

THE SHADOW BANKING BEHAVIOUR IN INTERNET OF THINGS: EVIDENCE FROM ECONOMY OPERATION MODE IN CHINA

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Article History:

- received 06 May 2021
- accepted 21 December 2021
- first published online 17 March 2022

Abstract. With the acceleration of world economic integration and enterprise management globalization, the advent of Internet of things based on Internet and information technology has become inevitable. The Internet of things also brings about a cascading effect between firms' shadow banking behaviour and bank connections. This study investigates the relationship between firms' shadow banking behaviour and bank connections by analysing a sample of Chinese listed firms in Internet of things industry. The results show that bank connections eliminate information asymmetry between banks and firms, bank connections are positively related to firms' long-term debt, and as long-term debt increases, firms' shadow banking behaviour also increases. Furthermore, this finding shows very strong robustness, the empirical analysis provides sufficient evidence that firms' shadow banking behaviour increased with bank connections in Internet of things industry. In addition, the evidence also shows that the tendency of shadow banking behaviour is more pronounced in non-state-owned enterprises (NSOEs) than state-owned enterprises (SOEs) by sub-sample sensitivity analysis.

Keywords: internet of things, shadow banking behaviour, bank connections, sub-sample sensitivity analysis.

JEL Classification: G31, G32, O16, L14.

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Introduction

The internet of things is an extension and expansion of the network based on the Internet. It combines various information sensing devices with the network to form a huge network, realizing the interconnection of people, machines and things at any time and any place. The Internet of things also plays an important role in the field of business, which can realize transactions and value-added services on the Internet, which are electronic, networked and informationized industry. The Internet of things itself has the characteristics of openness, globality, low cost and high efficiency. It has also become the intrinsic feature of e-business, which not only change the production, operation and management activities of enterprises themselves, but also affect the reaction process between firms' shadow banking behaviour and bank connections.

This study examines Chinese Internet of things listed firms' shadow banking behaviour in the presence of bank firm staff connections. Prior research has documented that non-financial

firms with more access to financial resources engaged more in shadow banking behaviour, such as State-owned enterprises (SOEs), big listed firms, and firms holding voting shares of banks (Allen et al., 2019; Du et al., 2017; Yao et al., 2019; Zhang, 2015). These studies are related to how formal institutions influence firms' shadow banking behaviour. However, whether and how firms' shadow banking behaviour is influenced by informal institutions, especially, by social network connection, is still to be investigated (Deng et al., 2021; Fu & Li, 2021). The development of shadow banking cannot be abandoned because of its disadvantages. It should not only play its positive role in economic development, but also lock its negative impact on financial risks.

Shadow banks have differences in different development stages. At the initial stage of development, the loan substitution rate is high, and a large number of funds enter the real economy, which has a significant marginal contribution to the economy. Among them, the loan substitution of joint-stock banks is particularly prominent. At this time, although shadow banking weakens the effectiveness of monetary policy, it also alleviates the damage to the economy caused by the tough policy forcing banks to withdraw capital and cut off loans; With the regulation of shadow banking strengthened, some funds turned to "interbank". At this time, the contribution of shadow banks to the economy decreased, but the influx of capital into the capital market pushed up asset price bubbles and accumulated a lot of financial risks. In this context, informal institutions such as bank firm social network can play a role of balance (Bertay et al., 2015; Bonfim et al., 2018; Castelli et al., 2012).

This paper contributes to the literature by investigating whether and how a less discussed informal institution, bank firm staff connection, which is measured as the hiring of staff who have bank working experience by listed firms as board members, directors, and managers, have influence on firms' shadow banking behaviour. We conjecture that social network connection should play a crucial role in firms' shadow banking behaviour, and effect is more pronounced in non-state-owned firms (NSOE) for the following two reasons (Castelli et al., 2012; Degryse & Cayseele, 2000; Engelberg et al., 2012).

Firstly, bank firm staff connection can alleviate the information asymmetry between firms and banks, so that firms can get easier access to bank loans. Former studies have documented that social network connection mitigate firms' financial constraints and improve firms cash policies and risk-taking policies (Engelberg et al., 2012; Zhai et al., 2017). As financial resources relieved, firms can have more resources to engage in shadow banking behaviour.

Secondly, staff with bank working experience can bring firms knowledge about financial assets investment and change firms' financial assets investment policies. Upper-echelons theory hold that organizational outcomes, strategies, or performance levels, are partially predicted by managerial background characteristics (Dong & Doukas, 2021; Duong et al., 2021; Hambrick & Mason, 1984). Board members, directors and managers with bank working experience are specialist in financial assets investment and the financial markets. They know well that return on financial assets is far greater than the return on other assets. According to Liu et al. (2014), average return on financial assets ranged from 25.25% to 35.94% from 2008 to 2012, while return on other assets ranged from 5.11% to 7.36% during the same period. Thus, they would lead firms to the investment of shadow banking assets (Du et al., 2017; Kloks, 2021; Miller, 2021).

As prior research mainly focuses on how formal institutions have impact on shadow banking behaviour, from the perspective of informal institutions, this study investigates the relationship between firms' shadow banking behaviour and bank connections. This study proceeds in three steps: firstly, it examines the relationship between bank connections and firms' short-term and long-term debt in Internet of things industry, thereby establishing the foundation for the next step of investigation. Secondly, this study examines how bank connections influence firms' shadow banking behaviour. Lastly, Compare the bank-connected state-owned firms' shadow banking behaviour with that of bank-connected private firms in Internet of things industry.

1. Literature review and hypotheses development

Information asymmetry alleviation and financial based professional knowledge are the two main benefits that social network connection between firm and bank could bring to firms. Thus, it is expected that firms with staff with bank working experience as board members, directors and managers would engage more shadow banking behaviour.

The influence of formal institutions on firms' shadow banking behaviour and the influence of informal institutions on firms' behaviour:

Both formal and informal institutions will have an impact on firms' behaviour. Informal institutions such as bank firm social network can alleviate information asymmetry between firm and bank and help firms to get more bank loan resources, especially when the formal institution environment does not work well.

As the Chinese capital market's development has been slow; hence, firms exist in an environment with insufficient means of financing. Financial constraints are pervasive in the Chinese market. According to the survey released by the China Entrepreneur Survey System on April 8, 2011, 31.7% and 38.5% of sole proprietorship entrepreneurs from state-owned enterprises and non-state-owned enterprises, respectively, believe that "bank loans cannot meet the normal production and operation needs". Similarly, 62.6% and 72.2% of sole proprietorship entrepreneurs from state-owned and non-state-owned enterprises, respectively, believe that "bank loans cannot meet the financing needs for external expansion of enterprises". Moreover, 61.3% of state controlled companies (enterprises directly under the central ministries) and 74.6% of private and family entrepreneurs believe that "bank loans cannot meet the financing needs for external expansion". The survey shows that most firms face financial constraints and the situation is worse for non-state-owned firms.

With the emergence of industry 5.0, our industry will be more promising, more flexible, more sustainable and more people-centered. Banks, as the main credit suppliers, play a crucial role in Chinese financial markets, employing different strategies for firms with different risks. Those with lower risk and greater information transparency can secure more loans, which often exceed their needs for real economic investment; hence, they have resources to invest in shadow banking assets. Conversely, those with higher risk and greater information asymmetry cannot secure loans from banks; consequently, they have incentive to seek other financial means and turn to the shadow banking system. The pervasive and severe financial constraints facing most Chinese firms provide a breeding ground for rapid growth of shadow

banking. According to Lu et al. (2015), the total volume of shadow banking was about 27 trillion RMB in 2012; of this, nonfinancial institutions contributed 4 trillion RMB, nearly 14.8% of the total amount.

To survive in such an environment, firms endeavour to establish good relationships with creditors; close ties with creditors benefit firms by helping mitigate frictions related to asymmetric information. Petersen and Rajan (1994) show that good relationships help small firms increase their loan availability. Berger and Udell (1995) highlight that bank-borrower relationships play an important role in the process of gathering information and setting loan contract terms. Small firms with good banking relationships can offer lower collateral while enjoying preferred interest rates. Berger and Udell (2002) argue that relationship lending, whose contract terms are preferred by borrowers, depends on the accumulation of soft information gathered by the loan officer. Espenlaub et al. (2012) showed that bank-connections improves bank's trust on firms and firms with bank connection showed significantly lower sensitivity of corporate investment to internal cash flow. Engelberg et al. (2012) documented that interpersonal linkage between firm staff and bank staff could help firms to get interest rate. Hilt (2018) demonstrates that firms with a bank director on their Board fared better in an economic panic. Therefore, good relationship with banks can mitigate information asymmetry and help firms to get more financial resources to get involved in shadow banking behaviour.

On the other hand, do firms also have incentives to know their creditors better? The answer is obviously yes. According to Upper-echelons theories (Dong & Doukas, 2021; Duong et al., 2021; Hambrick & Mason, 1984), the organizational strategies and firm performance are partially predicted by managerial background characteristics. Board members, directors or manager with bank working experience would help firms also require information about their creditors, especially given that banks are the main participants in the shadow banking system. The definition of the shadow banking system, which comprises financial intermediary behaviour outside the regular banking system, gives the impression that banks have nothing to do with it. However, banks are the main service suppliers of shadow banking products, including wealth management products, entrusted loans, bank-trust cooperation products, and bank-security firm cooperation products (Lu et al., 2015). These products are outside the banks' regular balance sheets; thus, outsiders are barely aware of such shadow banking products. whereas staff with bank working experience know well that banks' shadow banking products and those of their closely related partners could yield abnormally high returns compared to the average return on firm assets. However, if firms were to set up bank connections by hiring board members, directors, and managers who previously worked in commercial banks or banking policy, their better understanding of banks could be used to influence the firms' financing and investment decisions. Moreover, staff with bank working experience are specialists on how to balance the risk and income, they are also specialist on financial assets management and investment. So that firms with such kind of bank connection would engage more in shadow banking behaviour.

Furthermore, short-term and long-term debts have different impacts on firms. The amount of long-term debt is almost always larger than the amount of short-term debt. Long-term loans are generally used for large investment projects, which may sometimes last for decades, while short-term loans are generally used for emergent temporary turnover. Firms

with a much larger amount of long-term loans have enough time to make good monetary arrangements for unexpected opportunities or problems. Conversely, short-term debts need to be repaid in due course, often leaving firms short of time in such situations. Thus, staff with bank working experience would intend to get more long-term loans to show the board their value to the firm. They are specialists in loan mismatch, and they would use long-term loans to do shadow banking behaviours if there are excess long-term loans.

All in all, this paper proposes the following hypothesis:

H1a. *Bank connections are positively related to short-term debt.*

H1b. *Bank connections are positively related to long-term debt.*

H2. *Non-financial firms with bank connections undertake more intermediary behaviour than their non-connected counterparts.*

H2a. *Bank-connected non-financial firms can obtain greater amounts of loans, especially long-term loans, to engage in greater relending.*

H2b. *Bank-connected non-financial firms can obtain greater amounts of loans, especially short-term loans, to engage in greater relending.*

Furthermore, given the nature of their ownership, state-owned firms are inherently related to state-owned banks as they have the same controlling shareholder. However, things are quite different for non-state-owned firms, which face more severe financial constraints than their state-owned peers due to ownership discrimination, giving them incentive to seek bank connections. Moreover, while the main purpose of state-owned firms sometimes focuses on issues such as employment or stability, non-state-owned firms struggle to earn profits for their shareholders. Once loan resources are obtained, these firms would not hesitate to grasp an arbitrage opportunity should the occasion arise. Based on these facts, this study proposes the following hypotheses:

H3. *Bank-connected non-state-owned non-financial firms undertake more shadow banking behaviour than their non-connected counterparts.*

In sum, based on the logic that bank-firms staff connection can alleviate information asymmetry between banks and firms to promote firms' financial ability, and that according to Upper Echelons Theory, managers, board members, directors with bank working experience are expertise in financial investment, therefore this paper postulate that bank-firm staff connection would increase firms' shadow banking behaviour.

2. Methodology

Although borrowing and lending between firms is prohibited by the Chinese General Rules of Loan issued by the Central Bank in 1996, firms find various ways to engage in relending because of the huge market demand. Interest rates range between 4–10% when commercial banks grant loans to their large listed firm customers while interest rates on private loans are often 24% or higher. This abnormally high profit potential lures firms with sufficient resources to undertake relending activities. However, it is difficult to assess from a single account item

whether firms behave as surrogate financial intermediaries. Recently, Du et al. (2017) found an approach for recognizing firms' intermediary behaviour. Based on pecking order theory, they find that if firms hold more financial assets as their financial liabilities increase, it can be inferred that they are engaging in surrogate intermediary behaviour. Based on their model, this paper tests the relationship between firm relending and bank connections.

To test H1, run the following regressions:

$$\begin{aligned} \text{shortterm debt} / \text{sales}_{it} = & \beta_0 + \beta_1 BC_{it} + \beta_2 \text{size}_{it} + \beta_3 \tan g_{it} + \beta_4 ROA_{it} + \\ & \beta_5 \text{age}_{it} + \beta_6 \text{leverage}_{it} + \beta_7 \ln \text{sales}_{it} + \varepsilon_{it} \end{aligned} \quad (1)$$

Next, to test H2, construct the following regressions based on Shin and Zhao (2013) and Du et al. (2017):

$$\begin{aligned} \log\left(\frac{\text{financial assets}}{\text{sales}}\right)_{it} = & \beta_0 + \beta_1 \log\left(\frac{\text{shortterm debt}}{\text{sales}}\right)_{it} + \beta_2 BC_{it} + \\ & \beta_3 BC \times \log\left(\frac{\text{shortterm debt}}{\text{sales}}\right)_{it} + \beta_4 \text{Controls}_{it} + \varepsilon_{it} \end{aligned} \quad (2)$$

Also use the three models to test H3 by categorizing our sample into four groups: state-owned firms with and without bank connections, and non-state-owned firms with and without bank connections. Specifically, this paper compares the shadow banking behaviour of state-owned firms with and without bank connections, as well as that of non-state-owned enterprises with and without bank connections.

2.1. Measurement of dependent variable: the logarithm of financial assets to sales

Prior work has documented several ways of measuring firms' financial asset holdings, such as the sum of cash and short-term investments (Du et al., 2017; Shin & Zhao, 2013), sum of other current and non-current assets due within a year, other non-current assets, entrusted financial management, other receivables (Han et al., 2017), and total amount of loans entrusted (Li, 2017). Short-term investments are no longer used, according to Chinese 2007 New Accounting Standards. Hence, we construct financial asset holdings as the logarithm of the sum of cash, short-term investments, tradable financial assets, net value of available-for-sale financial assets, net value of held-to-maturity investments, and net amount of financial assets purchased for resale divided by sales. This paper will use Han et al. (2017)'s proxy as a robustness test.

2.2. Measurement of independent variables

This paper uses the logarithm of short-term debt to sales, logarithm of long-term debt to sales, and logarithm of total financial liabilities to sales as our independent variables.

2.3. Measurement of independent variable – bank connections (BC)

Prior literature employs several means of measuring bank connections, including duration of bank-firm cooperation connection (Berger & Udell, 2002; Degryse & Cayseele, 2000; Petersen

& Rajan, 1995), bank shareholding connections (Hao et al., 2014), and social network connections (Engelberg et al., 2012; Hilt, 2018). This paper categorizes firms as bank-connected if they hire board members, directors, or managers who previously worked in commercial or policy banks. This is justifiable, because compared to other social network connections, such as firm managers and bank staff attending the same college or sharing the same third-party first job experience, bank insiders know more than outsiders about how banks operate their shadow banking products. Moreover, bank insiders are financial professionals and have social networks among nonbank financial institutions such as regulators, trust companies, and security firms, which give them an advantage in detecting policy changes and other information that may influence credit offerings in the overall market. In contrast, bank shareholding connections and common schoolmate or workmate connections do not have these professional or insider information advantages. Accordingly, this paper constructs bank connections as a dummy variable that equals 1 if firms hire staff with prior commercial or policy bank working experience as their board members, directors, or managers, and 0 otherwise.

2.4. Measurement of ownership

This paper measures ownership by the characteristics of the controlling shareholder. If the ultimate controlling shareholder is the government, the variable *state dummy* equals 1, and 0 otherwise.

2.5. Control variables

Prior literature documents that firm size, leverage, sales, firm age, and return on assets (ROA) can represent a firm's financing ability, which is closely related to the firm's lending ability since firms cannot undertake relending activities without sufficient resources. In addition, this paper used fixed effects to control for firm characteristics that do not change with time and also control for year effects.

3. Empirical results

3.1. Data and statistics

To test the hypothesis of the relationship between bank connections and firm shadow banking behaviour, financial statement data and personnel information of board members, directors, and managers from the databases CSMAR, which is the most used databases of listed firms in China, is employed. The advantage of CSMAR is that it not only gathers and extracts timely financial reports of all listed firms in China, but also includes personnel information, such as educational background, working experience of board members, managers, and directors which is of great importance to the study, because we construct the proxy for bank connections based on bank working experience of firms' board members, directors and managers. Define bank connection (BC) as a dummy variable, which equals to 1 if firms hire staff with bank working experience as board members, directors and managers, and 0 otherwise.

Excluding financial institutions (SIC code containing J) from our sample as our purpose is to test the relationship between non-financial firms' shadow banking behaviour and bank

connections. This paper also deleted Special Treatment (ST) and PT (Particular Transfer) firms, because the purpose of these abnormal firms is to survive, not to undertake intermediary behaviour. This paper also excluded firm-year observations that have missing values. Variables, except dummy variables, are winsorized from 1% to 99% to eliminate the effect of outliers. The final sample covers fiscal years from 2003 to 2016 with 10,140 firm year observations. There are 198 bank-connected firms with 970 firm-year observations in our sample.

This paper used Stata 13.0 to conduct the empirical analyses. The summary statistics are presented in Table 1.

BC is a dummy variable representing bank connections and equals 1 if firms hire board members, directors, or managers who previously worked in commercial or policy banks and 0 otherwise. Financial assets are defined as the sum of cash, short term investments, tradable financial assets, net value of available-for-sale financial assets, net value of held-to-maturity investments, and net amount of financial assets purchased for resale short-term investments. Financial liabilities are defined as the sum of short-term and long-term debts. *Tangi* represents tangible assets divided by total assets. ROA is defined as the return on assets. Age refers to the firm's listed age. Growth refers to sales growth rate over the previous year. Firm Leverage is defined as financial liabilities divided by total assets. N is the number of observations. Unit of sales is RMB million.

As shown in Table 1, firms with large sales volumes establish bank connections by hiring board members, directors, or managers who previously worked at commercial or policy banks. Specifically, the mean sales of firms with bank connections are 11,696.9 million RMB, almost twice as great as the mean sales of firms without bank connections (6,450.9 million RMB). Both ratios of financial assets to sales and financial liabilities to sales of bank-connected firms (0.52 and 0.72, respectively) are much higher than those of non-connected firms (0.39 and 0.59, respectively). Regarding leverage structure, the mean values provide interesting results. We expected that bank connections increase both short-term and long-term debt, and find that the short-term debt to sales ratio of bank-connected firms is 0.34 while that of non-bank-connected firms is 0.29; similarly, the mean long-term debt to sales ratio of bank-connected firms is 0.43 while that of non-bank-connected firms is 0.24. These results suggest that bank-connected firms prefer long-term debt over short-term debt. Next, *tangi* represents the value of fixed assets to sales and is a proxy for collateral. A higher value of *tangi* indicates a firm has the ability to obtain a larger mortgage; generally speaking, a higher value of *tangi* implies greater financing ability. However, the mean value of *tangi* of bank-connected firms (0.22) is lower than that of non-bank-connected firms (0.28). Nonetheless, the former can obtain greater debt. The listed *age*, *growth* rate, and *leverage* of bank-connected firms are higher than those of their non-bank-connected counterparts.

3.2. Bank connections and firms' financing ability

This section presents the empirical regression results. First, this paper presents the results for the relationship between bank connections and firms' financing ability, that is, short-term and long-term debt. Second, this paper showed the results for the relationship between bank connections and firms' shadow banking behaviour, and thereafter investigate the difference between the shadow banking behaviour of bank-connected state-owned firms and other firms.

Table 1. Summary statistics of Chinese listed nonfinancial firms (2003–2016)

Firm Data Summary Statistics					
variables	full sample				
	mean	Std.dev	min	max	N
Sales	6975.78	15830.96	37.68	1.00E+05	9505
Financial assets/sales	0.4	0.5	0.02	3.53	9505
Financial liability/sales	0.61	0.79	0	4.85	9505
Short-term/sales	0.34	0.4	0	2.27	9505
Long-term debt/sales	0.26	0.54	0	3.42	9276
Tangi	0.27	0.19	0	0.77	9505
ROA	0.05	0.05	0	0.26	9505
Age	12.37	5.57	0	26	9505
Growth	0.33	0.63	0	4.94	9505
Leverage	0.53	0.18	0.03	1	9505
variables	Bank Connected Firms				
	mean	Std.dev	min	max	N
Sales	11696.9	22677.95	37.68	1.00E+05	951
Financial assets/sales	0.52	0.61	0.02	3.53	951
Financial liability/sales	0.72	0.95	0	4.85	951
Short-term/sales	0.29	0.37	0	2.27	951
Long-term debt/sales	0.43	0.75	0	3.42	912
Tangi	0.22	0.2	0	0.77	951
ROA	0.05	0.05	0	0.26	951
Age	15.68	5.35	0	26	951
Growth	0.4	0.84	0	4.94	951
Leverage	0.54	0.2	0.07	0.99	951
variables	Non-Bank Connected Firms				
	mean	Std.dev	min	max	N
Sales	6450.9	14785.41	37.68	1.00E+05	8554
Financial assets/sales	0.39	0.49	0.02	3.53	8554
Financial liability/sales	0.59	0.76	0	4.85	8554
Short-term/sales	0.34	0.4	0	2.27	8554
Long-term debt/sales	0.24	0.5	0	3.42	8364
Tangi	0.28	0.19	0	0.77	8554
ROA	0.05	0.05	0	0.26	8554
Age	12	5.48	0	26	8554
Growth	0.33	0.6	0	4.94	8554
Leverage	0.53	0.18	0.03	1	8554

A firm's bank loans comprise short-term and long-term debt. Short-term debt is due within one accounting year whereas long-term debt is due beyond one accounting year. This regression tests the relationship between bank connections and firms' short-term and long-term debt.

Table 2 illustrates the relationship between bank connections (BC) and short-term debt. The coefficients of BC in columns (1) and (2) are significantly negatively related to short-term debt, indicating that bank connections have a negative effect on firms' access to more short-term debt, especially among state-owned enterprises. These results imply that firms with bank connections have less short-term debt, potentially due to the small amounts involved in short-term debt. Bank-connected staff would likely save their bargaining power for larger debt amounts, that is, long-term debt.

Table 2. Relationship between bank connections and short-term debt

	(1)	(2)	(3)
	Full Sample	SOE	NSOE
BC	-0.035*** (-3.00)	-0.032** (-2.39)	-0.011 (-0.49)
size	0.295*** (39.82)	0.292*** (31.96)	0.314*** (23.43)
ln(sales)	-0.309*** (-50.53)	-0.347*** (-44.99)	-0.287*** (-26.71)
tangi	0.079*** (2.98)	-0.047 (-1.56)	0.256*** (4.87)
leverage	0.863*** (40.45)	0.847*** (32.56)	0.764*** (19.93)
state dummy	0.006 (0.44)		
ROA	0.486*** (7.93)	0.280*** (3.94)	0.675*** (6.16)
age	-0.020*** (-17.39)	-0.012*** (-8.86)	-0.032*** (-13.63)
Constant	0.203* (1.88)	1.012*** (7.21)	-0.518*** (-2.81)
year fixed effect	yes	yes	yes
firm fixed effect	yes	yes	yes
N	11296	7297	3999
R ² _adj	0.275	0.280	0.214
F	276.645	190.026	92.973

Note: The independent variable is the ratio of short-term debt to sales. BC represents bank connections. State dummy is a dummy variable that equals 1 if the ultimate controller is the government or a governmental unit, and 0 otherwise. SOE and NSOE refer to state-owned and non-state-owned enterprises, respectively. t statistics are included in parentheses. * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$.

Table 3 shows the relationship between bank connections and long-term debt. The coefficients of *BC* in columns (1) and (3) are significantly positively related to long-term debt, thereby indicating that bank connections have a positive effect on firms' access to amounts of long-term debt, especially for non-state-owned enterprises. These results indicate that firms with bank connections may have more long-term debt compared to their non-connected peers, especially for non-state-owned enterprises. The coefficient of *BC* in column (2) is positive but not significant. This implies that the effect is statistically insignificant for state-owned firms and proves the existence of ownership discrimination when banks extend credit to firms.

Table 3. Relationship between bank connections and long-term debt

	(1)	(2)	(3)
	Full Sample	SOE	NSOE
<i>BC</i>	0.033** (2.17)	0.009 (0.53)	0.078*** (2.66)
size	0.473*** (49.96)	0.498*** (41.74)	0.407*** (23.14)
ln(sales)	-0.389*** (-49.87)	-0.418*** (-41.72)	-0.339*** (-24.12)
tangi	0.235*** (7.01)	0.372*** (9.57)	-0.059 (-0.87)
leverage	0.611*** (22.40)	0.660*** (19.44)	0.647*** (12.72)
state dummy	-0.040** (-2.35)		
ROA	-0.442*** (-5.69)	-0.384*** (-4.17)	-0.502*** (-3.47)
age	-0.006*** (-4.05)	-0.008*** (-4.26)	-0.005* (-1.66)
year fixed effect	yes	yes	yes
firm fixed effect	yes	yes	yes
Constant	-2.153*** (-15.61)	-2.156*** (-11.70)	-1.737*** (-7.18)
N	10831	7096	3735
R ² _adj	0.221	0.249	0.102
F	211.254	163.990	53.656

Note: The independent variable is the ratio of *long-term debt to sales*. *BC* represents bank connections. *State dummy* is a dummy variable that equals 1 if the ultimate controller is the government or a governmental unit, and 0 otherwise. SOE and NSOE refer to state-owned and non-state-owned enterprises, respectively. t statistics are included in parentheses. * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$.

3.3. Bank connections and firms' shadow banking behaviour

The regressions in this section introduce three interactions in three models. Columns (1), (3), and (5) of Table 4 test how financial assets change with a change in short-term debt, long-term debt, and financial liabilities, respectively. Columns (2), (4), and (6), respectively, additionally test whether financial asset holdings differ between bank-connected firms and their non-bank-connected counterparts with a change in short-term debt, long-term debt, and financial liabilities holdings as a whole.

Table 4 shows the relationship between bank connections and firms' shadow banking behaviour. Columns 1, 3, and 5 suggest that as a firm's bank loans increase, its financial assets also increase. This violates pecking order theory's prediction that, in real economic investments, firms first consume cheaper internal funds before turning to more expensive external funding alternatives; thus, financial assets and financial liabilities would be negatively correlated. However, the coefficients of the logarithms of short-term debt to sales, long-term debt to sales, and financial liabilities to sales in columns 1, 3, and 5, respectively, are significantly positively related to the logarithm of financial assets to sales, implying that as bank loans increase, the financial asset holdings of non-financial firms also increase. This characteristic is similar to banks; as banks borrow in order to lend, their financial assets and financial liabilities move in the same direction.

Column 2 shows how changes in short-term debt influence financial asset holdings of bank-connected firms compared with non-bank-connected firms. The coefficient of the interaction between bank connections and the logarithm of short-term debt to sales is positively related with the logarithm of financial assets to sales. This implies that bank-connected firms hold more financial assets, since short-term debt increases compared to their non-connected counterparts. However, the effect is statistically insignificant.

Column 4 shows how changes in long-term debt influence the financial asset holdings of bank-connected firms compared with their non-bank-connected counterparts. The coefficient of the interaction between bank connections and the logarithm of long-term debt to sales is positively related to the logarithm of financial assets to sales, implying that, compared to their non-connected counterparts, bank-connected firms hold more financial assets as long-term debt increases. This effect is statistically significant; on average, bank-connected firms hold an additional 0.039 units of the logarithm of financial assets to sales than their non-bank-connected peers when facing the same one-unit increase in the logarithm of long-term debt to sales.

Column 6 explores how changes in financial liabilities as a whole influence financial asset holding of bank-connected firms compared to their non-connected counterparts. The coefficient of the interaction between bank connections and the logarithm of financial liabilities to sales is positively related to the logarithm of financial assets to sales, suggesting that as financial liabilities increase, bank-connected firms hold more financial assets compared to their non-connected counterparts. This effect is statistically significant; on average, bank-connected firms hold an additional 0.055 units of the logarithm of financial assets to sales than their non-bank-connected peers when facing the same unit increase in the logarithm of financial liabilities to sales.

Table 4. Chinese non-financial firms: panel regressions of bank connections and firms' shadow banking behaviour (2003–2016)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
ln(short-term debt/sales)	0.124***	0.119***				
	(9.41)	(8.87)				
BC		0.126		0.108		0.094
		(1.46)		(1.47)		(1.48)
BC*ln(short-term debt/sales)		0.052				
		(1.60)				
ln(long-term debt/sales)			0.087***	0.081***		
			(8.44)	(8.14)		
BC*ln(long-term debt/sales)				0.039**		
				(2.03)		
ln(financial liability/sales)					0.181***	0.174***
					(11.38)	(10.84)
BC*ln(financial liability/sales)						0.055**
						(1.98)
ln(sales)	-0.230***	-0.230***	-0.271***	-0.272***	-0.214***	-0.215***
	(-8.34)	(-8.38)	(-9.35)	(-9.52)	(-8.12)	(-8.22)
Tangi	-1.985***	-1.987***	-2.112***	-2.111***	-2.067***	-2.072***
	(-16.10)	(-16.12)	(-16.39)	(-16.38)	(-17.73)	(-17.76)
ROA	-0.694***	-0.680***	-0.453	-0.438	-0.443*	-0.424*
	(-3.01)	(-2.97)	(-1.60)	(-1.55)	(-1.95)	(-1.88)
Leverage	-0.857***	-0.855***	-0.659***	-0.663***	-1.109***	-1.106***
	(-7.05)	(-7.03)	(-5.24)	(-5.27)	(-9.01)	(-8.97)
Age	0.048***	0.047***	0.049***	0.048***	0.048***	0.047***
	(11.02)	(10.29)	(10.07)	(9.56)	(11.49)	(10.80)
Growth	-0.014	-0.014	-0.007	-0.008	-0.015	-0.015
	(-0.90)	(-0.93)	(-0.49)	(-0.51)	(-1.05)	(-1.08)
Constant	4.350***	4.351***	5.243***	5.258***	4.166***	4.192***
	(7.96)	(8.00)	(9.01)	(9.17)	(8.06)	(8.17)
Firm fixed effects	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
N	9102	9102	6751	6751	9505	9505
R ² _adj	0.248	0.249	0.265	0.266	0.270	0.271
F	58.947	54.059	53.260	48.618	64.479	59.242

Note: The independent variables are *ln (short-term debt to sales)*, *ln (long-term debt to sales)*, and *ln (financial assets to sales)* in each of the three regressions, respectively. *BC* is a dummy variable representing bank connections and equals 1 if firms engage directors, board members, and managers who previously worked at commercial banks or policy banks, and 0 otherwise. Financial liabilities are the sum of short-term and long-term debt. *t* statistics are included in parentheses. * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$.

From Table 4, it can be inferred that long-term debt plays a more important role in bank-connected firms' participation in shadow banking activities than short-term debt does. The reason for this phenomenon may be that bank connections yield more long-term debt. The amount of long-term debt is almost always larger than that of short-term debt and there is a time mismatch for firms using long-term debt. As such, firms with bank connections can make better use of their funds by relending. This not only demonstrates the resource yielding power of bank connections, but also the reduction in information asymmetry when there is a bank-connected person working in non-financial firms.

3.4. Bank connections, firms' shadow banking behaviour, and ownership

Table 5 reports the differences in the effects of bank connections on firms' shadow banking behaviour between state-owned enterprises (SOE) and non-state-owned enterprises (NSOE). Columns (1), (3), and (5) list the shadow banking behaviour of SOE while columns (2), (4), and (6) present the shadow banking behaviour of NSOE.

The coefficient of the logarithm of short-term debt to sales in column (1) is positively related to the logarithm of financial assets to sales with a value of 0.077. This implies that, for SOE, as short-term debt increases, financial assets increase. In other words, short-term debt is a resource for the shadow banking behaviour of SOEs. However, the coefficient of the interaction between bank connections and the logarithm of short-term debt to sales is insignificantly negatively related to the dependent variable, the logarithm of financial assets to sales. This implies that bank connections do not play an important role for SOEs, suggesting state-owned firms would not undertake additional surrogate intermediary behaviour if they had bank connections compared with their non-connected state-owned counterparts.

The coefficient of the logarithm of short-term debt to sales in column (2) is also positively related to the logarithm of financial assets to sales with a value of 0.182, which is much higher than that of state-owned enterprises (0.077). This implies that for NSOE, as short-term debt increases, financial asset holdings also increase. In other words, short-term debt acts a resource for shadow banking behaviour of NSOEs. However, the coefficient of the interaction between bank connections and the logarithm of short-term debt to sales is significantly positively related to the logarithm of financial assets to sales. In contrast to state-owned firms, this implies that non-state-owned firms with bank connections do engage more in shadow banking behaviour. On average, bank-connected NSOEs hold an additional 0.105 units of the logarithm of financial assets to sales than their non-bank-connected non-state-owned peers when facing the same unit increase in the logarithm of short-term debt to sales.

The coefficient of the logarithm of long-term debt to sales in column (3) is significantly positively related to the logarithm of financial assets to sales (0.086), implying that, for SOEs, as long-term debt increases, financial assets also increase. In other words, long-term debt is also a resource for the shadow banking behaviour of SOEs. However, the coefficient of the interaction between bank connections and the logarithm of long-term debt to sales is insignificantly positively related to the dependent variable, the logarithm of financial assets to sales. This means that compared to non-bank-connected state-owned firms, bank connections have no significant effect on the shadow banking behaviour of state-owned firms. Similar to the case of short-term debt, bank connections do not influence state enterprises' surrogate intermediary behaviour.

Table 5. Bank connections and firms' shadow banking behaviour by ownership type

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	SOE	NSOE	SOE	NSOE	SOE	NSOE
ln(short-term debt/sales)	0.077***	0.182***				
	(5.28)	(6.61)				
BC	-0.036	0.317**	0.023	0.293*	0.030	0.206
	(-0.43)	(2.00)	(0.30)	(1.90)	(0.44)	(1.64)
BC*ln(short-term debt/sales)	-0.015	0.105**				
	(-0.43)	(2.09)				
ln(long-term debt/sales)			0.086***	0.075***		
			(7.28)	(4.03)		
BC*ln(long-term debt/sales)			0.018	0.072*		
			(0.95)	(1.91)		
ln(financial liabilities/sales)					0.128***	0.233***
					(6.67)	(8.40)
BC* ln(financial liabilities/sales)					0.025	0.077*
					(0.77)	(1.91)
ln(sales)	-0.319***	-0.170***	-0.304***	-0.245***	-0.287***	-0.175***
	(-9.75)	(-3.96)	(-9.51)	(-4.52)	(-9.04)	(-4.21)
Tangi	-2.216***	-1.682***	-2.117***	-2.330***	-2.264***	-1.825***
	(-14.62)	(-6.70)	(-13.80)	(-8.01)	(-15.94)	(-7.52)
ROA	-0.326	-1.131***	0.073	-1.578***	-0.034	-0.969**
	(-1.19)	(-2.81)	(0.24)	(-2.70)	(-0.12)	(-2.53)
Leverage	-0.576***	-1.014***	-0.707***	-0.362	-0.887***	-1.156***
	(-3.93)	(-4.65)	(-4.86)	(-1.35)	(-5.91)	(-5.17)
Age	0.053***	0.038***	0.052***	0.043***	0.052***	0.038***
	(9.76)	(4.06)	(8.97)	(3.70)	(10.00)	(4.22)
Growth	0.018	-0.049*	0.026*	-0.045*	0.016	-0.054**
	(1.19)	(-1.85)	(1.71)	(-1.73)	(1.10)	(-2.28)
Constant	6.042***	3.303***	5.976***	4.595***	5.569***	3.504***
	(9.22)	(3.97)	(9.24)	(4.30)	(8.87)	(4.36)
Year fixed effects	yes	yes	yes	yes	yes	yes
Firm fixed effect	yes	yes	yes	yes	yes	yes
N	6143	2959	4747	2004	6386	3119
R ² _adj	0.260	0.253	0.273	0.265	0.274	0.274
F	37.400	19.046	36.765	14.429	40.977	21.275

Note: The independent variable is the logarithm of financial assets to sales. SOE and NSOE stands for state-owned and non-state-owned enterprises, respectively. BC is a dummy variable representing bank connections and equals 1 if firms engage directors, board members, and managers who previously worked at commercial banks or policy banks, and 0 otherwise. Financial liabilities are the sum of short-term and long-term debt. t statistics are included in parentheses. * p < 0.1, ** p < 0.05, and *** p < 0.01.

The coefficient of the logarithm of long-term debt to sales in column (4) is also positively related to the logarithm of financial assets to sales, although its value is slightly smaller than in the case of state-owned peers. This may suggest that non-state-owned firms face more severe financial constraints than state-owned firms as they carry less long-term debt. The positive relationship demonstrates that long-term debt is also a resource for the shadow banking behaviour of NSOE. More importantly, the coefficient of the interaction between bank connections and the logarithm of long-term debt to sales is significantly positively related to the logarithm of financial assets to sales. This means that, in stark contrast to state-owned firms, non-state-owned firms with bank connections engage in more relending activities than non-bank-connected non-state-owned firms. On average, bank-connected non-state-owned firms hold 0.072 additional units of the logarithm of financial assets to sales than their non-bank-connected non-state-owned peers when facing the same unit increase in the logarithm of long-term debt to sales. This indicates there is a statistical difference in the engagement in shadow banking behaviours for non-state-owned firms who set up bank connections.

The coefficient of the logarithm of financial liabilities to sales in column (5) is significantly positively related to the logarithm of financial assets to sales, implying that for SOEs, as financial liabilities increase, financial assets also increase. However, the value of the coefficient is 0.128, almost half of that of NSOEs (0.233; column 6), indicating that state-owned firms engage in comparatively less surrogate intermediary behaviour than non-state-owned firms. Moreover, the coefficient of the interaction between bank connections and the logarithm of financial liabilities to sales is insignificantly positively related to the dependent variable, the logarithm of financial assets to sales. This indicates that bank connections do not exert a significant effect on the shadow banking behaviour of state-owned firms compared to their non-bank-connected counterparts.

The coefficient of the logarithm of financial liabilities to sales in column (6) is also positively related to the logarithm of financial assets to sales with a larger value than that of their state-owned peers. This may suggest that NSOEs engage in relending businesses more than state-owned firms. More importantly, the coefficient of the interaction between bank connections and the logarithm of financial liabilities to sales is significantly positively related to the logarithm of financial assets to sales. This implies that, in contrast to state-owned firms, non-state-owned firms with bank connections engage more in shadow banking behaviour than non-bank-connected non-state-owned firms. On average, bank-connected non-state-owned firms hold 0.077 additional units of the logarithm of financial assets to sales than their non-bank-connected non-state-owned peers when facing the same one-unit increase.

3.5. Robustness test

This study uses Han et al. (2017)'s proxy of firms' shadow banking behaviour to test the robustness of the relationship between firms' shadow banking behaviour and bank connections. Han et al. (2017) measure firms' holding of shadow banking products as the sum of other current assets, non-current assets due within a year, other non-current assets, entrusted financial management, and other receivables to sales. According to their study of staff from the accountancy departments of different firms, in instances of private lending between firms or a third party, firms record the loaned amount into one or more of these accounts. The

results in Table 6 show that as long-term debt increases, bank-connected firms engage in more shadow banking behaviour, on average, than their non-connected peers, consistent with our findings above.

Table 6. Robustness test results

Variable	(1)	(2)	(3)	(4)	(5)	(6)
ln(short-term debt/ sales)	0.067***	0.068***				
	(6.73)	(6.73)				
BC		-0.027		0.136**		0.024
		(-0.42)		(2.09)		(0.46)
BC* ln(short-term debt/sales)		-0.020				
		(-0.83)				
ln(long-term debt/sales)			0.029***	0.024***		
			(3.31)	(2.67)		
BC* ln(long-term debt/sales)				0.034**		
				(2.01)		
ln(financial liabilities/sales)					0.081***	0.081***
					(8.13)	(7.90)
BC* ln(financial liabilities/sales)						-0.002
						(-0.11)
ln(sales)	-0.829***	-0.829***	-0.824***	-0.826***	-0.825***	-0.825***
	(-52.29)	(-52.28)	(-41.45)	(-41.52)	(-53.94)	(-53.88)
Tangi	-0.342***	-0.341***	-0.465***	-0.464***	-0.396***	-0.396***
	(-3.51)	(-3.50)	(-4.07)	(-4.06)	(-4.19)	(-4.20)
ROA	0.184	0.177	0.029	0.036	0.241	0.239
	(1.04)	(1.00)	(0.11)	(0.14)	(1.37)	(1.35)
Leverage	0.228***	0.229***	0.648***	0.642***	0.153**	0.154**
	(2.99)	(3.00)	(6.51)	(6.45)	(1.99)	(2.01)
Age	0.076***	0.075***	0.065***	0.064***	0.074***	0.073***
	(18.02)	(17.68)	(12.87)	(12.54)	(18.12)	(17.70)
Growth	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(-0.58)	(-0.58)	(-0.49)	(-0.49)	(-0.57)	(-0.57)
Constant	16.282***	16.286***	16.201***	16.227***	16.272***	16.275***
	(51.76)	(51.74)	(40.96)	(41.00)	(53.64)	(53.59)
year fixed effects	yes	yes	yes	yes	yes	yes
firm fixed effects	yes	yes	yes	yes	yes	yes
N	5134	5134	3630	3630	5360	5360
R ² _adj	0.380	0.380	0.344	0.345	0.388	0.388
F	197.604	178.773	128.170	116.320	211.353	191.182

Note: The independent variable is the logarithm of the sum of other current assets, non-current assets due within a year, other non-current assets, entrusted financial management, and other receivables to sales. t statistics are included in parentheses. * p < 0.1, ** p < 0.05, and *** p < 0.01.

Conclusions

This study tests the relationship between bank connections and firms' shadow banking behaviour for Internet of things industry, as well as the difference in the effects of bank connections on firms' shadow banking behaviour between state-owned and non-state-owned firms. It can be seen from the result analysis that firms' shadow banking behaviour can be detected by a violation of pecking order theory with the emergence of Internet of things. In pecking order theory, firms consume internal cash holdings first and then turn to external financing sources when there is an investment that needs financing. The violation of pecking order implies that firms behave like banks, who borrow in order to lend. In our investigation, we find that non-financial listed firms do engage in shadow banking behaviour. Additionally, we find that regardless of type (short-term debt, long-term debt, or financial liabilities as a whole), when bank loans increase, firms' holdings of cash and short-term investments increase. This means firms' short-term and long-term loans are both used for investing in shadow banking products such as entrusted loans and trust investments.

This paper also found that for bank-connected firms in Internet of things industry, different loan resources have different effects on the allocation of firms' relending business. It is found that as their long-term debt increases, bank-connected firms hold more short-term financial investments than their peers without bank connections. Setting up bank connections by hiring board members, directors, or managers who previously worked at banks may offer two benefits for firms. Firstly, firms with this type of bank connection are large firms with significant sales volumes; thus, their financing needs are significantly large and extend over long periods of time. Based on our investigation, it is found that bank connections do bring them significantly greater long-term loan resources compared to firms without bank connections. Secondly, firms with bank connections have access to professional information and skills related to shadow banking products. In fact, banks are heavily engaged in shadow banking behaviour. Bank-related shadow banking products are those products or services offered by banks or institutions that work closely with banks, which include financial products like wealth management products, entrusted loans, bank-trust cooperation products, and bank-security firms cooperation products. According to Liu et al. (2014), the average return on these products (25.25–35.94%) is much higher than average return on assets (5.11–7.36%) People with prior working experience in banks are aware of this and thus, when bank-connected firms' holdings of long-term debt increase, they hold more financial assets than non-bank-connected firms. Because people are more confident for Internet of things industry, bank-connected firms can better use their long-term debt if they have an arbitrage opportunity.

In addition, the effect of bank connections on state-owned firms and non-state-owned firms differs for Internet of things industry. Since state-owned firms have an advantage in the financing market, their financial constraints are less severe than those of non-state-owned firms. Bank connections do not have much of an effect on state-owned firms' shadow banking behaviour. However, things are quite different for non-state-owned firms; due to ownership discrimination, they face more severe financial constraints than their state-owned peers. In

this case, bank connections do enhance the shadow banking behaviour of non-state-owned firms. It is found that the shadow banking behaviour coefficient of non-state-owned firms is higher than that of state-owned firms, indicating that non-state-owned firms have more incentives to engage in relending. Moreover, the coefficient of the interaction between bank connections and the logarithms of long-term debt to sales and financial liabilities to sales are each significantly positively related to the logarithm of financial assets to sales. This suggests bank connections have an effect on the shadow banking behaviour of non-state-owned firms but not that of state-owned firms.

These findings may have implications for understanding bank connections and firms' cash holdings with the influence of Internet of things. Bank connections increase firms' shadow banking behaviour as they provide large firms with access to more long-term debt; this is the resource function of bank connections. Bank connections also offer professional information and judgement for firms' relending businesses. Bank-connected personnel know more about banks' shadow banking products and are well aware that such products yield significantly greater earnings than assets in place. Under the background of Internet of things, long-term debt in Internet of things industry also affords connected firms more time for repayment, allowing them to better arrange their financial investments should an arbitrage opportunity arise. This finding implies that policymakers may wish to develop policies that ease the market's financial constraints, so firms engage in less shadow banking and focus more on their primary businesses. The above analysis provides sufficient evidence that firms' Shadow Banking Behaviour Increased with Bank Connections in Internet of things industry.

While existing literature primarily focuses on how formal institutions have influence on shadow banking behaviour, this study attempts to extend the literature by test whether and how a less discussed informal institution, bank-firm staff connection has impact on firms' shadow banking behaviour. Since bank-firm staff connection brings financial investment knowledge to firms and reduces information asymmetry between firms and bank which promote firms' financing ability to engage in shadow banking behaviour. For policy makers, firms shadow banking behaviour should be regulated to prevent the risks to the financial system, and for firms, they should consider to use relationship properly and make a balance between short-term high return of shadow banking behaviour and the risks behind it.

There are some shortcomings in this study, for this study does not investigate whether banks hiring staff with listed firms working experience as board members, directors and managers have the same effect on firms shadow banking behaviour, because relationships are mutual. It might be valuable to study the counter-relationship between firms and banks to enrich the literature of the informal institutions on firm performance.

Acknowledgements

I want to thank my mentor Professor Chung-Hua Shen for his help in my study. I would also like to thank my family and friends for their love and support.

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