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Local Bank, Digital Financial Inclusion and SME Financing Constraints: Empirical Evidence from China

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ABSTRACT

This paper investigates the impact of local banks and digital financial inclusion on Small and Medium-sized Enterprise (SME) financing constraints. Using data from Chinese SMEs for the period 2007–2017, our robust results find that (1) SMEs' financing constraints are negatively associated with the proportion of local bank branches and the degree of digital financial inclusion; (2) the effect of local banks is more pronounced for firms which are small, transparent, and located in the regions less dependent on bank credit; and (3) local bank branches and digital financial inclusion have a substitution effect on alleviating SMEs' financial constraints. The findings shed light on how digital finance technologies could influence traditional SME-bank relationships and have important policy and managerial implications.

KEYWORDS



Local banks; digital financial inclusion; financing constraints; SMEs; China


1. Introduction

Rapid development in new financial technologies such as online banking and digital payments has intensified the competition between large nationwide banks and small local banks, and affected bank credit availabilities for Small and Medium-sized Enterprises (SMEs). Empirical evidence generally supports the idea that small local banks have comparative advantages in lending to SMEs (DeYoung 2002), because they are scattered around all areas, less bureaucratic and more flexible. These characteristics minimize information asymmetry between banks and SMEs (Almazan 2002; Hauswald and Marquez 2006) and build up a long-term firm-bank relationship (Agarwal and Hauswald 2010; Berger et al. 2005).

In the last 15 years, the Chinese banking sector has been leading in the use of digital finance technologies to serve a wide population including vulnerable groups in the UN's financial inclusion strategy. A new concept, digital financial inclusion, has emerged, which is defined as "digital access to, and the use of, formal financial services by the excluded and underserved population" (CGAP 2015, 1) and could be an active channel for speeding up the process of financial inclusion. However, digital financial inclusion could also add more advantages to large nationwide banks in competition with local banks in providing finance to SMEs. Nevertheless, little evidence is found in the literature about the effect of digital financial inclusion on SME financing through local banks and firm-bank relationships.

To fill in this knowledge gap, this paper aims to investigate how local banks and digital financial inclusion in China affect SME financial constraints. Using a panel data of Chinese SMEs with 11,610 firm-year observations covering the period 2007–2017, this paper employs a well-established identification strategy of financial constraints proposed by Ryan, O'Toole, and McCann (2014) to examine the sensitivity of firm-level investment to changes in internal fund availability. We find that SMEs

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located in areas with a significant proportion of local bank branches or a higher degree of digital financial inclusion have fewer financial constraints. The findings conclude that local banks and digital financial inclusion play positive and significant roles in reducing SME financing constraints. We further assess the interactive impact of local bank branch and digital financial inclusion on SME financing constraints and the results show that local bank branch and digital financial inclusion have substitution effects on alleviating SMEs' financial constraints, which might indirectly prove, under the development of digital financial inclusion, that large nationwide banks can effectively participate in competition with local banks in serving SMEs. Therefore, the traditional dominant market for small local banks to help SMEs could shrink, and consequently, the SME-bank relationship could be changed. We argue that the findings may have implications for other transition economies (e.g., Vietnam) as they share this unique banking composition, i.e., large state-owned banks with nationwide branch networks and small local banks which are restricted to operating locally.

The rest of this paper is organized as follows. [Section 2](#) explains the theoretical reasoning used to formulate testable hypotheses. [Section 3](#) presents datasets, variables and empirical models. [Section 4](#) discusses the main results. [Section 5](#) makes conclusions and clarifies the contributions of this study.

2. Theoretical Reasoning

2.1. Local Banks and SME Financing Constraints

SMEs are more dependent on the external financing supplied by commercial banks (Berger and Udell 1998) because most of them are not qualified to raise money from the stock market. However, informational opacity and a lack of audited financial statements are two typical characteristics of SMEs (Hasan et al. 2017), which results in SMEs facing more financing constraints than large firms. Besides, the credit application process in large banks is highly bureaucratic and mainly based on “hard” transaction lending (i.e., asset-based and financial statement lending). Thus, traditionally, large banks focus on more substantial scale lending to larger firms (Berger et al. 2005), while discriminating against SMEs in lending as most SMEs are privately owned, located in small towns and villages, and require frequent loans of small amounts (Cousin 2007; Cull and Xu 2005).

In contrast, small local banks have comparative advantages in forming relationships with local borrowers compared to their larger counterparts (DeYoung 2002). Relationship lending is based mainly on “soft” information gathered through continuous contacts with firms in the provision of financial services (Wu, Song, and Zeng 2008). In other words, small local banks have a “shorter” distance to SME clients and can interact with them more frequently than larger banks (Uchida, Udell, and Watanabe 2008). As a result, local banks can promptly familiarize SME clients' financial positions, closely monitor their operations, and provide professional services accordingly (Atanassov 2015). Furthermore, due to less bureaucracy and operating more locally, capable local banks can offer better lending terms to SMEs. Thus, SMEs can enjoy lower bank loan interest rates and pledge fewer assets for loans, which could help reduce SMEs' financing constraints and lead to the possibility of establishing a long-term relationship (Berger et al. 2005; Hasan et al. 2017). This healthy relationship would encourage local banks to invest more in information acquisition to further reduce informational asymmetries between banks and SMEs (Hadlock and James 2002).

In line with the above-mentioned reasoning, the first hypothesis (H1) can be expressed as:

H1: Local banks are conducive to alleviating financing constraints for SMEs.

2.2. Digital Financial Inclusion and SME Financing Constraints

In the last decade, FinTech (Financial Technology), broadly known as digital finance, has become more and more popular in delivering innovative financial products and services through the internet, PCs,

mobiles and contactless cards linking to digital payment systems (Manyika et al. 2016), which have introduced novel ways of communication and interaction between lenders and borrowers (Gomber, Koch, and Siering 2017). Digital finance refers to “all products, services, technology and/or infrastructure that enable individuals and companies to have access to payments, savings, and credit facilities via the internet (online) without the need to visit a bank branch or to deal directly with the financial service provider” (Ozili 2018, 330). The definition clearly suggests that digital finance is a *revolution* currently taking place in the lending environment, and specifically, the context of financial inclusion.

Digital finance can bring substantial benefits to the firm-bank relationship (Ozili 2018). Digital finance enables banks and financial institutions to significantly enlarge their client numbers and diversify/increase their financial products and services without the need of investing proportionately in branches and staff. In other words, the banking sector’s long-term performance would be improved from the promotion of digital finance. Moreover, through a digital transaction platform, firms and individuals can access broad, diversified, affordable, convenient banking and other services provided by banks, financial institutions, and even non-financial sectors.

Given that digital finance can bring benefits to banks/financial institutions and firms/individuals, digital financial inclusion is particularly suitable for SME financing. For example, through digital transaction platforms, applying for and obtaining loans is much more accessible than before. In the environment of digital financial inclusion, the problem of geographical “distance” between banks and SMEs can be effectively overcome. Meanwhile, with the application of big data technology, the information asymmetry between banks and SMEs can be significantly reduced. Furthermore, with the development of digital financial inclusion, the costs of the banking sector are substantially lower than before, which allows banks/financial institutions to provide more products and services specially designed to suit the needs of SMEs (Ozili 2018).

Besides, when large nationwide banks (state-owned commercial banks, joint-stock commercial banks, and postal savings banks) and small local banks (city commercial banks, rural cooperative financial institutions, and village and township banks) compete in the market of digital financial inclusion, large banks are in a better position than their smaller counterparts not only because they have the advantages of capital, experience and talent, but also because they can attract major suppliers of digital financial services. In China, Alipay and WeChat Pay prefer, for example, to cooperate with large nationwide banks than small local banks. This fact means a significant increase in the lending amounts available to SMEs who are traditionally ignored by large banks.

Following this line of arguing, the second hypothesis (H2) can be presented as:

H2: The development of digital financial inclusion is conducive to alleviating financing constraints for SMEs.

3. Empirical Method

3.1. Data

As our focus is SME financing constraints, we collect sample data from the over-the-counter (OTC) market in China.¹ The OTC market is an equity trading market which provides financing for companies that have not met the public listing requirements for the Main Board Market, either because their financial disclosure standards are lower, or their trading volumes are smaller. It has thus become a vital financing venue for numerous privately-owned SMEs, such as entrepreneurial and high-tech companies, because they face challenges in obtaining loans from banks and consequently increasing barriers.

A firm dataset is constructed using the China Stock Market & Accounting Research (CSMAR, <http://cn.gtadata.com/>) database containing general and financial information based on standardized financial statements and records for listed companies, including the firms in the OTC market.² We

collect sample data from CSMAR, provincial bank data from Regional Financial Operation Reports published by the People's Bank of China, provincial digital financial inclusion data from Peking University Digital Inclusive Finance Index published by the Digital Finance Research Center of Peking University (Guo et al. 2020), and province-level data on macroeconomic items from the China Statistical Yearbook issued by the National Bureau of Statistics of China.³

The initial sample includes all firms in the OTC market over the period 2007–2017.⁴ After excluding those firm-year observations with missing values, financial firms and firms located in the province of Tibet due to its abnormal macroeconomic information, the final sample consists of 11,610 firm-year observations.

3.2. Variables

3.2.1. Measuring Financing Constraints

We measure financing constraints following the approach proposed by Fazzari, Hubbard, and Petersen (1988), who argue that firms with financing constraints are those whose investment is highly sensitive to the availability of internal financing. To be specific, firms with financing constraints find it difficult to obtain external funding; as such, investment in such firms relies heavily on internal funds. We follow an improved method as described in Ryan, O'Toole, and McCann (2014). The regression model (1) is set to evaluate financing constraints as:

$$Investment_{ijk,t} = \alpha_0 + \alpha_1 Cash_{ijk,t-1} + \varepsilon \quad (1)$$

where the dependent variable is *Investment*, and the explanatory variable is *Cash*. Representing firm *i*'s fixed asset investment, *Investment* is equal to the net accumulation of fixed assets (accounting for depreciation, amortization and/or revaluations) for firm *i* in sector *j* and province *k* in year *t*, normalized by firm *i*'s fixed assets at the beginning of the year. *Cash* represents firm *i*'s cash stock, equaling the value of the balance of cash and cash equivalents for firm *i* in sector *j* and province *k*, normalized by firm *i*'s capital stock. To avoid endogeneity problems caused by potential reverse causality, *Cash* is lagged by one period in model (1). If the coefficient of *Cash* is statistically positive (i.e., $\alpha_1 > 0$), it indicates that a positive sensitivity of investment to cash, which means that the firm would have financing constraints.

3.2.2. Local Bank Branches and Digital Financial Inclusion

We set a variable *Branch%* as an indicator of the percentage of local bank branches of total bank branches, which equals the proportion of local bank branches in all bank branches across the provinces. The higher the *Branch%* value is, the greater the extent of the local bank presence. If smaller cash-investment sensitivity among firms in country-years where local banks have higher market share can be observed, it would suggest local banks are conducive to alleviating financing constraints for SMEs; thus, *H1* can be confirmed,

The variable digital financial inclusion, *DIG*, is the natural logarithm of the degree of digital financial inclusion index for province *k* at year *t*. The digital inclusive finance index is designed and measured by the Digital Finance Research Center of Peking University, which uses the massive data on inclusive digital finance from Ant Financial Services Group.⁵ The index includes three dimensions, 11-second indexes and 33-specific indexes.⁶ Their calculation methods are based on the calculation methods for human development indexes (Bhanojirao 1991) and use logarithmic efficiency functions to consolidate the three dimensions into a comprehensive index.

DIG represents the level of digital financial services, and the higher the index is, the greater the development of digital financial services in the region would be. If we observe smaller cash-investment sensitivity among firms in country-years where digital financial inclusion index is higher, it suggests that the development of digital financial inclusion is beneficial for reducing financing constraints for SMEs (*H2*).

3.2.3. Control Variables

To avoid heterogeneity, we use a set of firm-level and province-level control variables following several relevant studies about SME financing constraints and external financing (see Hasan et al. 2017; Laeven 2003; Petersen and Rajan 1994; Rice and Strahan 2010).

Considering that revenue does not only affect firms' cash holding position but also influences the resources that they can use for investment (Bond and Meghir 1994), we add a variable *Sale* to model (1), which is the ratio of sales to total asset for firm *i*. As firm size can affect the availability of bank loan, e.g., banks are reluctant to lend to small firms because they are more opaque in terms of information and have a higher operation risk, we use *Asset* to represent the size of the firm, which is the natural logarithm of firm assets. *Growth* is firm *i*'s growth ability measured by its growth rate of revenue. The firms with high growth trend suggest that they have more investment opportunities.

Meanwhile, *ROA* is firm *i*'s profitability, measured by its ratio of net profit to total asset. When firms have investment opportunities that potentially get returns, they will increase investment. *LEV* is firm *i*'s financial leverage measured by its ratio of total debt to total asset. High financial leverage suggests a firm has a high proportion of debts which would decrease the likelihood that the firm would receive further loans from banks for investment. *Age* is firm *i*'s establishment period, which is the natural logarithm of firm age. The firm age can affect firm investment because firms at different stages have different investment preferences. For instance, younger firms are likely to invest more, while older ones are expected to hold or take back their investments.

Besides firm-level control variables, we also control for some variables at a provincial level including the natural logarithm of regional gross domestic product (*GDP*), representing the degree of economic development, the regional gross domestic product growth rate (*GDPgrowth*), the proportion of the government's financial expenditure on regional GDP (*Gov Expenditure*), and the degree of inflation in each province (*CPI*), because these factors might influence firms' investment behavior or financing constraints directly or indirectly. Table 1 provides a statistics summary of our main variables.

3.3. Empirical Model

Based on the model (1), to measure SME financing constraints, we add banking market structure (*Branch%*) and index of digital financial inclusion (*DIG*) in province *k* and control variables for controlling the characteristics of firm *i*, sector *j*, province *k* and year *t*. The empirical model is

$$\begin{aligned} Investment_{it} = & \beta_0 + \beta_1 Sale_{ijk,t-1} + \beta_2 Cash_{ijk,t-1} + \beta_3 Branch\%_{kt} \\ & + \beta_4 Cash_{ijk,t-1} \times Branch\%_{kt} + \beta_5 DIG_{kt} + \beta_6 Cash_{ijk,t-1} \\ & \times DIG_{kt} + \theta_{ijkt} + \gamma P_{kt} + \rho K_k + \omega I_j + \varphi Y_t + \varepsilon_{ijkt} \end{aligned} \quad (2)$$

Table 1. Summary statistics.

Variables	N	Mean	Median	St. Dev.	p5	p25	p75	p95
<i>Investment</i>	11610	1.015	-0.016	18.004	-0.373	-0.104	0.257	2.667
<i>Cash</i>	11610	0.634	0.379	1.057	0.022	0.147	0.785	1.988
<i>Branch%</i>	11610	0.364	0.385	0.101	0.200	0.245	0.457	0.511
<i>DIG</i>	11610	5.492	5.502	0.200	5.123	5.397	5.622	5.799
<i>Sale</i>	11610	0.784	0.676	0.593	0.161	0.448	0.984	1.702
<i>Asset</i>	11610	18.333	18.378	1.118	16.458	17.583	19.101	20.029
<i>Growth</i>	11610	0.368	0.144	1.768	-0.207	0.001	0.400	1.342
<i>ROA</i>	11610	0.010	0.041	1.268	-0.235	-0.011	0.098	0.216
<i>LEV</i>	11610	0.406	0.377	1.601	0.070	0.222	0.533	0.749
<i>Age</i>	11610	2.261	2.303	0.469	1.386	1.946	2.639	2.944
<i>GDP</i>	11610	10.449	10.311	0.641	9.579	10.044	11.124	11.361
<i>GDPgrowth</i>	11610	0.077	0.077	0.014	0.066	0.069	0.081	0.096
<i>Gov Expenditure</i>	11610	0.201	0.195	0.079	0.127	0.148	0.244	0.268
<i>CPI</i>	11610	0.019	0.017	0.006	0.012	0.015	0.021	0.032

where F_{ijkb} , P_{kb} , K_{kj} , I_j , and Y_t are vectors of firm controls, province controls, province dummies, industry dummies and year dummies, respectively. Based on the analysis in the theoretical reasoning, we expect that local banks and digital financial inclusion can alleviate SME financing constraints and reduce the sensitivity between investment and cash, i.e., $\beta_4 < 0$ and $\beta_6 < 0$.

To avoid endogeneity problems caused by potential reverse causality running from the dependent variable to the explanatory variables, *Sale*, *Cash*, *Asset*, *Lev*, *Growth*, and *ROA* are lagged by one period. Meantime, to avoid the potential measurement error of investment resources, we use GMM (the generalized method of moments) estimation, instrumenting for *Sale* using the second and third lagged values of *Sale*.

4. Results and Discussions

4.1. Main Results

Table 2 shows the main findings from the baseline analysis for firm investment estimated by two-stage GMM. In the column (1), the coefficient of cash stock (*Cash*) is positive and significant at 1% level, implying that firms' investment is sensitive to the availability of internal funds. Specifically, an increase in *Cash* of 1% is on average associated with 0.21% increase in *Investment*. We interpret the result as SMEs relying on internal financing to invest in projects, suggesting the firms in our sample have financing constraints. The result is consistent with those of Ding, Guariglia, and Knight (2013) and Howell (2016), who reported that SMEs face a severe funding shortage in China.

In column (2), the share of local bank branches in the province (*Branch%*) and the interaction between the percentage of local bank branches and cash stock (*Cash*×*Branch%*) are added. The result indicates the coefficient of *Branch%* is not significant, meaning the numbers of local bank branches are insignificant in affecting SMEs' investment. However, we find the interaction variable (*Cash*×*Branch%*) is negative and significant at 1% level, suggesting that the proportion of SME funds received from local bank branches can effectively reduce the SMEs' financial constraints. Moreover, considering that the impact of local bank branches on the local economy is significant, we move the share of local bank branches from 5% to 95% percentile and observe that the sensitivity of investment to cash decreases from 0.074 ($0.117 - 0.217 \times 20\%$) to 0.006 ($0.117 - 0.217 \times 51\%$). The finding supports the results in DeYoung (2002), as well as Hauswald and Marquez (2006), who argue that local small banks have a comparative advantage in providing financing to SMEs because the degree of information asymmetry is lower between SMEs and local banks. Therefore, SMEs are more likely to ease financing constraints through bank credit in the regions with a high local bank presence.

In column (3), the digital financial inclusion index (*DIG*) and the interaction between the digital financial inclusion index and cash stock (*Cash*×*DIG*) are added. The coefficient of *DIG* is not significant, which means the availability of digital financial inclusion cannot automatically bring benefits to SMEs' investment. However, the interaction variable *DIG*×*Cash* is negative and highly significant, suggesting that the level to which SMEs use digital financial inclusion can reduce financial constraints. To evaluate its economic significance for the relationship, if the province in which firms are located move from 5% to 95% percentile of digital financial inclusion, we can observe the sensitivity of investment to cash is shifted from 0.059 ($0.515 - 0.089 \times 5.12$) to -0.0012 ($0.515 - 0.089 \times 5.80$). This result confirms Hypothesis 2, concluding that the development of digital financial inclusion is conducive to alleviating financing constraints for SMEs. The findings are consistent with that of Chauvet and Jacolin (2017), who found that financial inclusion reduces the "financing gap" facing SMEs and encourages investment activities.

Finally, in column (4), we add *Branch%*, *Cash*×*Branch%*, *DIG*, *Cash*×*DIG*, *Branch%*×*DIG* and *Cash*×*Branch%*×*DIG* in the regression model. The interaction variable *Cash*×*Branch%*×*DIG* is significantly positive. In contrast, the signs of the other variables have not changed, implying that local banks and digital financial inclusion play substitution roles in alleviating SME financing constraints.

Table 2. Baseline estimates of the impact of local bank branch and digital financial inclusion on SME financing constraints.

	(1)	(2)	(3)	(4)
Dep Var: <i>Investment</i>	model 1	model 2	model 3	model 4
<i>Sale</i>	0.081 (0.015)***	0.081 (0.015)***	0.082 (0.015)***	0.083 (0.015)***
<i>Cash</i>	0.021 (0.003)***	0.117 (0.024)***	0.515 (0.089)***	1.788 (0.575)***
<i>Branch%</i>		-0.664 (0.426)		-0.679 (0.425)
<i>Cash×Branch%</i>		-0.217 (0.054)***		-2.778 (1.276)**
<i>DIG</i>			-0.270 (0.196)	-0.519 (0.222)**
<i>Cash×DIG</i>			-0.089 (0.016)***	-0.297 (0.103)***
<i>Branch%×DIG</i>				-0.318 (0.235)
<i>Cash×Branch%×DIG</i>				0.452 (0.228)**
<i>Asset</i>	0.167 (0.003)***	0.165 (0.003)***	0.167 (0.003)***	0.164 (0.003)***
<i>Growth</i>	-0.011 (0.001)***	-0.011 (0.002)***	-0.011 (0.001)***	-0.011 (0.001)***
<i>ROA</i>	-0.008 (0.002)***	-0.008 (0.002)***	-0.008 (0.002)***	-0.008 (0.002)***
<i>LEV</i>	0.002 (0.001)**	0.004 (0.002)**	0.003 (0.001)**	0.003 (0.001)**
<i>Age</i>	-0.027 (0.008)***	-0.027 (0.008)***	-0.028 (0.008)***	-0.028 (0.008)***
<i>GDP</i>	0.099 (0.140)	0.088 (0.143)	0.105 (0.140)	0.068 (0.143)
<i>GDPgrowth</i>	0.483 (0.567)	0.524 (0.572)	0.451 (0.568)	0.535 (0.571)
<i>Gov Expenditure</i>	0.225 (0.631)	0.140 (0.675)	0.138 (0.632)	-0.169 (0.683)
<i>CPI</i>	-0.800 (1.187)	-1.042 (1.204)	-1.041 (1.198)	-1.593 (1.222)
<i>N</i>	11610	11610	11610	11610
<i>Hansen's J (P-value)</i>	.179	.164	.191	.162

** and ***Signify statistical significance at 5%, and 1%, respectively. Robust standard errors are shown in parentheses.

The finding suggests that the local banks are conducive to alleviating SME financing constraints; however, with the development of digital financial inclusion, the role of local banks has been gradually reduced. This might be attributed to the fact that the development of digital financial inclusion could enable large and state-owned banks to positively and effectively join the competition in serving SMEs because they have the advantages of capital, experience and talent for developing digital technologies and cooperating with suppliers of digital financial services. Specifically, this can be explained from three perspectives. First, traditionally, compared with small local banks, one of the disadvantages of large nationwide banks is that they hardly reach many SMEs located in less developed regions. However, digital technologies can overcome the fundamental distance problem through information technology, such as electronic exchange systems, online and mobile banking, which can increase SME accessibility to the financial services provided by large nationwide banks. Second, large banks can take advantage of big data technology to improve SME information opacity and reduce lending risk. Third, digital information technologies can help large banks shorten decision-making processes and reduce bureaucratic procedures.

To the extent that the omitted variables or measurement errors may cause estimation bias, we further perform robustness checks to verify the stability of our baseline results in Table 3. We first re-estimate the impact of local banks and digital financial inclusion on SME financing constraints by considering the investment-cash flow sensitivity model where the ratio of capital expenditures to

Table 3. Results of heterogeneous test: small vs. medium firms.

Dep Var: <i>Investment</i>	(1)	(2)
	<i>Small</i> = 1	<i>Small</i> = 0
<i>Sale</i>	0.029 (0.021)	0.050 (0.020)**
<i>Cash</i>	0.787 (0.042)***	1.120 (0.340)***
<i>Branch%</i>	-0.120 (0.430)	-0.610 (0.492)
<i>Cash</i> × <i>Branch%</i>	-0.496 (0.026)***	0.195 (0.188)
<i>DIG</i>	-0.483 (0.273)*	-0.358 (0.243)
<i>Cash</i> × <i>DIG</i>	-0.096 (0.007)***	-0.238 (0.059)***
<i>Asset</i>	0.073 (0.005)***	0.232 (0.007)***
<i>Growth</i>	-0.004 (0.001)***	-0.018 (0.003)***
<i>ROA</i>	-0.002 (0.001)**	-0.191 (0.032)***
<i>LEV</i>	0.001 (0.001)	0.084 (0.022)***
<i>Age</i>	-0.001 (0.008)	-0.036 (0.009)***
<i>GDP</i>	-0.019 (0.135)	0.163 (0.168)
<i>GDP</i> growth	0.025 (0.512)	0.622 (0.678)
<i>Gov Expenditure</i>	-0.315 (0.685)	0.124 (0.791)
<i>CPI</i>	0.618 (1.203)	-1.513 (1.419)
<i>N</i>	2113	9497
<i>Hansen's J (P-value)</i>	.642	.200

*, **, and ***Signify statistical significance at 10%, 5%, and 1%, respectively. Robust standard errors are shown in parentheses.

total assets of firm i in time t is linked to the ratio of operating cash flow to total assets of firm i in time $t-1$. All other variables are similar to those in model (2). We also test the alternative of local banks and digital financial inclusion in alleviating SME financing constraints through the bank loans held by SMEs. The rationale for doing so is that obtaining bank credits from whatever types of banks could ease SME financing constraints. The regression model we consider thus uses the ratio of bank loan to total assets of firm i in time t as dependent variable, and all other variables are the same as in model (2). The results for both tests with alternative measures confirm and support our hypotheses.⁷

4.2. Heterogeneity Tests

Although the results thus far indicate that local banks and digital financial inclusion can alleviate SME financing constraints, there is the possibility of a heterogeneity issue attributed to specific firm characteristics. To elaborate, we might expect the effect of local banks and digital financial inclusion to be offset or enhanced among firms that are relatively small, opaque and situated in a different market environment. We therefore need to address these concerns accordingly.

4.2.1. Firm Size

Table 3 presents the extension results of our empirical model used to test heterogeneous effects across categories of firm size. We divide the sample into two groups by the size of SMEs. *Small* is a dummy

variable that equals one if the firm classifies as a small enterprise according to China's official categories of firm sizes, zero otherwise. Small firms are firms with sales of less than 20 million RMB yuan.

In column (1), we estimate the impact of local banks and digital financial inclusion on small firms. The interaction variables, $Cash \times Branch\%$ and $Cash \times DIG$, are negative and significant at 1% level, suggesting that the development of local banks and digital financial inclusion can alleviate financing constraints for small firms. The result is principally consistent with what we found in the baseline regression results. However, in column (2), only the interaction variable $Cash \times DIG$ is significantly negative, which means digital financial inclusion plays a better role in alleviating financing constraints for medium firms than for small firms. The finding suggests that, although the development of local banks and digital financial inclusion generally reduces financing constraints for small and medium firms, the presence of local banks is more helpful for small firms than medium ones. In contrast, digital financial inclusion is more beneficial for medium-sized firms.

4.2.2. Firm Opacity

To test the heterogeneous effects linking to firms' opacity, we calculate the ratio of firm i 's intangible assets to total assets. Following the method of Ryan, O'Toole, and McCann (2014), we set a dummy variable *Opacity*. *Opacity* equals to one if the firm i 's intangible assets ratio is higher than the median of the year, otherwise zero. We lag the variable *Opacity* by one period to avoid reverse causality between investment and the ratio of intangible assets. Table 4 presents the results.

In column (1), we estimate the impact of local banks and digital financial inclusion on opaque firms. We find that only the interaction variable $Cash \times DIG$ is significantly negative, and the other, $Cash \times Branch\%$, is not. However, for transparent firms in column (2), $Cash \times Branch\%$ and $Cash \times DIG$ are both negative and statistically significant. The results suggest that although the development of digital financial inclusion is generally good for all SMEs, local banks are more willing to serve transparent firms. This result is in line with the argument of Rajan and Zingales (1995) that tangible assets can serve as collateral and diminish the risk for lenders from debt defaults.

4.2.3. Bank Market Power

In this subsection, we test whether the effects of local banks and digital financial inclusion differ when the structures of the financial system are different in provinces. Considering that bank credit is the most important financing channel for SMEs, we mainly analyze the effect of bank market power (proxied by bank credit). We define bank market power here as the share of bank credits in the total values of finance in a given province. Generally, the firms in the regions where the primary source of external funding is through bank lending are forced to seek bank credit as they have few alternatives. Additionally, in the provinces with higher bank market power, the credit market is a seller's market, and banks have ultimate power; in this case, even small local banks may be reluctant to pay extra costs to serve SMEs. Therefore, we expect that the effect of local banks and digital financial inclusion on SMEs financing constraints should decrease in the provinces that have higher bank market power. To measure the bank market power in a region, we follow the studies of Demirgüç-Kunt, Feyen, and Levine (2013) and Ryan, O'Toole, and McCann (2014) and define the bank market power first:

$$Bank\ Market\ Power_{kt} = \frac{BankCredit_{kt}}{BankCredit_{it} + MarketCapitalisation_{kt}} \quad (3)$$

where *BankCredit* is total bank credit of province k in year t ; *MarketCapitalisation* is the total value of listed companies' market capitalization of province k in year t . We set a dummy variable *Bankpower* which takes a value of one if the province's financial structure is higher than the median of the year, meaning the firms in the provinces where the bank credit power is higher.

Table 5 presents the results. For the firms in the provinces where bank market power is lower (column (2)), $Cash \times Branch\%$ and $Cash \times DIG$ are all negative and significant at 1% level, which is

Table 4. Results of heterogeneous test: opaque vs. transparent firms.

Dep Var: <i>Investment</i>	(1)	(2)
	<i>Opacity</i> = 1	<i>Opacity</i> = 0
<i>Sale</i>	0.037 (0.016)**	0.110 (0.018)***
<i>Cash</i>	1.187 (0.610)*	0.726 (0.220)***
<i>Branch%</i>	-0.713 (0.993)	-0.888 (0.798)
<i>Cash</i> × <i>Branch%</i>	0.602 (0.558)	-0.348 (0.150)**
<i>DIG</i>	-0.711 (0.319)**	-0.026 (0.304)
<i>Cash</i> × <i>DIG</i>	-0.312 (0.121)***	-0.097 (0.037)***
<i>Asset</i>	0.238 (0.013)***	0.104 (0.009)***
<i>Growth</i>	-0.063 (0.007)***	-0.005 (0.001)***
<i>ROA</i>	-0.216 (0.031)***	-0.003 (0.001)***
<i>LEV</i>	0.106 (0.024)***	0.003 (0.001)***
<i>Age</i>	-0.038 (0.012)***	-0.029 (0.014)**
<i>GDP</i>	0.366 (0.192)*	-0.267 (0.139)*
<i>GDP</i> growth	0.296 (0.803)	0.476 (0.658)
<i>Gov Expenditure</i>	0.342 (1.059)	-1.406 (1.012)
<i>CPI</i>	-1.146 (1.554)	-1.095 (1.794)
<i>N</i>	6165	5445
<i>Hansen's J (P-value)</i>	.359	.337

*, **, and ***Signify statistical significance at 10%, 5%, and 1%, respectively. Robust standard errors are shown in parentheses.

consistent with the baseline regression results. However, the firms in the provinces where bank credit power is higher (column (1)), the interaction term *Cash*×*DIG* is not significant, and *Cash*×*Branch%* is significantly positive, which means (1) the development of local banks and digital financial inclusion is not as equally important for alleviating financing constraints for SMEs in the regions with high bank market power as in the regions with low bank market power; (2) higher bank market power in a region would not help ease SME financing constraints.

5. Conclusion

Using a large data set that includes 11,610 SME firm-year observations over the period 2007–2017, this paper analyzes the effect of local bank branches and digital financial inclusion on SME financing constraints. We find that there is a relatively high sensitivity of firms' investment to the availability of internal funds, suggesting SMEs face difficulties in obtaining external financing. We find that the variation in cash-investment sensitivity is captured by the share of local banks and the development of digital financial inclusion. Specifically, both local banks and digital financial inclusion can reduce cash-investment sensitivity, which indicates that local banks and digital financial inclusion are conducive to alleviating financing constraints for SMEs. Further, we assess the interactive impact of local banks and digital financial inclusion on reducing SMEs' financing constraints, and the results show that local banks and digital financial inclusion have a substitution effect on reducing financing constraints for SMEs.

Table 5. Results of heterogeneous test: regional bank market power.

Dep Var: <i>Investment</i>	(1)	(2)
	<i>BankPower</i> = 1	<i>BankPower</i> = 0
<i>Sale</i>	0.067 (0.023)***	0.098 (0.019)***
<i>Cash</i>	-1.089 (0.395)***	0.516 (0.108)***
<i>Branch%</i>	0.469 (0.914)	-0.902 (0.648)
<i>Cash×Branch%</i>	1.071 (0.239)***	-0.291 (0.067)***
<i>DIG</i>	-0.249 (0.426)	-1.582 (0.489)***
<i>Cash×DIG</i>	0.032 (0.056)	-0.067 (0.019)***
<i>Asset</i>	0.169 (0.006)***	0.168 (0.005)***
<i>Growth</i>	-0.018 (0.004)***	-0.009 (0.002)***
<i>ROA</i>	-0.176 (0.024)***	0.005 (0.004)
<i>LEV</i>	-0.013 (0.003)***	0.094 (0.023)***
<i>Age</i>	-0.029 (0.012)**	-0.024 (0.011)**
<i>GDP</i>	-0.179 (0.264)	0.394 (0.498)
<i>GDPgrowth</i>	0.136 (0.756)	1.246 (1.200)
<i>Gov Expenditure</i>	-2.007 (1.585)	0.052 (1.156)
<i>CPI</i>	1.096 (2.428)	-2.357 (2.624)
<i>N</i>	5245	6365
<i>Hansen's J (P-value)</i>	.574	.079*

*, **, and ***Signify statistical significance at 10%, 5%, and 1%, respectively. Robust standard errors are shown in parentheses. Control variables are the same as in Table 2.

We also test the heterogeneity in the impact of local banks and digital financial inclusion on financing constraints with different firm and regional characteristics. First, we find that the effect of local banks on alleviating financial constraints is only significant for small firms. In contrast, the impact of digital financial inclusion is significant for both small and medium firms. This might be because smaller firms are more dependent than medium firms on obtaining relationship loans from local banks. Second, we find local banks are more conducive to transparent firms than their opaque counterparts, suggesting opaque firms face more financing constraints. Third, the positive contribution of local banks and digital financial inclusion in alleviating financial constraints only exists in the regions where the financial structure is less dependent on bank credit. It might be because bank market power is more extensive in the regions where SME financing is more dependent on bank credit.

The contributions of this paper to the literature are threefold. First, to the best of our knowledge, there is no research so far examining the impact of digital financial inclusion on alleviating SME financing constraints. As digital financial inclusion is a newly emerging concept which overlaps information technology and financial inclusion, the empirical evidence revealed in this paper thus provides interesting insights. Second, banking market structure research is generally focused on developed countries, especially in the United States (see Berger and Black 2011; Han, Zhang, and Greene 2017). However, in comparison with the U.S., banking systems in developing or transitional countries are much more crucial for providing finance to SMEs as these countries have less developed capital markets and strict regulatory systems in equity financing. China in particular is a unique institutional environment where large, national state-owned

banks and small, diversified ownership local banks operate simultaneously. We compute market shares of regional banks based on the number of branches within a given province. This approach differs with the measurement of bank market share in an open financial market (e.g. Tian and Han 2019). Presumably, it can be applied to other emerging countries with similar banking systems, especially to those economies transitioning from a centrally planned economy to a market economy. Third, the finding that local banks and digital financial inclusion are substituted should open a door to research on how digital financial inclusion has changed and will change SME-bank relationships; and many questions remain unanswered. For example, to what extent large banks and small banks use digital financial technologies differently in providing services to SMEs, how and why SMEs respond to them, and how these changes could alter the definitions of the concepts of formal and informal lending.

This research has important policy and managerial implications. The Chinese banking sector has undergone a dramatic reform in the last 40 years, characterized by banking deregulation and bank diversity, and strategically promoted the construction of digital financial inclusion in recent years. Our results provide strong evidence suggesting the strategies and policies in banking reform and digital financial inclusion have achieved their goals substantially, resulting in the significant contributions of local banks and digital financial inclusion to SME funding relief. More importantly, our study highlights that the involvement of new digital technologies in financial inclusion might reach a turning point for the establishment of new SME-bank relationships – perhaps subtle or intricate. Still, one can be certain that these new relationships will add different interpretations to what we understood before about the relationships between SMEs and small/large banks. However, our study is limited to a single country and in sample numbers. We expect more research to measure the types of banks and the degree of digital financial technologies used by different categories of banks and how their relationship changes as a result of using digital financial technologies.

Notes

1. Alipay is a third-party online mobile payment system (equivalent to PayPal in China), owned by the leading e-commerce giant, Alibaba Group. WeChat Pay is a digital wallet service by WeChat allowing users make mobile payments and online transactions.
2. The data that supports the findings of this study are available from the corresponding author upon reasonable request.
3. See <http://www.pbc.gov.cn/zhengcehuobisi/125207/125227/125960/126049/index.html> and <http://www.stats.gov.cn/tjsj/nds.j>.
4. The choice of 2007 as the starting point is due to the fact that in 2006, the Ministry of Finance of China issued new accounting standards which introduced fair values in accounting information. As such, there is a significant difference in financial information disclosure for listed firms before and after 2006, especially in terms of asset and liability measurements.
5. This group is a Fintech platform that serves small and micro enterprises and individual consumers in China.
6. See Appendix A in the Online Supplementary Document.
7. See Appendix B in the Online Supplementary Document.

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