performance of SMEs. If δ_1 is significantly positive, it means that Hypothesis 3 holds, indicating that there is a U-shaped relationship between Fintech development index and performance of SMEs. The coefficient of the Fintech development index (δ_1) would influence the turning point of this quadratic relationship.

In terms of control variables, the coefficient of the Growth is expected to be positive since the increase of the business growth should bring more revenue to the firm which increases corporate performance (Shen & Zhang, 2018). In terms of leverage, the coefficient of leverage should be negative because the performance of SMEs would decrease with the upwards financing costs of SMEs which is caused by the increase of leverage (Shen & Zhang, 2018). The coefficient of the firm size could be positive, negative or even zero given the different evidence were found by empirical analysis (Dong et al, 2017). The lag one phase of ROA is added to mitigate endogeneity problems for the variables that might be omitted (Yin et al, 2014). This should be significantly related to the dependent variable.

Model (4) aims to test Hypothesis 4 and examines the reverse U-shaped relationship between Fintech development and the risks of SMEs.

$$\sigma_{it}(ROA) = \lambda_0 + \lambda_1 FDI_{it} + \lambda_2 FDI_{it}^2 + \lambda_3 Growth_{it} + \lambda_4 Leverage_{it} + \lambda_5 LnTA_{it} + \lambda_6 \sigma_{i,t-1}(ROA) + \delta_i + \varepsilon_{it} \quad (4)$$

If Hypothesis 4 is established, the coefficient of the quadratic term of Fintech development index (λ_2) should be negative and significant. The coefficient of the Fintech development index (λ_1) would influence the turning point of this quadratic relationship as well.

Referring to the study of Yang & Wang (2019), this article controls the business growth, leverage and log of firm size. This is because: (1) The coefficient of Growth is expected to be positive because the higher business growth means the higher volatility of the business operation, this is particularly apparent for SMEs; (2) The leverage should be positively associated with the volatility of performance of SMEs since the increase of leverage would worsen the financing con-

¹Only 15 out of 655 companies have the state-owned shares over 50%, and this might cause inaccurate regression results.

straints of SMEs and increase their financing costs; (3) The larger the size of the firm could reduce the corporate risks given that more valuable collaterals could be used to defend the uncertainty. In addition, the similar treatment is adopted by adding the lag one phase of the dependent variable ($\sigma_{i,t-1}(ROA)$) to mitigate the potentially omitted variable biases.

4. REGRESSION ANALYSIS AND DISCUSSION

4. 1. DESCRIPTIVE STATISTICS

Table 4.1 presents descriptive statistics for the main variables. It can be seen that:

- (1) The average value of $\Delta Cash$ is -0.0179, the minimum value is -0.3863, and the maximum value is 0.7080, which indicates that there is a certain degree of fluctuation in the change of cash holdings of SMEs;
- (2) The average value of ROA is 0.0465, which means the average of ROA is 4.65%;
- (3) The standard deviation of ROA's three-year volatility is 0.2472, which indicates that the performance of SMEs is relatively volatile;
- (4) The standard deviation of core variable FDI is 0.4067, which indicates that the difference in Fintech development level among different provinces in China is huge;
- (5) The mean value of the core variable CF is 0.0456, the minimum value is -0.3573, and the maximum value is 0.4077, which indicates that there is a certain difference in the operating cash flow of SMEs;
- (6) The average value of Ownership is 0.0193, which means that the proportion of state-owned shares held by SMEs is generally low, and the mean can be used as the basis for the classification of robustness test;
- (7) For the control variables, no abnormal data was found in the descriptive statistics.

In addition, some outliers (FDI or Growth) may affect the regression results, therefore the treatment with 1% winsorization for all the continuous variables is appropriate.

Table 4.1. Descriptive Statistics

Variable	Mean	Medium	SD	Min	Max
$\Delta Cash$	-0.0179	-0.0127	0.0900	-0.3863	0.7080
ROA	0.0465	0.0415	0.0608	-0.3992	0.9644
$\sigma(ROA)$	0.3755	0.2900	0.2472	0.1000	0.9900
FDI	1.6603	1.7382	0.4067	0.6147	2.3953
CF	0.0456	0.0456	0.0711	-0.3573	0.4077
Ownership	0.0193	0.0000	0.0863	0.0000	0.8303
ΔNWC	-0.0028	-0.0078	0.1222	-0.4389	0.7922
ΔSD	0.0454	0.0381	0.1064	-1.5129	0.6313
Expend	0.0655	0.0521	0.0569	-0.2949	0.3572
Growth	0.2039	0.1085	0.7260	-0.6755	22.3954
Leverage	0.3715	0.3543	0.1944	0.0080	0.9526
TA	4.42E+09	2.21E+09	1.93E+10	1.19E+08	5.54E+11

Source: Calculated by authors

4. 2. CORRELATION MATRIX

Table 4.2 describes the correlation coefficients among variables. All correlation coefficients are less than 0.8, which indicates that there is no serious multicollinearity among the variables. Fur-

thermore, the correlation coefficient between ROA and Growth is 0.7870, which is relatively high compared to other variables but still does not exceed 0.8. The possible reason is that the profitability and growth of a company are positively correlated, which has a certain rationality. The correlation coefficients between other variables are all less than 0.5, indicating that the variables selected this time are independent of each other, and are therefore less likely to influence each other to cause biased estimation of the regression coefficients, thereby enhancing the robustness of the empirical model.

Table 4.2. Descriptive Statistics

	Δ Cash	ROA	σ (ROA)	FDI	CF	Ownership	Δ NWC	Δ SD	Expend	Growth	Leverage	TA
Δ Cash	1.0000											
ROA	0.0956	1.0000										
σ (ROA)	-0.0071	-0.0203	1.0000									
FDI	0.0412	0.0136	0.0508	1.0000								
CF	0.1723	0.3250	0.0021	0.0222	1.0000							
Ownership	0.0382	0.0042	0.0219	-0.1387	-0.0111	1.0000						
Δ NWC	0.5171	0.3477	-0.0123	0.1084	-0.0157	0.0440	1.0000					
Δ SD	0.0560	-0.0267	-0.0004	-0.0390	-0.1580	0.0276	-0.3857	1.0000				
Expend	-0.1890	0.0580	-0.0292	-0.1684	0.1150	0.0013	-0.3315	0.1483	1.0000			
Growth	0.1521	0.7870	-0.0395	0.0044	-0.0711	0.1120	0.1124	0.3105	0.0515	1.0000		
Leverage	0.1599	-0.3249	0.0463	0.0171	-0.2196	0.0493	-0.0479	0.2582	-0.0465	0.0684	1.0000	
TA	0.0319	-0.0239	0.0561	0.0420	0.0036	0.0202	0.0111	0.0174	-0.0488	0.0303	0.2214	1.0000

Source: Calculated by authors

4. 3. REGRESSION RESULTS AND ANALYSIS

4. 3. 1. HOW DOES FINTECH AFFECT THE FINANCING CONSTRAINTS OF SMES IN CHINA?

Table 4.3 Model 1 describes how Fintech affects the financing constraints of SMEs in China. In particular, the coefficient on the interaction between Fintech development and cash flows (α_3) equals to -0.126 which is significant at 1% significant level. This indicates that the development of Fintech could reduce the cash flow sensitivity of cash, which means that SMEs become less dependent on their internal capital with the increase of the Fintech development. In other words, Fintech could alleviate financing constraints of SMEs in China. This is possible that the development of Fintech has broadened the financing channels by employing P2P lending, crowdfunding and customized financing products provided by Fintech companies. With more channels of financing, the SMEs are more likely to get external capital which reduces the dependence on internal funds. At the same time, Fintech could reduce the financing costs and shorten the loan waiting for approval by using the virtual banks which are free from the limit of time and space.

The coefficient of cash flows is significantly positive (equals to 0.653) at 1% level, which indicates that SMEs in China are facing financing constraints. This finding is consistent with the researches of [Guo & Xu \(2012\)](#) and [Liang & Zhang \(2018\)](#). The financing constraints of SMEs in China might be caused by their intrinsic characteristics, such as imperfect information disclosure, poor corporate governance structure, high volatility in business operation and poor shareholder background. All these lead to a high expected return of investor for lending funds to SMEs, which increases the financing costs for external financing of SMEs. Another possible reason for the severe financing constraints faced by SMEs in China could be the discrimination

of ownership which would be discussed in the regression results of Model 2.

Apart from that, no evidence is found that the development of Fintech could directly affect the use of the cash holdings. As for the coefficients of control variables, the coefficients of net working capital and short-term debt (α_4 and α_5) are both significantly positive as expected, indicating that the increase of net working capital and short-term debt would increase the cash holdings of the firm. The coefficient of capital expenditure (α_6) is significantly negative (equals to -0.188) as expected, showing the increase of capital expenditure would consume the cash holdings.

4.3.2. THE MODERATING ROLE OF OWNERSHIP

Table 4.3 Model 2 (both 2H and 2L) show how ownership makes a difference in the effect of Fintech on financing constraints. Model 2H stands for the regression results of state-owned SMEs and Model 2L represents the results of non-state-owned SMEs.

The hypothesis 2 is established because the coefficient of the interaction term between Fintech development and cash flows (α_3) for non-state-owned SMEs is significantly negative (equals to -0.0827) at 5% level while that for state-owned SMEs is insignificant. This means that the development of Fintech could alleviate the financing constraints of Private SMEs (or non-state-owned SMEs), however, it has nothing to do with the financing constraints of state-owned SMEs. There might be three possible reasons for causing this phenomenon.

First, the information asymmetry of private SMEs might be improved by Fintech, especially for information disclosure in the process of external financing. For example, the crowdfunding platform would acquire firms to disclose detailed information about the investment projects so that the investors would have more information to make the investment decision. It is also possible that in the future the artificial intelligence could automatically collect all the relevant information (like tax information, financial information, major lawsuits, etc.) about SMEs so as to audit the authenticity of financial statements, analyze the feasibility of corporate finance, and recommend personalized financing products for them.

Second, the funds provided by Fintech might be more appropriate for private SMEs because Fintech is competitive in providing flexible and convenient financing services with a small number of funds, which is what SMEs demand. However, Fintech might be restricted for the state-owned SMEs due to the rules and regulations of SOEs or risk control requirement of Chinese government (Yu Et al, 2019). For instance, the regulation might require that the state-owned SMEs could only borrow from financial institutions who are well-qualified and hold the licenses. This might prevent the state-owned SMEs from using the financing products from Fintech companies.

Third, the discrimination of ownership could also explain why Fintech could alleviate the financing constraints of Private SMEs but not for state-owned SMEs (Bin & Liu, 2002; Zhang, 2009). In China, state-owned property rights and political relations are important credit substitution mechanisms in the process of external financing. This discrimination makes the state-owned SMEs easier to get credit loans with low financing costs from traditional financial institutions, which reduces the motivation of state-owned SMEs to use Fintech².

However, the discrimination of ownership leads to a disadvantaged position in the capital market for private SMEs because no guarantee or promise would be made by the nation or the

² Due to space limitations, this paper does not go further on the mitigation effect of traditional financial development on the financing constraints of state-owned enterprises. However, this is in line with the research topic of this paper since the focus of this research is about Fintech. If you are interested in this, you can use the similar technique as what this paper does to construct a traditional financial development index and introduce it into the cash flow sensitivity of cash model to test the mitigation effect.

government when the firm goes bankrupt. In this context, the private SMEs are less likely to get low-cost financing from traditional financial institutions. Therefore, they feel desperate to find more financing channels through Fintech.

As for the significance of the coefficients of other variables, most results are consistent with the results of Model 1 except for the coefficient of capital expenditure in Model 2H and the coefficient of the Fintech development index in Model 2L.

The former might be caused by the low volatility of capital expenditures of state-owned SMEs because most of the state-owned enterprises usually focus on stable operations, they will not consider too much investment in the future, which makes the capital expenditures at a very low level or even at zero. In addition, the smaller sample size (N=217) compared with private SMEs group might also contribute to this insignificance.

The latter inconsistency for the coefficient of FDI shows that the development of Fintech could increase the use of the cash holdings for private SMEs. It could be argued that the development of Fintech could bring more external funds which also increases the use of the cash holdings of private SMEs. However, this would not necessarily happen because the use of the cash holdings is related to other omitted variables, such as the corporate governance, risk-taking preference of the CEO, etc. No theory could explain this statistical significance that why the development of Fintech could increase the use of the cash holdings by this regression since there might be omitted variable bias. Therefore, this article believes that the development of Fintech should have no impact on the use of cash holdings of SMEs. The robustness test would be conducted to further confirm this conclusion.

Table 4.3. Regression results for Hypothesis 1&2

Dep. Var	Model 1 Δ Cash	Model 2H Δ Cash	Model 2L Δ Cash
CF	0.653*** (0.0520)	0.950*** (0.2463)	0.568*** (0.0557)
FDI	-0.0314 (0.0383)	0.00975 (0.0143)	0.00575** (0.0027)
CF×FDI	-0.126*** (0.0305)	-0.261 (0.1585)	-0.0827** (0.0323)
Δ NWC	0.616*** (0.0112)	0.677*** (0.0556)	0.614*** (0.0115)
Δ SD	0.368*** (0.0160)	0.371*** (0.0789)	0.368*** (0.0168)
Expend	-0.188*** (0.0357)	-0.207 (0.1618)	-0.198*** (0.0381)
_Cons	-0.0178 (0.0228)	-0.0530* (0.0277)	-0.0433*** (0.0060)
Year	Controlled	Controlled	Controlled
N	3262	217	3045
R ²	0.6076	0.6578	0.5888

Standard errors in parentheses

*p<0.10 **p<0.05 ***p<0.01

Source: Calculated by authors

4. 3. 3. HOW DOES FINTECH INFLUENCE THE PERFORMANCE OF SMES?

Table 4.4 Model 3 presents the results for regression based on Model (3). The coefficient of the FDI squared term (δ_2) equals to 0.0069 which is significant at 10% level, this indicates that there

is a U-shaped relationship between ROA and FDI. The coefficient of FDI (δ_1) is not significant, this means that the turning point is 0. Further, it could be inferred that the effect of Fintech on the business performance of SMEs presents an upward U-shaped trend with the increase in Fintech development index because the index is always positive. The above confirms the correctness of Hypothesis 3.

There might be three main reasons to explain this marginal increasing relationship.

First, the network effect has led to an exponential growth in social idle funds, which in turn has reduced corporate financing costs. According to Metcalf's Law of Network Economics, the accumulation of social idle capital based on Fintech will increase as the number of users participating in the entire Fintech system increases (Hendler & Golbeck, 2008; Gao et al., 2017). The development of Fintech would make the accumulation of idle capital in society show an arithmetic progression and bring a lot of low-cost external funds to SMEs. With the development of Fintech, the accelerated growth of external capital supply can greatly reduce the financing costs of SMEs. This makes SMEs have enough accelerating low-cost external capital, thereby they will increase their investment and scale up to improve their performance.

Second, the development of Fintech could alleviate the problem of information asymmetry, which improves the efficiency of corporate finance, and thus promotes corporate investment. With the in-depth development of Fintech, the information platform constructed by Fintech companies would make the information disclosure of SMEs more transparent, which enhances the credibility of the financial statements of SMEs. This improvement could attract more strategic investors to participate in the business and decision-making of SMEs, which in turn promotes the investment performance of SMEs.

Third, Fintech could provide "consulting + financing" supporting services for SMEs, thereby improving corporate performance. On the one hand, relying on big data analysis technology, Fintech enterprises could help SMEs analyze current macroeconomic trends and industry development situations, and provide all-round strategic consulting services according to the financial status of SMEs to improve their long-term business profitability. On the other hand, according to the strategic plan formulated, Fintech companies could provide more supporting financing channels for SMEs, such as crowdfunding, P2P lending, ABS, etc. These innovative financial products will be able to support the future growth of the company and thereby improve the profitability of SMEs.

In terms of the significance of the coefficients of the control variables, the coefficient of growth is significant and positive (equals to 0.0143), which implies that the increase of the growth could raise the performance of SMEs. This might be that the increase in business growth should bring more revenue to the firm which increases corporate performance. The coefficient of leverage is negative and significant (equals to -0.104), this might be that the performance of SMEs would decrease with the upwards financing costs of SMEs which is caused by the increase of leverage. The firm size is also positively related to the performance of SMEs given the positive and significant coefficient of the log of the firm size (equals to 0.0188). The lag one phase of ROA is significant in Model 3, which helps with mitigating the endogeneity problem (the omitted variable bias) to some extent.

In summary, Hypothesis 3 passed the test. Specifically, the performance of SMEs showed an upward single-sided U-shaped relationship with the increase of the Fintech development index. In other words, the development of Fintech could promote the performance of SMEs, and this promotion effect is marginal increasing.

4. 3. 4. HOW DOES FINTECH INFLUENCE THE RISKS OF SMES?

Table 4.4 Model 4 describes the results for regression based on Model (4). The coefficient of FDI (λ_1) is significantly negative at 5% level, and the coefficient of the FDI squared term (λ_2) is significantly positive at 1% level. The turning point is calculated at 0.903 for FDI based on these two coefficients. Combined with the turning point for FDI at 0.903, the relationship states that the risks of SMEs would decrease with the increase of FDI when FDI is less than 0.903. After this turning point, the risks of SMEs would increase with the increase of FDI. However, this turning point might not be trustworthy as only 22.2% of the observations lies below this value. Moreover, there could be omitted variable bias that might influence the coefficients of FDI and its quadratic term.

While the relationship between Fintech and corporate risk is shown to be non-linear, the coefficient of the FDI squared term (λ_2) is opposite as expected. The relationship between Fintech and corporate risk is like the shape of “U”, but not like the reverse “U” as expected. This is quite unusual because the empirical evidence shows that the risks of SMEs would be increased finally with the development of Fintech, while in theory Fintech should serve as an effective risk control tool based on big data analysis. This contradiction might be explained in the following aspects.

The reason why the incremental risk of SMEs is marginal increasing (the coefficient of the FDI squared term is significantly positive) could be the negative network externalities which is caused by the lack of supervision. Fintech is a double-edged sword. If it is used well, it can effectively control risks. On the contrary, it will magnify the risk due to network effects. Since 2013, Fintech has developed rapidly in China. Some new financial businesses have appeared one after another, like Yu’eobao, Crowdfunding, P2P lending, Internet insurance, etc.

However, due to the poor self-discipline and lack of supervision in the Fintech industry, systemic risks have accumulated and erupted in 2016, and there have been vicious incidents such as usurious loans, P2P credit defaults, P2P and crowdfunding platform running events. In particular, the usury would significantly increase the financing costs of SMEs and thereby increase the risks of SMEs. The negative P2P lending events might lead to the mistrust between investors and Fintech companies, which indirectly reduces the financing of SMEs.

Besides, the marginal increase in the incremental risk of SMEs might be caused by the immature development of Fintech. This may be a sample selection issue. Because this article selected the data of China’s listed SMEs in 2011-2015 as a sample, however, during this period the development of FinTech in China is still in its infancy. Because of the immature technologies and the lack of supervision, Fintech increases the systematic risks which transfer to the risks of SMEs.

Another possible factor for magnifying the negative effect of Fintech is the bull market. From 2014 to 2015, China’s capital market changed from a bull market to a bear market. Whether it is a bull market or a bear market, it will greatly affect the company’s net profit and total assets, thus affecting the ROA and its volatility. Meanwhile, the effect of the bull market would be magnified by Fintech through the network effect.

In the bull market, listed companies may have a strong window-dressing willing and crazy strategies for mergers and acquisitions. For instance, it is common for corporate executives to use insider information to manipulate stock prices to obtain gray income in the Chinese stock market due to the immature regulation system. In particular, the executives might manipulate the ROA creating a situation of “firstly drop, then rise sharply” by adopting adjusted accounting standards. This potentially increase the risks of SMEs.

Another common phenomenon in the bull market in China is that the executives might be crazy

about conducting M&A, which also magnify the risks of SMEs. Usually, the executives would try their best to sell the good story of the company's future development and accumulate plenty of goodwill through various M&A projects so as to support higher valuation for their companies. When it is in the bear market and the bull market is likely approaching, they will make a large amount of goodwill impairment to significantly reduce the net profit so as to prepare for the next manipulation. This also increase the potential risks of SMEs.

Table 4.4 Model 4 also presents the significance of the coefficients of the control variables. Apart from the coefficient of the lag one phase of the dependent variable, the rest coefficients are all insignificant. This might be caused by the omitted variable bias or sample selection problem above. However, since most of the unobservable factors are controlled by the lag one phase of the dependent variable, the effect of Fintech on the incremental financial risk of SMEs could be well studied by Model 4 even if other control variables are not significant.

In summary, Hypothesis 4 does not pass. The empirical evidence shows that Fintech could significantly increase the risks of SMEs which is quite opposite to the Hypothesis 4. A possible reason for this is the lack of supervision for the Fintech industry. To further confirm this conclusion, the robustness checks need to be conducted.

Table 4.4. Regression results for Hypothesis 3&4

Dep. Var	Model 3 ROA	Model 4 $\sigma(\text{ROA})$
FDI	-0.0402 (0.0337)	-0.861* (0.4426)
FDI ²	0.00690* (0.0036)	0.477*** (0.1569)
Growth	0.0143*** (0.0023)	-0.0505 (0.0335)
Leverage	-0.104*** (0.0104)	0.0675 (0.1388)
LnTA	0.0188*** (0.0040)	-0.000687 (0.0717)
ROAt-1	0.0558** (0.0235)	
$\sigma t-1(\text{ROA})$		-0.478*** (0.0390)
_Cons	-0.284*** (0.0924)	0.529 (1.6031)
Year	Controlled	Controlled
N	2606	1302
R ²	0.1276	0.2042

Standard errors in parentheses

* p<0.10 ** p<0.05 ***p<0.01

Source: Calculated by authors

5. ROBUSTNESS CHECKS

5. 1. RESULTS BY SUBSTITUTING VARIABLES

This article follows Soedarmono, Machrouh and Tarazi's idea to substitute total assets (*TA*) by using total revenue (*TR*). This is because there was a bull market from 2014 to 2015 in China,

and most listed SMEs' total assets jumped dramatically which might cause the total assets to be overestimated. Instead, the total revenue might be a better proxy for measuring the total scale of the firms because it is not affected by the bull market and draws a more objective blueprint for the firms' scales.

Table 5.1 shows the robust results of robustness checks by substituting total assets to total revenue for Hypothesis 1 and 2.

Column 1 of Table 5.1 shows that Fintech could alleviate the financing constraints of SMEs in China given the coefficient on the interaction between Fintech development and cash flows is significantly negative (equals to -0.177), which is consistent with the result of Regression Model (1).

Column 2 of Table 5.1 describes the level of cash flow sensitivity for state-owned SMEs could not be reduced by Fintech, which means that Fintech could not alleviate the financing constraints for state-owned SMEs.

However, Column 3 of Table 5.1 presents the alleviating effect of Fintech on financing constraints of Private SMEs with a significantly negative coefficient (equals to -0.152) on the interaction between Fintech development and cash flows. This confirms the correctness of Hypothesis 2.

Table 5.1. Results of Robustness Checks by Substituting Variables for HI&H2

Dep. Var	Column 1 ΔCashTR	Column 2 ΔCashTR	Column 3 ΔCashTR
CFTR	0.845*** (0.0654)	0.634*** (0.2556)	0.763*** (0.0715)
FDI	-0.0143 (0.0993)	0.0232 (0.4237)	0.0162 (0.1044)
FDI $\times$ CFTR	-0.177*** (0.0375)	-0.00876 (0.1723)	-0.152*** (0.0403)
ΔNWCTR	0.611*** (0.0113)	0.750*** (0.0567)	0.589*** (0.0118)
ΔSDTR	0.410*** (0.0180)	0.588*** (0.0677)	0.388*** (0.0189)
ExpendTR	-0.130*** (0.0344)	-0.114 (0.1577)	-0.145*** (0.0365)
_Cons	-0.0790 (0.0586)	-0.151 (0.2106)	-0.0832 (0.0622)
Year	Controlled	Controlled	Controlled
N	3262	217	3045
R ²	0.5849	0.7188	0.5654

Standard errors in parentheses

*p<0.10 **p<0.05 ***p<0.01

Source: Calculated by authors

Table 5.2 Column 4 presents the results of robustness checks for H3 by substituting total assets to total revenue. In particular, the upward single-sided U-shaped relationship between Fintech development index and ROA of SMEs was confirmed with an insignificant coefficient of FDI and a significantly positive coefficient of FDI squared term. This is consistent with the result of the test for Hypothesis 3.

Table 5.2 Column 5 presents very similar results to the regression result of Model 4. The coefficient of FDI squared term is significantly positive at 0.477, and the coefficient of FDI is

significant and negative at -0.835. The turning point is calculated at 0.875, which is close to the 0.903 in Model 4. Therefore, a similar explanation can be applied.

Table 5.2. Results of Robustness Checks by Substituting TA for H3 & H4

Dep. Var	Model 4 ROA	Model 5 $\sigma(\text{ROA})$
FDI	-0.0321 (0.0318)	-0.835* (0.4421)
FDI ²	0.00749** (0.0034)	0.477*** (0.1572)
Growth	0.0188*** (0.0023)	-0.0292 (0.0321)
Leverage	-0.133*** (0.0100)	0.117 (0.1398)
LnTR	0.0345*** (0.0034)	-0.0442 (0.0590)
ROAt-1	0.0694** (0.0225)	
$\sigma\text{-}1(\text{ROA})$		-0.476*** (0.0390)
_Cons	-0.603*** (0.0787)	1.374 (1.3455)
Year	Controlled	Controlled
N	2606	1302
R ²	0.2209	0.2025

Standard errors in parentheses

*p<0.10 **p<0.05 ***p<0.01

Source: Calculated by authors

5. 2. RESULTS BY DIVIDING SAMPLES

The second way to run the robustness tests is to adjust the standards to get different samples or data and run the regression to check whether the outcomes are still robust. Although the sample is collected from the SMEs board, some firms are now not SMEs at all. For instance, one firm called “HIK VISION³” (stock code: 002415) started in 2001 as the SME, and now grows to a big giant company with nearly 300 billion capitalizations. Therefore, this article would divide the sample into two sub-groups by using the mean value of the firm size (4.42e+09) and select the one with the size lower than the mean value to test the research hypothesis 1, 3 and 4.

For hypothesis 2, the mean value of ownership (0.0193) was introduced as the standard for dividing the sample into state-owned SMEs and private SMEs groups instead of using 5% as the classification standard. This article would use the above two classification standards to get the adjusted samples and run the robustness checks.

Table 5.3 presents the results of robustness checks by using the adjusted samples for Hypothesis 1 and 2.

Column 6 of Table 5.3 shows the same conclusion that Fintech development could alleviate the

³ HIKVISION is currently the leading company in China’s security industry. The company was sanctioned by the United States because of the Sino-US trade war. It can be easily seen that HIKVISION is no longer in the category of SMEs. Besides, since the component stocks of the SME board would not be regularly adjusted, it is necessary to re-segment the collected samples according to the size of the company.

financing constraints of SMEs with the significantly negative coefficient (equals to -0.987 and is significant at 1% level) of the interaction between Fintech development index and cash flows. Meanwhile, the significance level is not changed and is still at 1% level. This indicates that the regression result of hypothesis 1 is robust after excluding some relatively big firms listed in the SME board of Chinese stock exchange.

Column 7 and 8 of Table 5.3 present the results of robustness checks for the mediating role of ownership in the effect of Fintech on financing constraints of SMEs. The coefficient on the interaction between Fintech development and cash flows in Column 7 (State-owned SMEs group) is insignificant, while the coefficient is significantly negative in Column 8 (Private SMEs group). This further confirms that the development of Fintech has a better mitigating effect on the financing constraints of non-state-owned SMEs compared with state-owned SMEs, which means that the regression results for hypothesis 2 are still robust by changing the classification standard.

Table 5.3. Results of Robustness Checks by Dividing Samples for H1 & H2

Dep. Var	Column 6 Δ Cash	Column 7 Δ Cash	Column 8 Δ Cash
CF	0.626*** (0.0638)	0.690*** (0.2069)	0.610*** (0.0572)
FDI	-0.0552 (0.0443)	-0.0504 (0.1533)	-0.0364 (0.0410)
FDI×CF	-0.0987*** (0.0380)	-0.141 (0.1438)	-0.107*** (0.0329)
Δ NWC	0.633*** (0.0127)	0.632*** (0.0475)	0.604*** (0.0121)
Δ SD	0.388*** (0.0197)	0.394*** (0.0672)	0.361*** (0.0169)
Expend	-0.243*** (0.0421)	-0.420*** (0.1395)	-0.196*** (0.0386)
_Cons	0.0000587 (0.0265)	0.00711 (0.0796)	-0.0123 (0.0248)
Year	Controlled	Controlled	Controlled
N	2592	315	2947
R ²	0.6283	0.6261	0.5920

Standard errors in parentheses

*p<0.10 **p<0.05 ***p<0.01

Source: Calculated by authors

Table 5.4 describes the results of robustness checks by using the adjusted samples for Hypothesis 3 and 4. Both the significance of the sign of the FDI squared term are consistent with the results of tests in Table 4.4.

Table 5.4. Results of Robustness Tests for H3 & H4 by Dividing Samples

Dep. Var	Column 9 ROA	Column 10 $\sigma(\text{ROA})$
FDI	-0.0259 (0.0401)	-0.750 (0.5248)
FDI ²	0.00907** (0.0044)	0.440*** (0.1844)
Growth	0.0169*** (0.0035)	-0.0695 (0.0466)
Leverage	-0.131*** (0.0122)	0.250 (0.1591)
LnTA	0.0284*** (0.0062)	0.00319 (0.0912)
ROAt-1	-0.0266 (0.0281)	
$\sigma\text{-1}(\text{ROA})$		-0.492*** (0.0470)
_Cons	-0.495*** (0.1370)	0.308 (1.9891)
Year	Controlled	Controlled
N	2008	1018
R ²	0.1456	0.2018

Standard errors in parentheses

*p<0.10 **p<0.05 ***p<0.01

Source: Calculated by authors

5. 3. RESULTS BY RUNNING ALTERNATIVE REGRESSION

As discussed in the literature review that a single indicator could be adopted as the measurement of financing constraints. The dividend payout ratio could be used as a measure for observing the level of financing constraints. The dividend payout ratio (DPR) is expected to be negatively related to the level of financing constraints because paying dividends shows that the firm is rich in its internal funds, therefore it would be less likely having the financing constraints problem or that the level of financing constraints of the firm is high.

By using the DPR as the dependent variable, the Fintech development index was introduced to the alternative regression model with the control variables, like Growth, Leverage and log of the firm size. It turns out that the coefficient of the Fintech development index is insignificant. This implies that Fintech could not alleviate the financing constraints of SMEs.

However, there might be omitted variable biases since some variables are not controlled, like the dividend policy, or P/E ratio. It is also noticeable that SMEs are less likely to pay dividends even if they do not have financing constraints problem. This might because that most SMEs are in the growth stage, which needs more funds to be injected to expand the scale of SMEs and earn more profits. Furthermore, the statistics of the dividend payout ratio confirms the assumption that SMEs are of a low dividend payout ratio with about 89% of the sample showing less than 1% dividend payout ratio. Therefore, it is reasonable to suspect that the result of this alternative regression is unreliable (Espallier & Guariglia, 2015; Li & Luo, 2015).

To summarize, although the result of the alternative regression by using the dividend payout ratio as the proxy for measuring financing constraints, this article believes that this technique is not suitable for SMEs and therefore the result might not be trustworthy.

6. RESEARCH CONCLUSIONS AND POLICY RECOMMENDATIONS

6. 1. RESEARCH CONCLUSIONS

Using a unique Fintech development data and the financial data of Chinese listed SMEs from 2011 to 2015, this article investigates how Fintech affects financing constraints of SMEs and how this impact further communicated to the performance and the risks of SMEs by adopting two-way fixed effects models. The main conclusions are as follows.

First, this article finds that the development of Fintech could alleviate the financing constraints of SMEs (Hypothesis 1 holds). This implies that Fintech might be an effective way to mitigate the problem of SME financing constraints.

Second, the research shows that the ownership act as a mediator on the effect of Fintech on financing constraints. In particular, the development of Fintech has a better mitigating effect on the financing constraints of private SMEs compared with state-owned SMEs (Hypothesis 2 holds).

Third, this paper explores the influence of Fintech on the performance of the SMEs. The result shows that the effect of Fintech on the business performance of SMEs is marginal increasing (Hypothesis 3 holds). Specifically, the performance of SMEs showed an upward single-sided U-shaped relationship with the increase of the Fintech development index.

It is unexpected to find the same upward single-sided U-shaped relationship between Fintech development index and the risks of SMEs (Hypothesis 4 not hold). This result is opposite to the hypotheses being proposed, showing that Fintech has not reduced risks, but has accelerated the risks of SMEs.

There might be some limitations to this article. For example, due to the limitation of data availability, this article only selects listed SMEs in China as the research sample, which might cause the sample selection problem and biases the research conclusions. It might also be a problem by using the Fintech development index with only one data source from a single top Fintech company, Ant Financial. Further improvement could be made to more accurately estimate the development of Fintech by collecting data from top 10 Fintech companies in China. Another concern is that this article only focuses on the risks of SMEs by using the volatility of ROA and Z-score, while not considers the default risks or information security risks.

Due to limited time, this article only explains the possible reasons why Fintech could alleviate financing constraints of SMEs but does not provide empirical evidence. Besides, it might be worthwhile to further discuss the industrial heterogeneity for the impact of Fintech on financing constraints, business performance and the risks of SMEs, especially for the high-tech industry in China. It is also a good idea to explore the effect of the three sub-indices of the Fintech development index (Coverage Breadth, Use Depth and Digital Supply Services Level) on the financing constraints of SMEs.

6. 2. POLICY RECOMMENDATIONS

According to the research conclusions, the policy recommendations are proposed as follows.

First, the government should formulate policies to promote the development of the Fintech industry and encourage financial innovation. In particular, the government should encourage innovative finance business models like P2P lending, crowdfunding, Internet ABS and other businesses to provide more financing channels for SMEs. In order to improve the efficiency of financing, the government should appropriately relax restrictions on foreign investment and allow the establishment of Fintech joint ventures to introduce advanced technologies or models

from developed countries to better serve Chinese SMEs. Also, the government should propose policies to support the development of artificial intelligence, blockchain and other technologies to further reduce financing costs and improve financing efficiency.

Second, the government should formulate support policies for the development of SMEs. Specifically, the government could provide special funds to SMEs through administrative means such as targeted RRR (reserve requirement ratio) reduction and targeted loan issuance. The government can also create a “government background” for SMEs through partial shareholding to ease the issue of ownership discrimination. Besides, the government should establish the incubator for SMEs to provide “consulting + financing” supporting services, so that all stages of SME development can have appropriate strategic planning and supporting financing services.

Third, the regulation of the Fintech industry needs to strike a balance between adapting to inclusive Fintech development and identifying potential risks of sustained release. Due to the existence of network effects, the innovative business model of Fintech has a significant role in promoting the performance of SMEs. However, Fintech is a double-edged sword. If it is not used properly, it will also amplify the risk. This is extremely obvious in the early stage of the Fintech development. Therefore, it is necessary to properly supervise the Fintech industry. Specifically, the government can follow the regulatory framework of “industry self-discipline first – government regulation keeps up”. The government can encourage many domestic head Fintech companies, like Ant Financial, Pingan Group and JD Finance etc, to set up industry associations and spontaneously to develop Fintech industry standards. After the industry guidelines are mature, the government can provide an effective institutional environment for the healthy development of financial technology by formulating relevant laws and regulations on Fintech. Moreover, the “regulatory sandbox” mentioned in the literature review can also be used to create a virtual experimental market to encourage innovation while well controlling the risks.

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