

Empirical Analysis of Hold-up Problem in Debt Financing: Evidence from Japanese Listed Firms

岩木 宏道

Empirical Analysis of Hold-up Problem in Debt Financing: Evidence from Japanese Listed Firms

Hiromichi Iwaki
Kanagawa University

【Abstract】 We investigate hold-up problems in debt financing among publicly traded firms with apparently limited information asymmetries. Based on the prediction by Rajan (1992), we examine how changes in short-term bank loan ratio affect firm investment behavior. We confirm that, while investment by bank-dependent firms reduces with increasing ratio of short-term loans, this negative effect is mitigated or offset for firms with access to the public debt market. Consistent with Rajan (1992), this finding suggests that, as many Japanese firms lack access to the public market because of the absence of public debt issuance under the BBB rating, even publicly traded firms could face potential hold-up problems in their relationships with banks. The results presented here help explain why firms without access to public debt have consistently lower investment rates than firms with such access, and suggest that the former face an underinvestment problem.

【Keywords】 Hold-up problems; Bank loans; Public debt markets; Investment; Financing constraints

JEL classification: E22; G30; G32

1 Introduction

This paper examines how the hold-up problem in publicly traded firm's debt financing affects their investment activities in Japan. Though no regulatory restrictions exist for the issuance of public debt (thanks to the deregulation of Japan's financial system), a clear cut-off exists whereby firms rated BBB or higher have access to the public debt market, while those rated below BBB do not. Moreover, Japan's stiff and inflexible debt financing transactions may increase the importance of the difference between public debt issuance and

bank financing. For example, while public debt almost never requires collateral, bank loans do, even if the borrowers are publicly traded companies.

This clear difference in access to the public debt market for publicly traded Japanese firms indicates that some firms have an alternative to bank financing while other firms are restricted. This clear distinction may offer the corporate finance literature insight into the different conditions under which firms raise debt funds.

There are two perspectives prominent in research on bank financing. As shown in Haubrich (1989), one is that both firms and banks benefit from long-term mutual relationships. Hoshi et al. (1991) present empirical evidence of the benefits of bank–firm relationships by examining data on Japanese listed firms, covering the period of 1965 to 1986; consistent with the argument in Diamond (1984), they find that banks produce information through their monitoring of firms and force firms to make more efficient managerial decisions. The other perspective is exemplified by the argument in Rajan (1992) that banks extract excessive rents from borrowing firms through their control rights to them exerted via lending. Interestingly, Hoshi et al. (1991), famous for their findings on the benefits of the bank–firm relationship, also point out the adverse possibility that banks will impose more costs on borrowing firms, as occurred during the deregulation of Japan’s financial system. This could happen for the following reasons. First, the savings required or the monitoring offered by banks could increase borrowing costs. Second, firms prefer to avoid giving banks control rights. Thus, firms able to use alternative debt financing might favor anonymous channels that avoid conferring such rights on banks.

The possibility suggested by Hoshi et al. (1991) is elaborated in contemporary theoretical work by Sharpe (1990) and Rajan (1992), who find that information produced through the bank–firm relationship creates information monopolies or hold-up problems. Rajan (1992) argues that the rents extracted by banks when a project goes well distort investment decisions by lowering firm incentives, which could be avoided if firms have access to arm’s length debt.⁽¹⁾ Empirical studies on this issue include Houston and James (1996), Detragiache, Garella, and Guiso (2000), Santos and Winton (2008), and Hale and Santos (2009).

This paper, following the prediction of Rajan (1992), studies the potential hold-up problem among publicly traded Japanese firms in relation to banks.⁽²⁾ Rajan (1992) presents a model in which firms dependent on banks have a potential hold-up problem, as the lending

(1) Rajan (1992) states that firms with multiple relationships with banks could mitigate their hold-up problems, but that this would work only under no-collusion or perfect competitiveness when lending to one firm.

(2) Among studies on bank–firm relationships in Japan, Pinkowitz and Williamson (2001) illuminate the power banks have over borrower firms by focusing on changes in firm cash holdings and showing the existence of bank monopoly power in extracting rents, which leads to firms holding more cash. Weinstein and Yafeh (1998) present the negative side of the bank–firm relationship in the light of firm performance in Japan. More recently, Uchino (2012) shows evidence that firms can mitigate bank rent extraction behavior by issuing public bonds through the investigation of bond issuance criteria deregulation in the early 1980s.

bank can exploit its bargaining power when negotiating project continuation if the loan offered to the firm is short-term.

A recent work on the effects of firm access to public debt on firm investment behavior by Harford and Uyasal (2014) shows that without access to public debt, firms face an underinvestment problem because banks permit borrower firms to make an investment only under conditions where the expected returns are sufficiently high. These findings imply two things: first, that a hold-up problem related to borrowing from banks exists, and second, that there is an association between dependence on banks for debt and underinvestment. In this paper, we deepen those two implications in Harford and Uyasal (2014) using Rajan's theoretical prediction.

To empirically test this prediction, we study how changes in the short-term bank loan ratio affect firm investment behavior.⁽³⁾ The results show that while bank-dependent firms face reduced investment as the ratio increases, firms with access to the public debt market mitigate this reduction, which is statistically and economically significant. This finding is consistent with the prediction by Rajan (1992) and contributes to the financing constraints literature by explaining why persistent differences in firm behavior, such as investments, are conditioned by access to public debt, through a direct inspection of the hold-up problems among listed firms.⁽⁴⁾ Interestingly, although firms without access to public debt seem to have closer relationships with banks, as required by both borrowers and lenders, our results suggest another side of the bank–firm relationship, despite Japan being famous for its main-bank system, which plausibly benefits both borrowing firms and lending banks by mitigating the information asymmetry problems described in Hoshi et al. (1990, 1991).

The remainder of this paper is organized as follows. Section 2 employs the theoretical framework for the hold-up problem described in Rajan (1992) to present empirically testable hypotheses and the study's methodology. In section 3, we describe the data and how to recognize whether a firm has access to the public debt market, and present an alternative measure. Section 4 reports the estimation results of the tested hypotheses, including a robustness test. Finally, Section 5 presents conclusions.

2 Theoretical prediction and empirical strategy

Intermediary institutions such as banks can not only force firms to conduct projects after lending but can also force the restructuring of financially distressed firms more effectively than arm's length investors can (Rajan, 1992); however, as some firms have no access to the public debt market, the hold-up problems caused when banks extract excessive rents

(3) In this sense, our approach to testing the hold-up problem differs from that of Houston and James (1996), who focus on the association between growth opportunities and bank loans.

(4) Financing constraints have been studied using various measures, with standards based on access to public debt having been used frequently, as in Whited (1992).

and distort firms' incentives can be severe. Rajan (1992) shows that banks' monitoring and control rights over firms can improve firm investment decisions but also lower firms' effort incentives.

In what follows, we confirm the theoretical mechanism discussed in Rajan (1992) by showing how the hold-up problems that occur when banks lend to firms are more prevalent for short-term loans.

2.1 Prediction in Rajan model

Rajan (1992) assumes that a firm initially borrows funds for a project from a bank to be invested at date 0 while the project yields cash flow only at date 2. If the lending term is short (from date 0 to date 1), the firm is subject to the bank's discretion regarding the continuation of the project: even if the project is healthy at date 1, the bank may not lend for another term (from date 1 to date 2, when the cash flow will occur). This discretion provides the bank direct control rights and holds up the firm manager. In this manner, a bank can extract rents from surpluses in return for new loan contracts ensuring the continuation of the project from date 1 to date 2.

The extent to which a bank extracts rents depends on the bargaining power of the firm relative to the bank, which is affected by the extent to which the firm is locked in to the bank. Even if the firm has lending relations with multiple banks, the locked-in condition is unlikely to be mitigated in the existence of, for instance, collusion among banks that have lending relations with the same firm or regulatory restrictions imposed by the government on the banking sector.⁽⁵⁾ Thus, firm access to an alternative debt source, such as public debt, can mitigate the hold-up problem: outside lenders, such as public bond investors, can also interfere with bank closure decisions that could be made if the relevant firm depends solely on bank loans and is required to negotiate with banks to obtain refinancing. Rajan (1992) suggests in his fourth proposition that the amount by which a firm must refinance at date 1 to continue a project determines the amount of rent or control rights the bank should receive: the more the debt to be refinanced at date 1 increases, the larger the bank's share of the surplus. Therefore, if the bank-dependent firm reduces the short-term loan requiring refinancing, then "the firm can reduce the value of the inside bank's information advantage over outsiders if the firm reduces the amount it has to roll over with the bank at date 1. It can do this by borrowing from both a bank and the arm's-length market at date 0 (Rajan (1992, p.1382))."

Diamond (1991, 1993) also argues, in line with Rajan (1992), that the possibility of a lender's liquidation increases if the ratio of the short-term bank loan is high relative to total debt and thus that liquidation can be avoided through the mixed use of long-term debt.

(5) Santos and Winton (2008) discuss bank collusion. The competitiveness of Japan's lending banks is most likely to be lowered through a reduction in the number of major banks with no restrictions on their location.

Therefore, firms that are restricted to debt financing through banks provide those banks with larger informational monopolies as their need for refinancing or short-term loans increases, which in turn reduces firms' effort incentives and worsens their hold-up problems; in contrast, firms not dependent on banks for debt financing and with access to the public debt market should be able to mitigate those problems. We summarize this proposal as follows.

Hypothesis 1 Controlling for other firm characteristics, an increase in the ratio of short-term bank loans to total loans (and total debt) exacerbates firms' hold-up problems and reduces their incentives; those problems are mitigated by access to the public debt market.

Rajan (1992) regards the effort incentive as physical or mental exertion by management in the case of a small firm, and as discretionary investment in the case of a large firm. Thus it is reasonable, when referring to publicly traded firms, to consider the latter case. That is, the real effect of hold-up problems on firm behavior can be observed through investment decisions. We present this prediction as follows.

Hypothesis 2 Firms facing severe hold-up problems simultaneously face a decrease in investment.

2.2 Empirical strategy

Rajan (1992, p.1378) shows that bank-dependent firms' bargaining power depends on the maturity of their loans. Banks retain direct control rights over firms with short-term loans. However, banks gain bargaining power over firms with long-term loans only by giving up their surpluses.

This paper proposes that the higher the ratio of short-term bank loans to debt for bank-dependent firms, the less incentive those firms have to invest and the more severe their hold-up problems, resulting in underinvestment. Meanwhile, firms with access to the public debt market have alternative means of debt financing and can thus mitigate their hold-up problems regardless of the terms of their loans.

To test the hold-up problems predicted in Rajan (1992), we estimate an equation expressing how the independent variable of the ratio of short-term loan to total debt affects firm investment:

$$\begin{aligned}
 INVEST_{it} = & \alpha_0 + \alpha_1 ST_BANKRATIO_{it} \\
 & + \alpha_2 ST_BANKRATIO_{it} \cdot ACCESS_{it} \\
 & + \alpha_3 ACCESS_{it} + other\ controls + \epsilon_{it}.
 \end{aligned} \tag{1}$$

Where INVEST is defined as the ratio of the firm's capital expenditure to total assets, and ST_BANKRATIO is a measure of the short-term bank debt ratio, which can be classified

into the following four types: Type A is the ratio of the short-term bank loan to total assets; Type B is the ratio using total debt as a denominator; Type C is the ratio using total bank debt as a denominator; and Type D is the ratio of the short-term debt to total debt.⁽⁶⁾ Note that in the fourth definition, ST_BANKRATIO includes not only the short-term bank loan but also short-term public debt as numerator. ACCESS indicates whether the firm has access to the public debt market, as detailed in section 3.3. In estimation (1), based on Rajan (1992), it is predicted that the coefficient associated with ST_BANKRATIO is negative because, as the ratio increases for firms without access to the public debt market, they face severe hold-up problems through banks' direct control rights. This causes these firms to avoid increasing their debt and leading, in turn, to underinvestment. However, as firms with access to the public debt market are free from or can mitigate the hold-up problem, the coefficient on the interaction term with ACCESS is predicted to be positive. In most of our estimations, we control for the effects of yearly changes and industries, with the exception of the sub-sample test for firms with access to the public debt market, where a specific firm dummy is used.

3 Data

3.1 Sample

Financial statement data for firms are drawn from Nikkei Needs Financial Quest. Definitions of variables are provided in the appendix.

The estimation period covers fiscal years 1999–2013 for all the estimations. The sample excludes financial sector firms and those without debt. Firms without debt may not be able to borrow or may not need to borrow. Some firms that qualify for an investment-grade rating may have simply not attempted to obtain credit ratings. Because this paper uses experience of issuing public debt as criteria for access, including such firms when determining whether firms have access to the public market would create a measurement error. Thus, this paper excludes firms without debt, following earlier studies on the market friction between firms with and without access to public debt, such as Houston and James (1996), Faulkender and Petersen (2006), Leary (2009), and Chava and Purnanandam (2011).

Table 1 reports the descriptive statistics of firm characteristics used in the regression analyses in this paper on both sub-samples, segmented according to firms' access to the public debt market. The classification used in this paper (detailed later) divides the total sample into 20,113 firm-year observations without access to public debt and 3,668 with access.⁽⁷⁾

(6) In this paper we regard loans to be repaid within 1 year as short-term bank debt. Owing to data restrictions, there exists a drawback in that we cannot distinguish between bank-oriented loans and loans extended by other institutions such as insurance companies.

(7) To deal with the outlier effect on the regression, all explanatory variables are trimmed out at upper and lower 1 percentile values. The table 1 reports the result after removing those variables.

Table 1: Summary statistics for firm characteristics.

With regards to short-term bank loan ratio, Types A, B, C, and D are defined as the ratio of short-term bank loans to assets; the ratio of short-term bank loans to total debt; the ratio of short-term bank loans to total bank loans; and the ratio of short-term debt to total debt, respectively. For a detailed definition of other variables, please see the appendix.

	(a) No Access			(b) Access			(a)-(b) Mean-Diff.
	mean	median	sd	mean	median	sd	
FIRM AGE	53.47	55.00	20.02	65.46	65.00	21.70	-13.04***
MB	1.02	0.95	0.36	1.12	1.05	0.30	-0.07***
TANGIBILITY	0.33	0.31	0.16	0.37	0.35	0.18	-0.07***
PROFITABILITY	0.04	0.04	0.05	0.05	0.05	0.05	-0.01***
INVEST	0.04	0.03	0.04	0.05	0.04	0.04	-0.01***
ASSETS	75,723	31,965	162,047	765,281	429,356	830,242	-727201.24***
SALES_GW	0.03	0.02	0.16	0.04	0.03	0.14	0.01**
LIQRAITO	0.53	0.54	0.17	0.46	0.47	0.17	0.09***
LEVERAGE	0.25	0.23	0.17	0.33	0.31	0.16	-0.10***
<i>Short-term bank loan ratio</i>							
Type A: short-term bank loan/assets	0.14	0.12	0.11	0.12	0.10	0.09	0.02***
Type B: short-term bank loan/debt	0.57	0.57	0.23	0.35	0.33	0.18	0.27***
Type C: short-term bank loan/bank loan	0.62	0.63	0.23	0.53	0.52	0.22	0.15***
Type D: short-term debt/debt	0.59	0.59	0.23	0.43	0.42	0.19	0.15***
<i>N</i>	20,113			3,668			

3.2 Time series variations in investment

Figure 1 shows the time series variations in firm investment rate averaged for the subsamples. These were based on whether the firm-year observation is categorized as representing a firm with access to the public debt market, where investment rate is defined as the ratio of investment expenditures to total assets. The figure shows the persistent differences in investment rate between the two groups; firms with access to the public debt market have a higher average investment rate than those without such access for the entire estimation period.

3.3 Classification

This paper defines public debt as commercial paper and publicly traded bonds, both of which have high market liquidity. According to the previous literature, there are two ways to distinguish between firms with and without access to public debt. The simplest method is to use the credit rating; that is, firms that have credit ratings for a given year can be regarded as having access to the public debt market.⁽⁸⁾ The other method is to use outstanding public debt information.⁽⁹⁾ The association between credit ratings and outstanding public debt has been examined for public US firms by Cantillo and Wright (2000).

Although obtaining a credit rating is not a regulatory requirement for firms seeking to issue publicly traded instruments, institutional investors do not purchase bonds from firms

(8) For example, see Whited (1992); Kashyap et al. (1994); and Faulkender and Petersen (2006).

(9) For example, see Houston and James (1996; 2001).

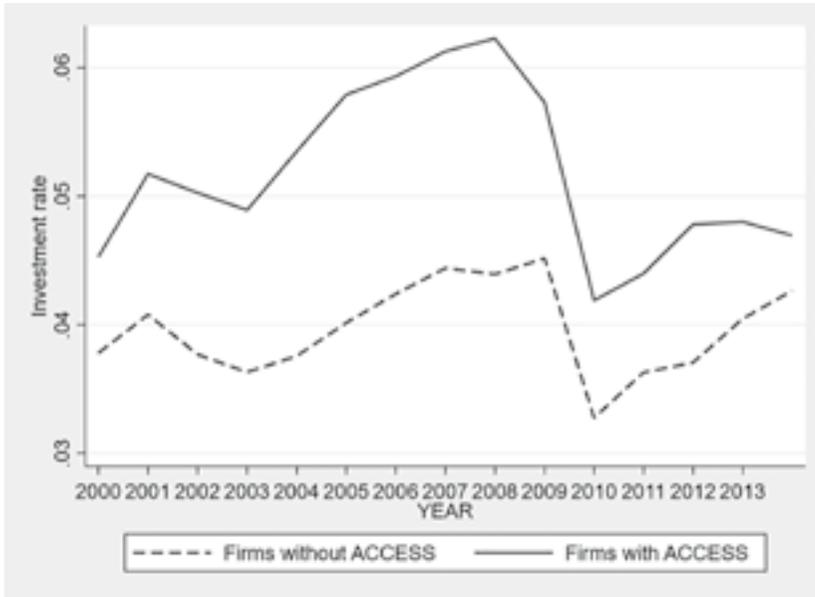


Figure 1: Average investment rate trajectories for firms with access to public debt and those without. Investment rate is defined as the rate of the investment expenditure to total assets.

without credit ratings.⁽¹⁰⁾ Furthermore, as found by Cantillo and Wright (2000), once firms obtain a credit rating they are likely to maintain their access to the public debt market, unless their financial situation drastically declines.

This paper thus considers firms with experience issuing public debt (corporate bond or commercial paper) within at least the past 5 years to have access to the public debt market. The classification used in this paper resembles that in Santos and Winton (2008).

4 Results

As argued by Rajan (1992), managers of firms dependent on banks for their debt financing suffer lowered effort incentives if their loans are short term, causing underinvestment through the hold-up problem. The result of the test for this prediction is reported in this section.

In investment theory, marginal q is a sufficient statistic but cannot be observed. Although Hayashi (1982) proposes the condition under which average Q (Tobin' Q), an observable variable, equals marginal q , this condition is unlikely to be met in reality. In applying the theory to a testable estimation, factors other than average Q proxying marginal q —specifically, those affecting firm investment behavior—must be considered. Empirically, we

(10) Especially in Japan, institutional investors do not purchase bonds below BBB. Issuing public debt is therefore less pervasive among listed companies in Japan than in capital markets in the United States.

use the Market-to-Book ratio (MB) to represent average Q in all the investment equations.

Hayashi's condition under which average Q is a sufficient statistic for firm investment is unlikely to be met in reality because of frictions in capital markets and the information transmission mechanism. Consequently, the regression analyses used in this paper consider other potential factors that influence firm investment behaviors. The other control variables used in the investment regression equations are as follows. Besides MB, following Kashyap et al. (1994), we include both sales growth (SALES_GW) and its lagged values (L.SALES_GW) in the regression, aiming to control for the effect of growth velocity on investment activities that is not captured by the variable, MB.

We also include firm age: immature firms invest more than mature firms, and so firm age may affect investment behavior. In the regression analyses, we use the natural logarithm of firm age ($\ln(1+\text{firm age})$) denoted by LN_AGE.

Under the financing frictions, firm cash holding behavior arises from the precautionary motive or to allow for flexibility for future investment (Keynes, 1934). From the perspective of the hold-up problem, managers may prefer holding cash to circumvent such problems and maintain their discretion over managerial decisions, including investment. Empirically, Opler et al. (1999) show evidence that firms prefer holding cash to ensure their ability to keep investing when needed. Harford et al. (2014) argue that firms hold cash to circumvent the refinancing risk related to short-term debt, which mitigates underinvestment problems. These are the reasons why we include the ratio of cash and its equivalent to total assets (CASHRATIO) in the basic specification for firm investment. Note that taking into account plausible managerial investment decisions, we use the lagged value of CASHRATIO (L.CASHRATIO) as an explanatory variable.

In this paper the key variable ST_BANKRATIO represents the potential hold-up effect caused by lending banks or the balance of bargaining power. However, the extent to which firms use debt may also affect the importance to them of short-term bank loans or short-term debt. If this influences the balance of bargaining power between lender and borrower and thus firm's investment, then the omitted variable problem arises. In light of this, we include debt usage level (LEVERAGE) as an explanatory variable.

From the asset-liability management perspective, asset maturity may also have potential to affect both ST_BANKRATIO and investment decisions. For instance, Myers (1977) shows that firms are likely to use short term debt relative to asset maturity, which enables them to mitigate underinvestment problems. According to this "matching hypothesis", firms may decide short-term (bank) debt based on their asset maturity. If so, excluding the effect of asset maturity causes omits variable bias that makes the coefficients of ST_BANKRATIO and its interaction term exceed those estimated by including this effect. In this sense, it is necessary to control for the effect of the asset maturity management decision. Empirically, we proxy asset maturity using the ratio of current assets to total assets (LIQRATIO).

If ST_BANKRATIO is irrelevant to investment, then its coefficients and interaction term

have no significance. On the contrary, as Rajan (1992) implies, if bank-dependent firms face reduced investment incentives as hold-up problems worsen, the increase in ST_BANKRATIO will lead those firms to decrease their observed investment levels.

4.1 The effect of short-term bank debt on investment

Table 2 reports the regression results where ST_BANKRATIO is defined as the ratio of short-term bank loan to total debt (Type A). The dependent variable used in the regression is the ratio of capital expenditure to total assets (INVEST). In column 1, we report the result using baseline explanatory variables (MB; SALES_GW; L.SALES_GW; LN_AGE; L.CASHRATIO; LIQRATIO), which shows that while average firms without access to the public debt market reduce their investment level by 1.4% as ST_BANKRATIO increases by 10%, such firms reverse the marginal effect by 0.95%, offsetting the adverse effect if they have access to the public debt market, both of which have statistical significance at 1%.

From column 2 through to column 5 we report results considering both potentially influential variables and baseline explanatory variables. In column 2, the additional variable is firm default risk using the Meton model (MERTONRISK).⁽¹¹⁾ Financing constraints increase for such firms as risk increases, which also leads to investment expenditures becoming limited. Because Japanese banks typically systematically restrict their lending for those firms that report losses for two successive fiscal years, which creates financing constraints for affected firms, in column 3 we include the dummy variable (REDOPE2) that takes the value one if firms report successive operating losses in the previous 2 years. In columns 4 and 5 both the regressions control for the effect of the degree differences in relationships with multiple banks.⁽¹²⁾ The former column reports the result including the degree of concentration of multiple banking relationships, which is proxied by Herfindahl index (BANKKONCENDENT) calculated using the loan share of each bank for a given firm. The latter column shows the result using the natural logarithm of the number of relationship banks. In sum, the coefficients on the key variables (ST_BANKRATIO and ACCESS*ST_BANKRATIO) are robust to the additional control variables based on their statistical and economic significance.

Table 3 reports the regression result using the alternative definitions of ST_BANKRATIO; Type B; Type C; and Type D.⁽¹³⁾ The difference between Type B and Type C is the denominator: the former uses total debt and the latter total bank debt. Type D, defined as the ratio of short-term debt (to be repaid within 1 year) to total debt, conceptually resembles

(11) Firm default risk using the Merton model in this paper is constructed using the methodology introduced by Bharath and Shumway (2008). For a detailed definition, see Appendix.

(12) The banking literature has two views on the effect of relationship intensity with banks: on the one hand, there exist arguments that bank-firm relationship intensity benefits firms (e.g. Petersen and Rajan, 1994, 1995), while on the other hand, Houston and James (1996) show empirical evidence that multiple banking relationships mitigate the hold-up problem caused by relationship banks and benefit borrowing firms.

(13) For detailed definitions see section 2.2.

Table 2: Effect of short term bank debt on investment.

For a detailed definition of each variable, please see the appendix. Finally, *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

ST_BANKRATIO:	(1) Type A	(2) Type A	(3) Type A	(4) Type A	(5) Type A
ST_BANKRATIO	-0.040*** (0.004)	-0.039*** (0.004)	-0.037*** (0.004)	-0.033*** (0.005)	-0.034*** (0.005)
ACCESS	-0.000 (0.001)	0.000 (0.001)	-0.000 (0.001)	-0.001 (0.001)	-0.000 (0.001)
ACCESS*ST_BANKRATIO	0.027*** (0.009)	0.019** (0.009)	0.018** (0.009)	0.027*** (0.010)	0.023** (0.011)
MB	0.012*** (0.001)	0.012*** (0.001)	0.012*** (0.001)	0.012*** (0.001)	0.013*** (0.001)
SALES.GW	0.020*** (0.002)	0.018*** (0.002)	0.019*** (0.002)	0.021*** (0.002)	0.022*** (0.002)
L.SALES.GW	0.031*** (0.002)	0.030*** (0.002)	0.029*** (0.002)	0.030*** (0.003)	0.030*** (0.002)
LN_AGE	-0.011*** (0.001)	-0.010*** (0.001)	-0.010*** (0.001)	-0.011*** (0.001)	-0.011*** (0.001)
L.CASHRATIO	0.020*** (0.003)	0.019*** (0.003)	0.020*** (0.003)	0.026*** (0.004)	0.027*** (0.004)
LEVERAGE	0.015*** (0.003)	0.014*** (0.003)	0.014*** (0.003)	0.007** (0.003)	0.009** (0.003)
LIQRATIO	-0.092*** (0.002)	-0.090*** (0.002)	-0.090*** (0.002)	-0.094*** (0.003)	-0.093*** (0.003)
MERTONRISK		-1.280 (5.715)	-0.778 (5.720)	-5.390* (3.106)	-5.662* (3.103)
REDOPE2			-0.008*** (0.001)	-0.009*** (0.001)	-0.010*** (0.001)
BANKCONCENT				-0.005*** (0.002)	
LN_NUM_BANKS					0.001* (0.001)
Constant	0.112*** (0.004)	0.105*** (0.004)	0.105*** (0.004)	0.113*** (0.004)	0.110*** (0.004)
Industry controls	Yes	Yes	Yes	Yes	Yes
Year controls	Yes	Yes	Yes	Yes	Yes
<i>N</i>	26486	23761	23758	18510	17736
<i>R</i> ²	0.282	0.285	0.286	0.292	0.298
<i>adj. R</i> ²	0.280	0.283	0.284	0.290	0.295

Table 3: Effect of short-term bank debt on investment using an alternative definition of ST_BANKRATIO. For a detailed definition of each variable, please see the appendix. Robust standard errors are reported in parentheses. Finally, *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)
ST_BANKRATIO:	Type B	Type C	Type D
ST_BANKRATIO	-0.010*** (0.001)	-0.013*** (0.001)	-0.012*** (0.001)
ACCESS	0.000 (0.001)	-0.004** (0.002)	-0.004** (0.002)
ACCESS*ST_BANKRATIO	0.008** (0.003)	0.015*** (0.003)	0.015*** (0.004)
MB	0.012*** (0.001)	0.012*** (0.001)	0.012*** (0.001)
SALES.GW	0.022*** (0.002)	0.022*** (0.002)	0.022*** (0.002)
L.SALES.GW	0.032*** (0.002)	0.033*** (0.002)	0.032*** (0.002)
LN.AGE	-0.011*** (0.001)	-0.011*** (0.001)	-0.011*** (0.001)
L.CASHRATIO	0.027*** (0.004)	0.029*** (0.004)	0.027*** (0.004)
LEVERAGE	-0.008*** (0.002)	-0.008*** (0.002)	-0.008*** (0.002)
LIQRATIO	-0.095*** (0.002)	-0.095*** (0.002)	-0.095*** (0.002)
Constant	0.117*** (0.004)	0.120*** (0.004)	0.118*** (0.004)
Industry controls	Yes	Yes	Yes
Year controls	Yes	Yes	Yes
<i>N</i>	23783	23323	23492
<i>R</i> ²	0.283	0.285	0.282
<i>adj. R</i> ²	0.281	0.283	0.280

the idea of debt maturity. Type D, for firms with access to the public debt market, includes both public debt and bank debt, which in this regard differs fundamentally from the other definitions of ST_BANKRATIO but has the benefit that it can demonstrate the different impacts between the case where short-term debt is sourced from bank loans (especially for firms without access to public debt) and that where short-term debt originates from both bank loans and public debt, such as public bond and commercial paper (especially for firms with access to public debt). The results in all of the columns in table 3 suggest that with the increase in the ratio of short-term bank debt to total debt or total bank debt, the bank-dependent borrower faces a reduction of investment rate, but firms with access to public

debt can mitigate the adverse effect of increases in short-term bank debt, consistent with the hypothesis of this paper.

5 Robustness test

5.1 Linear regression with endogenous effect of ACCESS

As Faulkender and Petersen (2006) point out, the dummy variable ACCESS, which is constructed using past experience in issuing public debt, can cause potential endogeneity. Although the methodology proposed by Faulkender and Petersen (2006) that uses two-stage estimation with the probit model in the first stage is popular in the literature (as in Leary (2009) and Harford and Uyasal (2014)), we adopt a different approach to tackle endogeneity using linear regression with endogenous treatment effects, a methodology proposed by Maddala (1983) based on Heckman (1976, 1978). The overall estimation structure is described below.

For convenience, we rewrite the equation (1) as follows:

$$INVEST_{it} = \delta_1 ST_BANKRATIO_{it} \cdot ACCESS_{it} + \delta_2 ACCESS_{it} + \mathbf{x}_{it}\boldsymbol{\beta} + \epsilon_{it}, \quad (2)$$

where \mathbf{x} represents other control variables used in the baseline regression, including a constant term and a sole variable ST_BANKRATIO.⁽¹⁴⁾ Below, we model the dummy variable ACCESS as follows:

$$ACCESS_{it} = \begin{cases} 1, & \text{if } \mathbf{w}_{it}\boldsymbol{\gamma} + u_{it} > 0 \\ 0, & \text{otherwise} \end{cases} \quad (3)$$

where, \mathbf{w} represents determinant factors affecting whether a firm has access to public debt; following Faulkender and Petersen (2006) these determinant factors include profitability (PROFITABILITY); tangibility (TANGIBILITY); growth opportunity (Tobin'Q: MB); natural logarithm of assets (LN_ASSETS); and natural logarithm of firm age (LN_AGE). The error terms ϵ in equation (2) and u in equation (3) are assumed to be bivariate normal with mean zero and their covariance matrix is assumed to be

$$\boldsymbol{\Sigma} = \begin{bmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{bmatrix}. \quad (4)$$

We estimate the above model using the maximum likelihood estimator derived by Maddala (1983), whose function is expressed as follows⁽¹⁵⁾:

(14) Covariates are MB; SALES_GW; L.SALES_GW; LN_AGE; L.CASHRATIO; LEVERAGE; and LIQRAITO.

(15) See StataCorp (2021) for the more detailed discussion on the estimation procedure and program used for this analysis.

$$\ln L_{it} = \begin{cases} \ln \Phi \left\{ \frac{\mathbf{w}_{it}\gamma + (y_{it} - \delta_1 ST_BANKRATIO_{it} - \delta_2 - \mathbf{x}_{it}\beta)\rho/\sigma}{\sqrt{1-\rho^2}} \right\} - \\ \frac{1}{2} \left(\frac{y_{it} - \delta_1 ST_BANKRATIO_{it} - \delta_2 - \mathbf{x}_{it}\beta}{\sigma} \right)^2 - \ln(\sqrt{2\pi}\sigma) & ACCESS_{it} = 1 \\ \ln \Phi \left\{ \frac{\mathbf{w}_{it}\gamma + (y_{it} - \mathbf{x}_{it}\beta)\rho/\sigma}{\sqrt{1-\rho^2}} \right\} - \frac{1}{2} \left(\frac{y_{it} - \mathbf{x}_{it}\beta}{\sigma} \right)^2 - \ln(\sqrt{2\pi}\sigma) & ACCESS_{it} = 0 \end{cases} \quad (5)$$

Where Φ is the cumulative distribution function of the standard normal distribution.

Table 4 reports the regression result based on the methodology derived by Maddala (1983). As the results show, the interaction terms between ACCESS and ST_BANKRATIO maintain their statistical significance regardless of the definition of ST_BANKRATIO. Additionally, the magnitudes of their coefficients resemble the previously reported results that do not deal with the endogeneity issue related to the dummy variable ACCESS.

Table 4: Regression with endogenous treatment effects of ACCESS variable.

For a detailed definition of each variable, please see the appendix. Robust standard errors are reported in parentheses. Finally, *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
ST_BANKRATIO:	Type A	Type B	Type C	Type D
ST_BANKRATIO	-0.040*** (0.004)	-0.010*** (0.001)	-0.013*** (0.001)	-0.012*** (0.001)
ACCESS	-0.001 (0.002)	0.001 (0.002)	-0.003 (0.002)	-0.003 (0.002)
ACCESS*ST_BANKRATIO	0.022** (0.009)	0.007** (0.003)	0.015*** (0.003)	0.015*** (0.004)
Other controls	Yes	Yes	Yes	Yes
Industry controls	Yes	Yes	Yes	Yes
Year controls	Yes	Yes	Yes	Yes
N	26321	23643	23183	23354

5.2 Regression dealing with another endogeneity concern

Based on the argument that firms should set debt maturity to match asset maturity (e.g. Myers, 1977), it may be necessary to take into account firm managerial decision structures. Specifically, while long-term debt is preferred for financing long-term assets such as fixed investment assets, short-term debt mainly originates for use as working capital. On the other hand, theoretically, as Diamond (1991) argues, firm credit quality determines the optimal debt maturity period. For firms with low or high credit quality, short-term debt should be used to achieve equilibrium, while firms with credit quality that lies in the middle of the range should use long-term debt.

Because of the existence of the above arguments, we simultaneously estimate the following two equations: one for investment and the other for the variable of interest, ST_BANKRATIO.

$$\begin{aligned}
INVEST_{it} = & \alpha_0 + \alpha_1 ST_BANKRATIO_{it} \\
& + \alpha_2 ST_BANKRATIO_{it} \cdot ACCESS_{it} \\
& + \alpha_3 ACCESS_{it} + other\ controls + \epsilon_{it},
\end{aligned} \tag{6}$$

$$\begin{aligned}
ST_BANKRATIO_{it} = & \beta_0 + \beta_1 LIQRATIO_{it} + \beta_2 LEVERAGE_{it} \\
& + \beta_3 LN_ASSETS_{it} + \beta_4 MB_{it} + \beta_5 MERTONRISK_{it} \\
& + industry + year + v_{it}.
\end{aligned} \tag{7}$$

We simultaneously estimate the two equations described above using the two-stage least squares method. In the first stage equation (7) is estimated, where LIQRATIO represents the proxy variable of asset maturity or the working capital; MERTONRISK and LEVERAGE represent the default risk and risk-related proxy, respectively; LN_ASSETS is a proxy representing credit quality; and MB is the proxy for growth opportunities, which Myers (1977) predicts should be positively associated with short-term debt. In the second stage, equation (6) is estimated.⁽¹⁶⁾ The regression results using these simultaneous methodologies are reported in table 5. According to the results, although it is only the first column that holds the statistically and economically significant result for the variable of interest, the coefficients on those variables in every columns have sign and magnitude in line with the paper's prediction. Based on this reasoning, overall, we conclude that the hypothesis is weakly supported. That is, as short-term bank debt ratio increases, while firms without access to public debt decrease their investment expenditures, those with access offset the negative impact from the hold-up effect arising from the increase in short-term bank debt.

5.3 Regression result using residuals instead of ST_BANKRATIO

For robustness to the endogeneity concern related to ST_BANKRATIO, we report the result using residuals generated from the regression of ST_BANKRATIO. Here, the aim of using their residuals is not just to deal with the endogeneity issue of short-term debt as an explanatory variable, but also to correspond to the plausibly pure hold-up effect by lending banks. This is because the residuals of regression of ST_BANKRATIO are the equivalents to what are left after excluding the firm's demand factors for the ST_BANKRATIO.

The residuals of the regression of ST_BANKRATIO are generated by estimating the same specification as in the equation (7). The generated residuals are introduced, instead of ST_BANKRATIO, in the baseline specification modeled in equation (1). Table 6 reports the results, where RESLST represents the generated residuals of regression of ST_BANKRATIO. Here again we observe results very similar to the previously reported results and coefficients on RESLST and its interaction term with ACCESS, supporting the robustness of the hypothesis that while there exists a positive association between short-term bank debt and

(16) The control variables used in equation (6) are the same as those used in equation (1), where industry and year effects are also controlled for.

Table 5: Regression result using simultaneous equations.

For a detailed definition of each variable please see the appendix. Robust standard errors are reported in parentheses. Finally, *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
ST_BANKRATIO:	TypeA	TypeB	TypeC	TypeD
<i>Second Stage</i>				
ST_BANKRATIO	-0.049* (0.027)	-0.024 (0.018)	-0.060 (0.056)	-0.030 (0.020)
ACCESS	-0.001 (0.003)	-0.008 (0.009)	-0.030 (0.029)	-0.013 (0.011)
ACCESS*ST_BANKRATIO	0.022** (0.011)	0.020 (0.016)	0.056 (0.048)	0.031* (0.018)
Other controls	Yes	Yes	Yes	Yes
Industry controls	Yes	Yes	Yes	Yes
Year controls	Yes	Yes	Yes	Yes
N	23761	21369	20966	21105
R ²	0.284	0.282	0.237	0.279
<i>First Stage (Dep.= ST_BANKRATIO)</i>				
LIQRATIO	0.091*** (0.003)	0.297*** (0.011)	0.327*** (0.011)	0.290*** (0.011)
LEVERAGE	0.558*** (0.003)	0.042*** (0.010)	-0.010 (0.010)	0.035*** (0.010)
LN_ASSETS	-0.007*** (0.000)	-0.013*** (0.001)	-0.007*** (0.001)	-0.013*** (0.001)
ACCESS	-0.042*** (0.001)	-0.163*** (0.005)	-0.045*** (0.005)	-0.097*** (0.005)
MB	-0.001 (0.001)	-0.010** (0.005)	-0.002 (0.005)	-0.011** (0.005)
LN_AGE	0.008*** (0.001)	0.031*** (0.004)	0.029*** (0.004)	0.030*** (0.004)
MERTONRISK	-4.045 (7.313)	-25.715 (27.331)	-16.720 (26.024)	4.438 (26.415)
Constant	0.016*** (0.006)	0.481*** (0.024)	0.497*** (0.023)	0.500*** (0.023)
Industry controls	Yes	Yes	Yes	Yes
Year controls	Yes	Yes	Yes	Yes
R ²	0.706	0.197	0.167	0.162

hold-up effects which cause the underinvestment problem, firms with access should reverse this problem.

5.4 Sub-sample test with firm fixed effects

Another concern is that unobservable effects specific to each firm may affect short-term

Table 6: Robustness test using residuals of short-term (bank) debt variables.

For a detailed definition of each variable, please see the appendix. Robust standard errors are reported in parentheses. Finally, *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
ST_BANKRATIO:	TypeA	TypeB	TypeC	TypeD
RESID_ST	-0.042*** (0.004)	-0.011*** (0.001)	-0.013*** (0.001)	-0.012*** (0.001)
ACCESS	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)
ACCESS*RESID_ST	0.032*** (0.011)	0.009*** (0.004)	0.017*** (0.003)	0.016*** (0.004)
MB	0.012*** (0.001)	0.013*** (0.001)	0.012*** (0.001)	0.013*** (0.001)
SALES_GW	0.018*** (0.002)	0.020*** (0.002)	0.020*** (0.002)	0.020*** (0.002)
L.SALES_GW	0.030*** (0.002)	0.032*** (0.002)	0.032*** (0.002)	0.032*** (0.002)
LN_AGE	-0.010*** (0.001)	-0.010*** (0.001)	-0.010*** (0.001)	-0.010*** (0.001)
L.CASHRATIO	0.018*** (0.003)	0.024*** (0.003)	0.026*** (0.004)	0.024*** (0.003)
LEVERAGE	-0.006*** (0.001)	-0.009*** (0.002)	-0.009*** (0.002)	-0.009*** (0.002)
LIQRATIO	-0.093*** (0.002)	-0.096*** (0.002)	-0.096*** (0.002)	-0.096*** (0.002)
Constant	0.106*** (0.003)	0.106*** (0.003)	0.107*** (0.003)	0.106*** (0.003)
Industry controls	Yes	Yes	Yes	Yes
Year controls	Yes	Yes	Yes	Yes
<i>N</i>	23761	21369	20966	21105
<i>R</i> ²	0.285	0.287	0.288	0.286
<i>adj. R</i> ²	0.283	0.285	0.287	0.284

bank debt level and thus directly or indirectly influence firm investment behavior. A solution to this concern is to use firm-fixed effects. Whereas the methodology offers benefits in controlling for the time-invariant firm specific effect, it also suffers a drawback in that it is difficult in the baseline specification to distinguish firm specific effects from the effect of firm access to the public debt market because of the high correlation between the two. Thus, to examine robustness to the effect of the firm fixed effect, in this study we run the regressions using sub-samples separated by whether firm-year observations have access to the public debt market: one for firms with identical ACCESS, and the other for firms with ACCESS equal to zero.

Table 7: Sub-sample test based on the status of access to the public debt market using fixed effect. Panel A and Panel B contain the results for firms without access to public debt and those with access, respectively. Robust standard errors are reported in parentheses. Finally, *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
ST_BANKRATIO:	TypeA	TypeB	TypeC	TypeD
Panel A				
ST_BANKRATIO	-0.033*** (0.009)	-0.008*** (0.002)	-0.010*** (0.002)	-0.009*** (0.002)
Other controls	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes
Year controls	Yes	Yes	Yes	Yes
<i>N</i>	22787	20154	19728	19878
<i>R</i> ²	0.083	0.084	0.086	0.085
<i>adj. R</i> ²	0.082	0.083	0.085	0.084
Panel B				
ST_BANKRATIO	-0.018 (0.014)	0.001 (0.004)	0.002 (0.003)	0.000 (0.003)
Other controls	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes
Year controls	Yes	Yes	Yes	Yes
<i>N</i>	3699	3629	3595	3614
<i>R</i> ²	0.175	0.180	0.174	0.179
<i>adj. R</i> ²	0.170	0.175	0.169	0.174

Table 7 reports the results of examining the effect of the short-term bank debt on investment with firm-fixed effects using sub-samples divided based on whether a firm has access to the public debt market. The control variables used for the analysis reported in table 7 are basically the same as the baseline regression except using firm-fixed effects instead of industry dummy variables. The results show that in panel A, for the sub-sample of firms without access to public debt, the coefficients on the ST_BANKRATIO are all statistically significant regardless of definitions of short-term bank debt ratio. Meanwhile, in panel B, for firms with access, the same coefficients lack significance. These results provide further evidence to support that if firms have access to the public debt market, they are immune to changes in short-term bank debt, a result consistent with the hypothesis in this paper.

The evidence in table 7 is also consistent with previous studies' findings that financing constraints differ with firms' access to public debt (e.g., Almeida, Campello, and Weisbach, 2004; Gilchrist and Himmelberg, 1995; Kashyap, Lamont, and Stein, 1994; Whited, 1992; and Fazzari et al., 1988).

6 Conclusion

Based on the prediction in Rajan (1992), this paper examines the hold-up problems that arise in firms' investment decisions by focusing on short-term bank loans. Controlling for

the factors that affect investment, we find the portion of short-term bank loans is critical to the behavior of firms dependent on bank loans or without access to the public debt market, while firms with such access appear not to be significantly affected. This implies that bank-dependent firms face potential hold-up problems in that their banks take a high share of their control rights and extract excessive rents, consistent with Rajan (1992).

Furthermore, given that our sample comprises publicly traded firms, which presumably suffer less severe information asymmetries, and that Japan has no public bond issuance market below BBB, our results suggest that many publicly traded firms of all sizes face potential hold-up problems in debt financing. This is consistent with another prediction by Hoshi et al. (1991), who refer to the side-effects of bank-firm relationships on firm manager incentives. The results of this paper are pertinent to the fact that firms without access to public debt tend to have lower investment than those with such access and offer clues as to why this phenomenon occurs.

This paper's findings also suggest that creating a market for speculative public bonds might allow firms slightly below BBB to increase their investment to levels enjoyed by firms with access to the public debt market. It nevertheless remains to be explained why a public debt issuance market below BBB has yet to be established, despite Japan's abolition of restrictive regulations and the advantages of access to such a market. This offers a direction for future research.

● Reference

- [1] Almeida, H., Campello, M., Weisbach, M., 2004. The cash flow sensitivity of cash. *Journal of Finance* 59, 707-722.
- [2] Cantillo, M., Wright, J., 2000. How do firms choose their lenders? An empirical investigation. *Review of Financial Studies* 13, 155-189.
- [3] Chava, S., Purnanandam, A., 2010. Is default risk negatively related to stock returns? *Review of Financial Studies* 23, 2523-2559.
- [4] Chava, S., Purnanandam, A., 2011. The effect of banking crisis on bank-dependent borrowers. *Journal of Financial Economics* 99, 116-135.
- [5] Detragiache, E.P., Garella, P., Guiso, L., 2000. Multiple versus single banking relationships: theory and evidence. *Journal of Finance* 55, 1133-1161.
- [6] Diamond, D.W., 1984. Financial intermediation and delegated monitoring. *Review of Economics Studies* 51, 393-414.
- [7] Diamond, D.W., 1991. Debt maturity structure and liquidity risk. *The Quarterly Journal of Economics* 106, 709-737.
- [8] Diamond, D.W., 1993. Seniority and maturity of debt contracts. *Journal of Financial Economics* 33, 341-368.
- [9] Faulkender, M., Petersen, M., 2006. Does the source of capital affect capital structure? *Review of Financial Studies* 19, 45-79.
- [10] Fazzari, S.M., Hubbard, R.G., Petersen, B.C., Blinder, A.S., Poterba, J.M., 1988. Financing constraints and corporate investment. *Brookings Papers on Economic Activity* 1, 141-206.
- [11] Gilchrist, S., Himmelberg, C.P., 1995. Evidence on the role of cash flow for investment. *Journal of Monetary Economics* 36, 541-572.

- [12] Hale, G., Santos, J., 2009. Do banks price their informational monopoly? *Journal of Financial Economics* 93, 185-206.
- [13] Harford, J., Uysal, V.B., 2014. Bond market access and investment. *Journal of Financial Economics* 112, 147-163.
- [14] Haubrich, J., 1989. Financial intermediation, delegated monitoring, and long-term relationships. *Journal of Banking and Finance* 13, 9-20.
- [15] Hayashi, F., 1982. Tobin's marginal Q and average Q: A neoclassical interpretation. *Econometrica* 50, 213-224.
- [16] Heckman, J. 1976. The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator for such models. *Annals of Economic and Social Measurement* 5, 475-959.
- [17] Heckman, J. 1978. Dummy endogenous variables in simultaneous equation system, *Econometrica* 46, 931-959.
- [18] Hoshi, T., Kashyap, A., Scharfstein, D., 1990. The role of banks in reducing the costs of financial distress in Japan. *Journal of Financial Economics* 27, 67-88.
- [19] Hoshi, T., Kashyap, A., Scharfstein, D., 1991. Corporate structure, liquidity, and investment: evidence from Japanese industrial groups. *Quarterly Journal of Economics* 106, 33-60.
- [20] Houston, J., James, C., 1996. Bank information monopolies and the mix of private and public debt claims. *The Journal of Finance* 51, 1863-1889.
- [21] Kashyap, A.K., Lamont, O.A., Stein, J.C., 1994. Credit conditions and the cyclical behavior of inventories. *Quarterly Journal of Economics* 109, 565-592.
- [22] Leary, M.T., 2009. Bank loan supply, lender choice, and corporate capital structure. *Journal of Finance* 64, 1143-1185.
- [23] Lemmon, M.L., Roberts, M. R., 2010. The response of corporate financing and investment to changes in the supply of credit. *Journal of Financial and Quantitative Analysis* 45, 555-587.
- [24] Maddala, G. S., 1983. *Limited-dependent and qualitative variables in Econometrics*. Cambridge University Press, Cambridge.
- [25] Myers, S., 1977. Determinants of corporate borrowing. *Journal of Financial Economics* 5, 147-175.
- [26] Opler, L., Pinkowitz, L., Williamson, R., 1999. The determinants and implications of corporate cash holdings. *Journal of Financial Economics* 52, 3-46.
- [27] Petersen, M., Rajan, R., 1994. The benefits of lending relationships: evidence from small business data. *Journal of Finance* 49, 3-37.
- [28] Petersen, M., Rajan, R., 1995. The effect of credit market competition on lending relationships. *Quarterly Journal of Economics* 110, 407-443.
- [29] Pinkowitz, L., Williamson, R., 2001. Bank power and cash holdings: Evidence from Japan. *Review of Financial Studies* 14, 1059-1082.
- [30] Rajan, R., 1992. Insiders and outsiders: The choice between informed and arm's-length debt. *Journal of Finance* 47, 1367-1400.
- [31] Santos, J.C., Winton, A., 2008. Bank loans, bonds, and information monopolies across the business cycle. *Journal of Finance* 63, 1315-1359.
- [32] Sharpe, S.A., 1990. Asymmetric information, bank lending, and implicit contracts: a stylized model of customer relationships. *Journal of Finance* 45, 1069-1087.
- [33] StataCorp LLC, 2021. *STATA Treatment-Effects Reference Manual: Potential Outcomes/Counterfactual Outcomes*, Release 17.
- [34] Uchino, T., 2012. Do Bond Issues Mitigate Hold-up Costs? Evidence from Japan's financial liberalization period. *RIETI Discussion Paper Series* 12-E-046.

- [35] Weinstein, D.E., Yafeh, Y., 1998. On the costs of a bank-centered financial system: Evidence from the changing main bank relations in Japan. *Journal of Finance* 53, 635-672.
- [36] Whited, T.M., 1992. Debt, liquidity constraints, and corporate investment: Evidence from panel data. *Journal of Finance* 47, 1425-1460.

Appendix: Variable definitions

ACCESS An indicator equal to one for firms with least one experience of issuing public debt in the past 5 years, including public bonds or commercial paper, and zero otherwise.

BANKCONCENT Bank lending concentration ratio for each firm using the Herfindahl index. It is defined as the sum of squared individual firm's outstanding loan shares of all bank loans amount, where *bank* refers to banks with deposit services.

CASHRATIO The ratio of cash and cash equivalents to total assets. In the regression, lagged value of CASHRATIO (L.CASHRATIO) is used.

INVEST The ratio of capital expenditure to total assets.

L.SALES_GW Lagged value of SALES_GW

LEVERAGE The ratio of book value of total debt (short-term plus long-term debt) to book value of assets.

LIQRATIO The ratio of current assets to total assets

LN_AGE The period since the firm was founded (FIRM AGE), which is defined as $\ln(1+\text{FIRM AGE})$.

LN_ASSETS The book value of assets (ASSETS), which is defined as $\ln(\text{ASSETS})$.

LN_NUM_BANKS Natural logarithm of total number of banks from which a firm has outstanding loans for a given year, where *bank* refers to banks that offer deposit services.

MB The ratio of the market value to book assets, where the market value of assets is defined as book assets minus book equity plus the market value of equity.

MERTONRISK A risk measure based on the Merton model. Following Bharath and Shumway (2008), Chava and Purnanandam (2010), and Chava and Purnanandam (2011), the variable is defined as follows:

$$DD \equiv \frac{\log((E + F)/F) + (r_{it-1} - \sigma_V^2/2)T}{\sigma_V \sqrt{T}},$$

where $\sigma_V = \frac{E}{E+F} \sigma_E + \frac{F}{E+F} (0.05 + 0.25 \sigma_E)$ and r_{it-1} is the firm's stock return over

the previous year; E is the market value of equity; F is the face value of debt; and σ_E is the stock return volatility estimated over the past year using monthly returns. T is set to 1 year. The defined variable RISK is computed as $N(-DD)$, where $N(\cdot)$ is the cumulative standard normal distribution function.

PROFITABILITY Operating profit divided by sales.

REDOPE2 An indicator equal to one if the firm records an operational deficit in both the immediately prior year and one other prior year and zero otherwise.

SALES_GW Annual rate of sales growth.

ST_BANKRATIO In this paper, short-term bank debt ratio is defined as the following four different types: Type A is defined as the ratio of short-term bank loans to total debt; Type B is the ratio of short-term bank loans to total debt; Type C is the ratio of short-term bank loans to bank debt; and Type D is the ratio of short-term debt (not limited to bank loans) to total debt for comparison and robustness purposes.

TANGIBILITY Net property plant and equipment scaled by the book value of assets.