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Identifying the bank balance sheet channel with firm-bank match-level loan data

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Business Cycles, Monetary Policy, and Bank Lending: Identifying the bank balance sheet channel with firm-bank match-level loan data*

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Abstract

This paper examines the impact of business cycles and monetary policy on bank loan supply. To this end, we use a unique firm-bank match-level dataset covering listed firms in Japan that allows us to control for firms' time-varying unobservable loan demand and endogenous bank-firm matching, so that we can identify the effects of business cycles and monetary policy on loan supply through the bank balance sheet channel. The estimation results indicate that banks with more liquidity or capital tend to lend more to their client firms. The quantitative impact of bank liquidity and capital on loan supply was economically sizable and larger when economic growth was lower. Furthermore, the quantitative impact of bank liquidity on the growth rate of loans more than doubled when quantitative easing was terminated. Overall, these results imply that changes in economic growth and monetary policy significantly affected loan supply through the bank balance sheet channel. We also find evidence that fluctuations in economic growth and monetary policy are transmitted to capital investment through the bank balance sheet channel in the case of firms with high investment opportunities.

Keywords: Bank balance sheet channel, Monetary policy, Time-variant firm individual effects
JEL classification: E44, E51, E52, G21

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1. Introduction

Contractive monetary policy and economic downturns potentially reduce the supply of loans provided by banks because their net worth is likely to contract, so that the agency problems involved in banks' financing through uninsured debt are severer in such a policy and economic environment (Stein 1998). Such an adverse impact of contractive monetary policy and economic downturns is likely to be larger for a bank with less capital or liquid assets as a ratio of total assets, who are likely to incur larger agency costs. To examine whether such a bank balance sheet channel really works, it is necessary to identify shocks to loan supply that can be disentangled from shocks to loan demand. In addition, it is necessary to address the assortative matching mechanism that may arise if better-performing borrowers are likely to borrow from better-performing banks. Few extant studies, however, successfully overcome these identification problems.

In this paper, we test the bank balance sheet channel hypothesis by addressing these identification problems using a unique dataset that contains information on the banks each firm transacts with, on the amount of outstanding loans each firm has with each bank, and on the balance sheet variables of each firm and bank. The dataset is a panel that covers firms listed on Japanese stock exchanges and spans almost three decades. Using this dataset, we examine, first, whether banks' net worth (measured in terms of capital and liquidity relative to total assets) affects changes in loan supply and, second, whether tighter monetary policy or lower economic growth strengthen the effects of bank net worth on changes in loan supply. To disentangle bank loan supply from demand, we control for firm-year fixed effects. We thus focus on the variation in changes in outstanding loans across banks for the same firm and year. Further, we control for bank-firm matching by including bank-firm fixed effects and focusing on the variation in changes in outstanding loans over time for the same bank and firm. We therefore can estimate the quantitative impact of monetary policy and business cycle on changes in outstanding loans through bank net worth. To the best of our knowledge, the only study that successfully overcomes the identification problems in testing the hypothesis that bank net worth plays a more important role in a contractive monetary policy environment or under lower economic growth is that by Jiménez et al. (2012). Using Spanish data on loan applications, they focus on whether banks accept firms' loan applications and whether firms whose applications for loans were rejected could borrow from other banks. On the other hand, we use data on the amounts of loans, which enable us to quantitatively assess the bank balance sheet channel, i.e., changes in bank lending caused by the changes in the real GDP growth rate and monetary policy. Moreover, we further investigate how the bank balance sheet channel affects firms' overall borrowing and investment.

The findings of our analysis can be summarized as follows. First, banks with higher capital-to-asset ratios and liquidity-to-asset ratios tended to supply more loans. Second, the effects of bank capital and bank liquidity on loan supply were stronger when the economic growth rate was lower. Third, the effects of bank liquidity on loan supply were weaker when monetary policy was loosened and stronger when monetary policy was tightened or the central bank exited from quantitative easing. Fourth, the effects of bank capital on loan supply were significant during the 2000s, when Japan's regulatory authorities strictly enforced capital adequacy regulations. Fifth, the quantitative impacts of bank liquidity and capital on the growth rate of loans were both economically sizable. The impact of bank liquidity more than doubled when quantitative easing was terminated. Sixth and finally, we also find evidence that fluctuations in economic growth and monetary policy are transmitted to capital investment through the bank balance sheet channel in the case of firms with high investment opportunities. Overall, our findings support the hypotheses that bank net worth affects loan supply and that the effect depends on monetary policy and economic growth. Moreover, such a bank balance sheet channel has a significant impact on firms' financing and investment.

The rest of the paper proceeds as follows. Section 2 briefly describes the Japanese loan market to provide some background to the following analysis. Next, Section 3 reviews the relevant literature and discusses the contribution of this study, while Section 4 describes the dataset and the empirical methodology. Section 5 then presents and discusses the results, and Section 6 concludes.

2. Background Information on the Japanese Loan Market

As mentioned, the dataset we use for our analysis covers a period of almost three decades. To provide some background on the Japanese loan market during this period, this section presents developments in key indicators from the early 1980s onward, including changes in the amount of loans outstanding, GDP growth, and the monetary policy rate.

We start by looking at the annual growth rate of firms' outstanding bank borrowing. Specifically, using the outstanding bank borrowing data from our dataset covering listed firms, we compute the growth rate of aggregate loans outstanding for listed firms. The results are depicted in Figure 1, where the solid line shows the growth rate of aggregate loans outstanding, while the dashed line shows the nominal GDP growth rate for each fiscal year. Looking at developments in loans outstanding and GDP growth together indicates that loans outstanding generally tended to move procyclically, although there are some periods, such as the period of the global financial crisis, in which they move countercyclically.

Next, in Figure 2, we look at the growth rate of loans outstanding for listed firms and the policy rate targeted by the Bank of Japan (BOJ).[1] Although outstanding loans seem to have increased in some years when the policy rate was low, the relationship between the two is weak. This is probably because the BOJ tends to increase the policy rate when aggregate economic activity is

[1] The Bank of Japan's policy target interest rate changed a number of times during our observation period. We therefore use the official discount rate (Koteibuai) from FY1981 to FY1984 and the annual average of the observed overnight interbank call rate from FY1985 to FY2010.

strong, and loan demand also tends to increase when economic activity is strong. Furthermore, since the late 1990s, the policy rate has been set to almost zero, which further obscures any relationship between the policy rate and aggregate loans outstanding. These considerations mean that we need to isolate loan supply shocks from loan demand.

Figure 3 plots the growth rate of aggregate loans outstanding for listed firms from the database and the growth rate of aggregate loans outstanding based on data from the Bank of Japan (shown by the line with round markers), which covers both listed and unlisted firms. While the aggregate loans outstanding of listed firms account for around 30% of the total loans outstanding of listed and unlisted firms, the trends of these two series are consistent with each other.

Finally, using data from our dataset on loans outstanding measured based on firm-bank matches, which we will explain in detail further below, we compute the annual loan growth rate for each firm-bank pair, which provides the distribution of the growth rates of loans outstanding for each firm-bank match in each year.[2] The results are depicted in Figure 4, where the bold solid and dashed lines labeled "Mean" and "Median" respectively represent the mean and median of the growth rates of loans outstanding for the firms in our dataset (i.e., listed firms). Figures 4 also depicts two thin lines (with plus and minus markers) that show plus and minus one standard deviation from the mean for each year. The lower line (i.e., the mean minus one standard deviation) was around minus 40% until the mid-1990s, after which it fell to around minus 60%. On the other hand, the upper line (i.e., the mean plus one standard deviation) fluctuates around 50% and does not show a particular trend. This implies that there was considerable heterogeneity in terms of the growth rate of outstanding loans at the bank-firm match level.

3. Related Literature

Bernanke and Gertler (1989), in their seminal work, show that negative shocks to borrowers' net worth aggravate agency costs of financing investment and thus reduce investment. Furthermore, they show that the marginal impact of borrowers' net worth on agency costs and investment is higher when their net worth is smaller. Contractive monetary policy and economic downturns are likely to reduce borrowers' net worth, to increase the agency costs borrowers incur, and hence to reduce investment by borrowers.

Although Bernanke and Gertler (1989) apply their model to firms, it can also be applied to the banking sector, because banks, in addition to taking deposits, which are insured, also raise funds by issuing uninsured debt, which is susceptible to agency costs In the case of the banking sector, Bernanke and Gertler's argument leads to the hypotheses that banks with smaller net worth supply fewer loans (Holmstrom and Tirole, 1997) and that the effects of bank net worth on loan supply are stronger when monetary policy is tightened or economic growth is lower. The latter hypothesis

[2] To compute the growth rate, we only use firm-bank pairs which had a loan relationship in two consecutive years.

concerning monetary policy transmission is often labeled the “bank-lending view.” According to this view, monetary policy shifts banks’ loan supply curves and thereby affects investment and other activities of bank-dependent borrowers (see, e.g., Bernanke and Blinder, 1988; Kashyap and Stein, 1994). Furthermore, shifts in loan supply depend on banks’ balance sheets. For example, when the central bank sells securities to a bank through open market operations and decreases the bank’s reserves, the bank may have to decrease its loans unless it makes up for any shortfall in deposits by selling security holdings or by issuing nonreservable debt. Banks with fewer liquid assets will need to decrease loans more if they cannot issue nonreservable debt or can do so only at a higher cost than deposits. Stein (1998) develops a formal model of credit rationing in bank financing markets based on the observation that most of the bank liabilities that escape reserve requirements are not covered by deposit insurance and hence are likely to be subject to adverse selection.

There is a substantial empirical literature on the role of bank net worth in loan supply. Examples include the studies by Romer and Romer (1990), Bernanke and Blinder (1992), Kashyap et al. (1993), Hoshi et al. (1993), Ueda (1993), and Ramey (1993), who use aggregate data to examine the bank lending channel of monetary policy. On the other hand, Jayaratne and Morgan (2000) use bank-level data to study the relationship between bank liquidity and loans, while Bernanke and Lown (1991), Peek and Rosengren (1997), Woo (1999), and Ito and Sasaki (2002) use bank-level data to examine the relationship between bank capital and loans. Meanwhile, Kashyap and Stein (2000), Favero et al. (1999), and Hosono (2006) use bank-level data to investigate the bank lending channel of monetary policy. Although most of these studies find significant effects of bank liquidity or capital on lending and that these effects are stronger when monetary policy is tight, the approach and data they use mean that they cannot clearly disentangle loan supply and demand shocks.

To isolate loan supply shocks from loan demand shocks, recent studies have employed a number of empirical strategies, ranging from event studies to the use of natural experiments and loan-level data.[3] The strategy most relevant to this paper is the use of loan-level information for firms with multiple bank relationships. The first to employ a strategy of identifying (bank-specific) loan supply shocks as changes in loans after controlling for firm-level fixed effects that are assumed to reflect firm-specific loan demand shocks (as well as aggregate loan supply shocks) were Khwaja and Mian (2008). They examined whether banks that experienced a larger withdrawal of deposits due to an exogenous shock (a nuclear experiment) reduced their lending to client firms more than other banks and found that this was indeed the case. Meanwhile, using data on loan applications in Spain, Jiménez et al. (2012) examined how changes in aggregate variables such as interest rates and GDP, as well as the interaction between these variables and lender bank characteristics, affect the likelihood of loans being granted. Extending the empirical strategy employed by Khwaja and Mian

[3] See Hosono and Miyakawa (2013) for a survey.

(2008), they controlled for the time-variant quality of potential borrowers by considering either firm-month or loan-level fixed effects.[4] They found that higher short-term interest rates and lower GDP growth reduced the probability that a loan was granted and that this tendency was stronger for banks with low capital (in periods of higher short-term interest rates and lower GDP growth) or low liquidity (in periods of higher short-term interest rates). While Jiménez et al. (2012) is the only one that successfully overcomes the identification problems in testing the hypothesis that bank net worth plays a more important role when monetary policy is contractive or economic growth is low, they do not estimate the quantitative impacts of bank capital and liquidity on changes in loan supply or the impacts of the bank balance sheet channel on firms' total loans and investment. Amiti and Weinstein (2013) also use matched bank-firm loan data to identify idiosyncratic bank shocks, i.e., movements in bank loan supply net of borrower characteristics and general credit conditions. Using Japanese firm-bank data, they show that idiosyncratic bank shocks have a large impact on firms' investment. However, they do not examine the bank balance sheet channel of monetary policy and GDP growth rates.

4. Data and Empirical Framework

4.1. Data and Hypotheses

This section provides a description of the data we use for our empirical analysis and sets out our hypotheses. We begin by describing our data. As our variable representing firm-bank level loan growth, we use data on loans outstanding obtained from Nikkei NEEDs Financial Quest. The dataset contains for all listed firms in Japan the amount of loans outstanding from each of their lender banks since FY1977.[5] What is more, the information is broken down into the amount of short-term and long-term loans outstanding. However, since the dataset only provides the amount of loans outstanding at the end of each fiscal year, we have no information on gross loan repayments or borrowing, but only the net difference in loans outstanding. We measure the change in total loans outstanding (i.e., the sum of short-term and long-term loans) between firm j and lender bank i from time t-1 to t by computing the log-difference of the amount of outstanding loans from the lender bank to the firm (LOANS(i,j,t)). To compute the growth rate of loans for a firm-bank pair, Δ LOANS(i,j,t), we only use firm-bank pair observations where a loan relationship existed both at time t and time t-1.[6] When firms borrow from multiple lender banks, there is a set of {i} corresponding

[4] They utilized information on a firm's successive loan applications to different banks when they controlled for loan-level fixed effects.

[5] The sum of all the firm-bank match-level loans outstanding in our dataset accounts for around 80% of the borrowing recorded in firms' balance sheets. Given that firms borrow from non-bank institutions and our dataset does not cover loans outstanding from credit unions and credit cooperatives, the coverage of our data on match-level loans outstanding is reasonably high.

[6] In other words, we specifically limit our analysis in this paper to the study of the change in outstanding loans from the banks that the firm has already built relationship with (i.e., the intensive margin of loan relationship) and not examine the initiation and termination of bank-firm relationship (i.e., the extensive margin). However, the firm-bank relationship was very stable during the observation period. To illustrate, out of the firm and bank pairs existing in FY

to the lender banks for each (j,t). As detailed in the next subsection, we model the determination of the change in loans outstanding, ΔLOANS(i,j,t) as a function of firm characteristics, bank characteristics, and aggregate-level variables. Other than the time-variant firm-level individual effects and year-specific effects, the only other data we need are information on bank characteristics and their interaction with aggregate-level variables. Information for most of the variables representing banks' financial characteristics is taken from Nikkei NEEDs Financial Quest. Specifically, for banks' size (BSIZE), we use the natural logarithm of banks' total asset. Banks' profitability (BROA) is measured as the ratio of banks' operating profit to total assets. To take into account banks' portfolio structure, we use the ratio of banks' Japanese government bond (JGB) holdings and the ratio of local municipal bond holdings to total assets (BJGB and BLOCALBOND). We also include banks' loan-to-deposit ratio (BLTD) to gauge each bank's lending opportunities. Banks' capital ratio is measured in the following two alternative ways. The first is the ratio of banks' total equity to total assets on their balance sheet, BTETA. Second, given that this variable does not sufficiently reflect the riskiness of each bank's assets, we also use the capital adequacy ratio, REGCAP, which we take from data provided by the Japan Bankers Association. The observation period is from FY1981 to FY2010 when we use BTETA for banks' capital ratio, and from FY1993 to FY2010 when we use REGCAP for banks' capital ratio, since data for REGCAP are available only from FY1993 onward. Instead of using the raw value of REGCAP, we adjust REGCAP by subtracting either 4% or 8% from the original level to take account of the fact that for regulatory reasons different groups of banks face different minimum capital ratios. Specifically, the minimum capital adequacy ratio differs depending on whether a bank operates domestically, in which case it is 4%, or whether it operates internationally, in which case it is 8%. For REGCAP, we therefore subtract either 4% or 8% depending on whether a bank operates only domestically or also internationally. On the other hand, for BTETA, we do not employ this adjustment. The final variable for banks' financial characteristics we use is banks' liquidity, BLIQ, which we compute as the ratio of (i) the sum of banks' cash and deposits, loans outstanding in the call market, securities for selling, and JGBs and local bonds minus required current deposits (i.e., required reserves) at the BOJ to (ii) total assets.[7] Given that no information on required reserves is available, we construct a proxy for it in the following two ways. First, as the required reserves for each bank over the period before the introduction of the zero interest rate policy and quantitative easing (QE) (i.e., until FY 1997), we use current deposits at the BOJ as the required reserve, given that banks had no incentive to hold excess reserves. Next, from FY 1997 to FY 2010, we compute the amount of required reserves using the data on the amount of deposits classified into various types, which we take from Nikkei NEEDs

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1994, 8.5% of the pair terminated their relations. On the other hand, out of the firm and bank pairs existing in FY 1995, 4.2% of the pair initiated their relations in FY 1995. These numbers imply that our analysis covers a large portion of the firm and bank pairs in our data set.

[7] In Japan, banks' cash does not count toward reserves, and only the current account balance at the BOJ does.

Financial Quest. Specifically, multiplying the required reserve ratio set by the BOJ by the amount of deposits of each type, we compute the required reserves. These estimated required reserves on average take a value of around 100% to 130 % of the actual current deposits at the BOJ over the period FY 1990-FY1996, which implies that our estimation is reasonably accurate. Given that a number of banks were involved in mergers and acquisitions (M&A) during our observation period, we drop the acquiring banks from our sample in the year of the M&A, because the balance sheet variables of such banks are likely to swing considerably as a result of such acquisitions.

As for aggregate-level variables, we use the growth rate of real GDP, GDPGROWTH, as well as various dummy variables accounting for changes in monetary policy. The first monetary policy variable, POLRATE_UP (POLRATE_DOWN), is a dummy variable taking a value of one when the targeted policy rate (i.e., either the official discount rate (Koteibuai) or the overnight (O/N) call rate) becomes strictly higher (lower) than the previous year. The change in the policy rate is measured using the official discount rate (Koteibuai) until FY1984 and the O/N call rate after FY1984.[8] The target rates are calculated as the annual average of monthly levels. As Table 1 shows, the target rate did not change in FY1988 and FY2005, which allows us to use the two variables in the estimation simultaneously when these two years are included in the observation period. The second monetary policy variable, QE_LOOSENING (QE_TIGHTENING), is a dummy variable taking a value of one when the target of the BOJ's quantitative easing policy (QE target), banks' current account balances at the BOJ, becomes strictly larger (smaller) than the previous year. The QE target level is measured as the average of the BOJ's target for banks' current account balances for each fiscal year. In the calculation of this average, we use the number of months for each target level as a weight and compute the weighted average of the QE target. The third variable representing changes in monetary policy we use is MPLOOSENING (MPTIGHTENING), which is a dummy variable taking a value of one when the BOJ strictly relaxes (tightens) monetary policy in terms of the policy rate or the QE target. MPLOOSENING is equal to zero when the policy target remains unchanged or represents a tightening (i.e., a higher policy rate or a lower target for current account balances), while MPTIGHTENING is equal to zero when the policy target remains unchanged or represents a loosening of monetary policy (i.e., a lower policy rate or a higher target for current account balances).

Based on the theoretical discussion above regarding the bank balance sheet channel of monetary policy transmission, we hypothesize that banks with higher capital- and liquidity-to-asset ratios tend to provide larger amounts of loans. Thus, the first hypothesis we test is as follows:

Hypothesis 1: Banks with a higher BTETA, REGCAP, or BLIQ provide larger amounts of loans.

[8] For the O/N call rate, we use the actually observed O/N call rate in the market.

We also hypothesize that this mechanism is enhanced when economic growth slows. This is because banks with a weaker balance sheet face larger frictions or do not have sufficient funds to allocate to borrower firms as macroeconomic conditions deteriorate.

Hypothesis 2: The positive marginal impact of BTETA, REGCAP, and BLIQ becomes smaller (larger) when GDPGROWTH is higher (lower).

We further hypothesize that the mechanism governing banks' loan provision also interacts with changes in monetary policy. For example, banks with less liquidity are expected to provide smaller amounts of loans to firms. Such banks, however, could provide larger amounts of loans under expansionary monetary policy. This is because even banks with low liquidity can secure sufficient amounts of funding to provide loans when the policy rate and hence actual short-term interest rates are low. In other words, we expect that the link between a strong balance sheet and loan amounts is less pronounced in an expansionary monetary policy environment.

Hypothesis 3: The positive marginal impact of BTETA, REGCAP, and BLIQ becomes smaller (larger) when POLRATE_DOWN, QE_LOOSENING, and/or MPLOOSENING take a value of one (POLRATE_UP, QE_TIGHTENING, and/or MPTIGHTENING take a value of one).

A full list of variables used in our estimation, their definitions, and summary statistics is provided in Table 2. Our observations cover the period from FY1981 to FY2010. The dataset contains observations on between 907 firms (in FY1982) and 1,666 firms (in FY2008) and 109 banks (in FY2010) and 153 banks (in FY1981) in any particular year.

4.2. Empirical Framework

The aim of our investigation is to examine the marginal impact of (i) bank balance sheet variables on banks' loan provision and (ii) their interaction with the aggregate-level variables while controlling for various firm characteristics, including time-variant loan demand. For this purpose, we estimate equation (1) below. In this equation, we take unobservable time-variant individual effects, $\eta(j, t)$, where subscript *j* denotes the firm and *t* the year, that determine loan demand into account. Incorporating the time-variant individual effects into our analysis, we control for all firm-year level shocks, including, for example, firms' loan demand, changes in firms' investment opportunities, and changes in the availability of other financing measures (e.g., corporate bonds and CP). $\mathrm{POLICY}(t)$ denotes either (a) POLRATE_DOWN, POLRATE_UP, QE_LOOSENING, and QETIGHT, (b) MPLOOSENING, or (c) MPTIGHTENING. To control for year-specific effects, we also include YEAR(t) in this estimation. Since we include year-specific effects in this equation, we cannot include GDPGROWTH or POLICY on their own, but only in their interacted form.

$$\begin{aligned}\Delta\,\mathrm{LOANS}(i,j,t) = {} & \eta(j,t) + \beta_1 \mathrm{BSIZE}(i,t-1) + \beta_2 \mathrm{BROA}(i,t-1) + \beta_3 \mathrm{BJGB}(i,t-1) \\ & + \beta_4 \mathrm{BLOCALBOND}(i,t-1) + \beta_5 \mathrm{BLTD}(i,t-1) + \beta_6 \mathrm{BCAP}(i,t-1) \\ & + \beta_7 \mathrm{BLIQ}(i,t-1) + \mathrm{YEAR}(t) \qquad + \gamma_1 \mathrm{BCAP}(i,t-1)\mathrm{GDPGROWTH}(t) \\ & + \gamma_2 \mathrm{BLIQ}(i,t-1)\mathrm{GDPGROWTH}(t) + \gamma_3 \mathrm{BCAP}(i,t-1)\mathrm{POLICY}(t) \\ & + \gamma_4 \mathrm{BLIQ}(i,t-1)\mathrm{POLICY}(t) + \varepsilon(i,j,t) \qquad (1)\end{aligned}$$

For the last term in the equation, $\varepsilon(i,j,t)$, we employ three alternative assumptions. The first is that $\varepsilon(i,j,t) \equiv \epsilon(t)$ is a random error. The second is that $\varepsilon(i,j,t) \equiv \delta(i) + \epsilon(t)$, where $\delta(i)$ is the bank-level fixed effect. This captures unobservable bank-specific time-invariant factors. Finally, for the most comprehensive model, we assume $\varepsilon(i,j,t) \equiv \delta(i,j) + \epsilon(t)$, where $\delta(i,j)$ is the firm-bank match fixed effect. This captures unobservable firm-bank relationship-specific time-invariant factors. Controlling for such firm-bank match fixed effect is useful if some firms and banks have a special relationship that affects loan growth. Note that when we control for $\delta(i,j)$, the bank-level fixed effect is automatically controlled for.

We include interaction terms between the aggregate-level variables on the one hand and banks' capital ratio, BCAP (i.e., BTETA or REGCAP), and their liquidity ratio, BLIQ, on the other. The coefficients of these interaction terms capture how the marginal effects of banks' capital ratio and liquidity ratio vary as the aggregate-level variables change. For example, suppose the interaction term between BTETA and GDPGROWTH has a negative coefficient, while BTETA on its own has a positive coefficient. This means that banks with a higher capital ratio tend to lend more than banks with a lower capital ratio, and this relationship is stronger when economic growth is weak.

To estimate this equation, we first eliminate the time-variant firm-level individual effect $\eta(j,t)$ by taking the difference between i's for the same j and t. As mentioned, in our analysis, we specifically focus on firms borrowing from multiple lender banks. Suppose firm j has I(j,t) and I(j,t-1) lender banks at the end of year t and t-1, respectively. Then the number of banks we use to estimate (1) for firm i in year t is min{I(j,t), I(j,t-1)}. This leads to equation (2) below, which is indexed by (i1, i2, j, t). In this equation, $\mathrm{BCHAR}(i,t-1)$ represents the vector of bank i's characteristics at the end of t-1. We estimate this equation under the three different assumptions for $\varepsilon(i,j,t)$ described above. The equation looks as follows:

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$$\begin{aligned}\Delta\,\mathrm{LOANS}(i1,j,t) -\ \Delta\,\mathrm{LOANS}(i2,j,t) \\ &= \boldsymbol{\beta}\{\mathrm{BCHAR}(i1,t-1) - \mathrm{BCHAR}(i2,t-1)\} \\ &+ \gamma_1\{\mathrm{BCAP}(i1,t-1) - \mathrm{BCAP}(i2,t-1)\}\mathrm{GDPGROWTH}(t) \\ &+ \gamma_2\{\mathrm{BLIQ}(i1,t-1) - \mathrm{BLIQ}(i2,t-1)\}\mathrm{GDPGROWTH}(t) \\ &+ \gamma_3\{\mathrm{BCAP}(i1,t-1) - \mathrm{BCAP}(i2,t-1)\}\mathrm{POLICY}(t) \\ &+ \gamma_4\{\mathrm{BLIQ}(i1,t-1) - \mathrm{BLIQ}(i2,t-1)\}\mathrm{POLICY}(t) + \varepsilon(i1,j,t) + \varepsilon(i2,j,t) \qquad (2)\end{aligned}$$

In the next section, we show the estimation results based on the model and discuss the implication of the results. Our main interest is in the signs of $\boldsymbol{\beta}$ and $\{\gamma_1, \gamma_2, \gamma_3, \gamma_4\}$.

5. Estimation Results

5.1. Baseline Estimation Results

The baseline results of our empirical analysis are presented in Tables 3 to 5. Each table has two sets of columns corresponding to either BCAP=BTETA (i.e., the first set of columns) or BCAP=REGCAP (i.e., the second set of columns). Because, as mentioned above, REGCAP data are available only from FY1993 onward, the sample size in the latter case is only about half of that in the former case. In each case, we show the results for the three models based on the alternative assumptions for $\varepsilon(i,j,t)$. The results in column (i) are based on the assumption that $\varepsilon(i,j,t) \equiv \epsilon(t)$, those in column (ii) on the assumption that $\varepsilon(i,j,t) \equiv \delta(i) + \epsilon(t)$, and those in column (iii) on the assumption that $\varepsilon(i,j,t) \equiv \delta(i,j) + \epsilon(t)$. In all the estimations, we run the regression using specification (2) above. More specifically, when we assume $\varepsilon(i,j,t) \equiv \epsilon(t)$, we run a pooled ordinary least squares (OLS) regression, while in the case of $\varepsilon(i,j,t) \equiv \delta(i) + \epsilon(t)$ we include the two bank-level fixed effects for banks i1 and i2. When we assume $\varepsilon(i,j,t) \equiv \delta(i,j) + \epsilon(t)$, we employ a fixed-effect panel estimation with (i1, i2, j)-level fixed effects.

Table 3 shows the results when using {POLRATE_DOWN, POLRATE_UP, QE_LOOSENING, QETIGHT} for $\mathrm{POLICY}(t)$. The actual value for each dummy variable and year is shown in Table. 1. We find the following. First, consistent with Hypothesis 1, banks with a higher capital ratio and liquidity ratio tend to provide larger amounts of loans to their client firms. In particular, the results in column (iii) imply that even after taking into account firm-bank relationship-specific factors (e.g., the geographical proximity between a firm and its bank or the sector specialization of the bank), we find a systematic pattern whereby banks with a better balance sheet (i.e., higher BCAP and BLIQ) tend to lend more than banks with a weaker balance sheet. We also find that banks that are larger in size, are more profitable, and that have a lower share of Japanese government bonds in their portfolio tend to provide larger amounts of loans. Among these results, the negative impact of Japanese government bonds is in contrast with the positive impact of liquid assets that include cash and deposits. This difference may be due to the market risk arising from the change in bond prices that government bonds are exposed to. The result suggests that banks taking larger market risk are more reluctant to take credit risk through loan provision. These results are robust to the inclusion of different levels of individual effects. On the other hand, we do not obtain consistent estimates for the loan-to-deposit ratio and the share of local municipal bonds, the results for which depend on the specification of the error term and the measure for banks' capital ratio.

Second, the results for the coefficients on the interaction term between bank characteristics and GDPGROWTH indicate that the positive marginal impact of these bank variables becomes smaller when GDPGROWTH is higher, supporting Hypothesis 2. In other words, the marginal impact of banks' capital and liquidity ratios on loan supply becomes larger when economic growth is slower. This may reflect that banks with a weaker balance sheet face larger friction in their own financing or that they do not have sufficient funds to allocate to borrower firms when macroeconomic conditions worsen.

Third, as for BLIQ, the introduction of QE mitigates its marginal impact on loan supply except for specification (iii) when using REGCAP as BCAP, while the termination of QE enhances it. This result implies that under QE, the economic importance of bank liquidity declines, while it increases when QE is terminated. As for decreases in the policy rate, the marginal impact of BCAP has a similar implication to that of BLIQ and QE (see specification (iii)). Namely, the negative coefficient on the interaction term of BCAP and POLRATE_DOWN implies that the economic importance of BCAP becomes smaller when the policy rate is lowered. These results are consistent with Hypothesis 3. On the other hand, somewhat surprisingly, the interaction term between BCAP and QE_TIGHTENING has a negative coefficient, which means that the economic importance of BCAP became weaker when the BOJ exited from QE. As we will see in the discussion on the results in Tables 4 and 5, however, this result is not robust to the use of alternative measures of monetary policy.

Let us consider the quantitative implications of these results. Specifically, let us focus on the results for the baseline model (i.e., the right-most model in Table 3). The coefficient on BLIQ in this estimation is 0.382, that on the interaction term of BLIQ and GDPGROWTH is -5.781, and that on the interaction term of BLIQ and QE_TIGHTENING is 0.504. Suppose that the liquidity ratio of lender bank i for firm j declines by one standard deviation (i.e., 0.068) in year t-1 and that monetary policy does not change in year t, while GDPGROWTH is 0 in year t. Given the estimated parameters, the model predicts that $\Delta\,\mathrm{LOANS(i,j,t)}$ will be $0.382 \times (0.068) = 2.6\%$ smaller than in the case that bank liquidity had not declined. Considering that the sample mean and the standard deviation of $\Delta\,\mathrm{LOANS(i,j,t)}$ are -0.3% and 48.8%, respectively, this implies that bank liquidity has an economically sizable impact on the growth rate of loans. Next, suppose that the economy is in a severe recession (i.e., GDPGROWTH=-0.02) in year t. Assuming again a one-standard deviation decline in BLIQ, $\Delta\,\mathrm{LOANS(i,j,t)}$ will be $0.382 \times (0.068) + (-5.781) \times (0.068) \times (-0.02) = 3.4\%$ smaller than in the absence of a decline in bank liquidity. Finally, suppose that quantitative easing is terminated (i.e., QETIGHT=1). Then $\Delta\,\mathrm{LOANS(i,j,t)}$ will be $0.382 \times (0.068) + 0.504 \times (0.068) \times 1 = 6.0\%$ smaller than without a decline in bank liquidity. Thus, the impact of bank liquidity more than doubles when quantitative easing is terminated when compared with the case of no change in monetary policy.

As another example, suppose the capital ratio (REGCAP) of lender bank i for firm j declines by one standard deviation (i.e., 2.671%) in year t-1 and that the real GDP growth rate is zero, while there is no change in monetary policy. Then, given the estimated parameters, the model predicts that $\Delta\,\mathrm{LOANS(i,j,t)}$ will be $0.016 \times (2.671) = 4.3\%$ smaller than if bank capital had not declined. Thus, the quantitative impact of bank capital is economically sizable and comparable to that of bank liquidity. If the economy is in a severe recession (i.e., GDPGROWTH=-0.02) in year t, the model predicts that $\Delta\,\mathrm{LOANS(i,j,t)}$ will be $0.016 \times (-2.671) + (-0.216) \times (-2.671) \times (-0.02) = 5.4\%$ smaller than in the case with no decline in bank capital.

5.2. Alternative POLICY Measures

Next, Tables 4 and 5 show the results when using MPLOOSENING or MPTIGHTENING for $\mathrm{POLICY(t)}$, respectively. The results are very similar to those in Table 3. Specifically, BCAP and BLIQ have a positive marginal effect on loan growth in all cases, and the marginal effect is stronger when the economy is in recession. In addition, the interaction terms of BLIQ on the one hand and MPTIGHTENING (i.e., Table 5) or MPLOOSENING (i.e., Table 4) on the other indicate that tighter monetary policy increases the economic importance of BLIQ, while more expansionary monetary policy reduces it. On the other hand, the marginal impact of BCAP does not change consistently in response to MPTIGHTENING or MPLOOSENING.

Table 6 shows results for the same regressions as in Tables 4 and 5 but for two different subperiods. The two subperiods are chosen so that we have sufficient variation in POLICY to be able to conduct our estimation. The first set of columns shows the results based on observations for the period FY1993-2004, while the second set of columns shows the results for FY2001-2010. The latter period is characterized by the adoption and termination of the quantitative easing policy. We use the model with all the individual effects (i.e., specification (iii)) and REGCAP for BCAP in this estimation.

Table 6 shows that the coefficients on BSIZE, BROA, and BJGB are all significant for both subperiods. More interestingly, the coefficients on BLIQ and the interaction term of BLIQ and POLICY are significant only for the second subperiod. This implies that the role of bank liquidity became more important in the second subperiod than in the first subperiod and was magnified specifically by changes in the quantitative easing policy in the 2000s. On the other hand, the coefficient on the interaction term of BLIQ and GDPGROWTH is significant only for the first subperiod. Furthermore, BCAP is also found to have a positive marginal effect only in the second subperiod. This likely reflects the strict enforcement of capital adequacy regulation in the early 2000s. Similarly, a significant negative coefficient on the interaction term between BCAP and GDPGROWTH is found only for the second subperiod. Finally, the interaction term between BCAP and changes in monetary policy is not significant in either subperiod.

5.3. Subsample Analysis

In this section, we apply the same model as in the previous section to various subsamples. The purpose of this additional analysis is to compare the magnitude of the estimated coefficients between two sets of firms with different characteristics and hence consider the mechanisms governing loan transactions in more detail. One may expect, for example, that firms with different characteristics face different responses from their lender banks when macroeconomic conditions or monetary policy change. Although we control for unobservable time-variant firm-specific individual effects in the baseline estimation, we implicitly assume that the effects of bank characteristics (e.g., BCAP and BLIQ) and their interaction with GDPGROWTH and POLICY on loan growth are the same for all firms in our sample. In the following subsample analysis, we relax this assumption. Throughout the analysis that follows, we use MPLOOSENING and MPTIGHTENING as the variables representing POLICY and we employ the model with all the individual effects (i.e., specification (iii)) and REGCAP for BCAP.

In our first subsample analysis, we divide firms by size, because firm size is often used as a proxy for opaqueness. Specifically, using total assets as our measure of firm size, we split the sample into firms whose total assets are equal to or smaller than the sample median and those whose total assets are larger than the median. The results are presented in Table 7(a) and indicate that all the results obtained in the previous section also hold for the smaller firms. On the other hand, for the larger firms, while the coefficients on the interaction terms of BCAP and BLIQ with GDPGROWTH are significant, the coefficients on the interaction terms of BCAP and BLIQ with POLICY are not significant. Given that firm size is used to proxy for the opaqueness of firms, this result implies that banks with a weaker balance sheet are more reluctant to supply loans to smaller firms especially during economic recession or under tighter monetary policy.

Next, we divide our observations into two subsamples based on the number of banks firms borrow from, adjusted for firm size. That is, given that the number of firms' lender banks is highly correlated with firm size, we use the ratio of the number of lender banks to the natural logarithm of firms' total assets. We conjecture that dispersed borrowing relations weaken the ties between the firm and each lender bank. If this is the case, the role of bank liquidity is more important for firms with a relatively large number of lender banks during recessions, because in such times banks with scarce liquidity are likely to lend more to closely-tied firms than to remote firms. Again, the observations are split into firms who fall below and above the sample median. The results are shown in the sets of columns labeled (i) and (ii) in Table 7(b). We find that the coefficients on the interaction terms of BLIQ and the POLICY variables are significant only for firms with a larger number of banks. This is consistent with our conjecture that the role of bank liquidity is more important for firms with a relatively large number of lender banks when monetary policy is tight.

In the two sets of columns in Table 7(b) labeled (ii-a) and (ii-b), we further split the observations for firms with a larger number of banks into two subsamples based on the loan share of the top lender. The purpose of this analysis is to examine how asymmetry in loan shares among lenders, which we try to capture by the top lender bank's share, affects the result obtained above. We find that the coefficient on BLIQ is significant only for firms whose top lender's loan share is above the median. Further, the absolute value of the coefficients on the interaction terms of BLIQ and the POLICY variables is larger for firms with a larger top lender loan share. In sum, the results in Tables 7(a) and (b) imply that, among firms with a large number of lender banks, the role of bank liquidity is important mainly for firms with a highly asymmetric loan share structure, that is, firms which have only weak ties with many banks other than their top lender.

5.4. Size and Direction of the Endogeneity Bias

All the empirical models we have been examining so far assume the existence of time-variant firm-specific individual effects. Omitting these firm-specific individual effects potentially results in biased estimates for the parameters seeking to capture bank balance sheet effects. In this section, we quantify these potential biases. For this purpose, we start by estimating the following equation:

$$\begin{aligned}\Delta\,\mathrm{LOANS}(i,j,t) = {} & \beta_1\mathrm{BSIZE}(i,t-1) + \beta_2\mathrm{BROA}(i,t-1) + \beta_3\mathrm{BJGB}(i,t-1) + \beta_3\mathrm{BJGB}(i,t-1) \\ & + \beta_4\mathrm{BLOCALBOND}(i,t-1) + \beta_5\mathrm{BLTD}(i,t-1) + \beta_6\mathrm{BCAP}(i,t-1) \\ & + \beta_7\mathrm{BLIQ}(i,t-1) + \mathrm{YEAR}(t) \\ & + \gamma_1\mathrm{BCAP}(i,t-1)\mathrm{GDPGROWTH}(t) + \gamma_2\mathrm{BLIQ}(i,t-1)\mathrm{GDPGROWTH}(t) \\ & + \gamma_3\mathrm{BCAP}(i,t-1)\mathrm{POLICY}(t) + \gamma_4\mathrm{BLIQ}(i,t-1)\mathrm{POLICY}(t) + \delta(i,j) \\ & + \epsilon(t) \qquad (3.1)\end{aligned}$$

This equation is almost identical to the baseline model given by equation (1) with the assumption that $\varepsilon(i,j,t) \equiv \delta(i,j) + \epsilon(t)$, but it does not include $\eta(j,t)$. In that regard, we consider (3.1) to be incorrectly specified. What we are interested in is how much the coefficients on the bank balance sheet variables and their interaction terms with the aggregate-level variables $\{\gamma_1, \gamma_2, \gamma_3, \gamma_4\}$

differ from the coefficient estimates obtained in Sections 5.1 and 5.2. If the two sets of coefficient estimates differ greatly, this would suggest that the bias due to endogeneity is quite substantial. For this estimation, we use the same sample as we used to obtain the results in Table 6.[9]

Table 8, under the columns labeled "Without Firm Characteristics," presents the results for the estimation based on (3.1) and on the right reproduces the results from column (ii) in Table 6 for ease of comparison. We use REGCAP for BCAP in this estimation. The table shows the following. First, the absolute value of the coefficient on BLIQ in the estimation based on (3.1) is substantially smaller than in the estimation based on equation (1). In fact, the estimate coefficient is not statistically different from zero. This means that the economic importance of bank liquidity in the provision of loans is underestimated when, as in (3.1), the model is incorrectly specified. This downward bias occurs when the firm time-varying individual effect, which captures firm-specific loan demand, is negatively correlated with bank liquidity. This could be the case, for example, if firms with good investment opportunities, and hence with larger loan demand, tend to borrow from both banks with low liquidity and banks with high liquidity, while firms with poorer investment opportunities and hence lower loan demand tend to borrow only from high-liquidity banks. As a result, the coefficient on BLIQ in the incorrectly specified model is closer to zero. Second, we also find that the absolute value of the negative coefficient on the interaction terms between BLIQ and GDPGROWTH or MPLOOSENING is smaller than that in the estimation based on equation (1). This implies that the economic impact of the bank balance sheet channel is underestimated if we do not properly control for the time-variant component of firm characteristics. This downward bias emerges when the firm time-varying individual effect, representing firm-specific loan demand, is positively correlated with the interaction of BLIQ and MPLOOSENING or with the interaction of BLIQ and GDPGROWTH. One interpretation of this bias is that firms with larger loan demand in a better economic environment or under expansionary monetary policy tend to borrow from banks with more liquidity. Therefore, if we do not control for such loan demand, the coefficient on the interaction term between BLIQ and GDPGROWTH or MPLOOSENING becomes closer to zero. This confirms the presence of endogeneity bias in the models if firms' loan demand is not properly controlled for.

Next, we examine to what extent the bias arising from omitting *unobservable* firm loan demand is reduced when we add *observable* firm characteristics that likely represents firms' loan demand. Specifically, we estimate the following equation, which is the same as equation (3.1) but incorporates a number of additional firm characteristics (F_CHAR):

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[9] To be more precise, we use the data of firms with equal to or more than two lender banks, which we used for the estimation of (2). The differences in the number of observations and the number of groups originate from the fact that the unit of observation for the estimation of (3.1) is firm-bank match while the unit of observation for the baseline estimation is firm and two lender banks (i.e., triplet).

$$
\begin{aligned}
\Delta\,\mathrm{LOAN(i,j,t)} = {} & \beta_1\mathrm{BSIZE(i,t-1)} + \beta_2\mathrm{BROA(i,t-1)} + \beta_3\mathrm{BJGB(i,t-1)} + \beta_3\mathrm{BJGB(i,t-1)} \\
& + \beta_4\mathrm{BLOCALBOND(i,t-1)} + \beta_5\mathrm{BLTD(i,t-1)} + \beta_6\mathrm{BCAP(i,t-1)} \\
& + \beta_7\mathrm{BLIQ(i,t-1)} + \mathrm{YEAR(t)} \\
& + \gamma_1\mathrm{BCAP(i,t-1)GDPGROWTH(t)} + \gamma_2\mathrm{BLIQ(i,t-1)GDPGROWTH(t)} \\
& + \gamma_3\mathrm{BCAP(i,t-1)POLICY(t)} + \gamma_4\mathrm{BLIQ(i,t-1)POLICY(t)} \\
& + \boldsymbol{\lambda}\mathbf{F\_CHAR(j,t-1)} + \delta\mathrm{(i,j)} + \epsilon\mathrm{(t)} \qquad (3.2)
\end{aligned}
$$

The additional characteristics include firms' price-to-book ratio, the number of lender banks relative to the logarithm of total assets, the natural logarithm of their total assets, the ratio of current profits to total assets, the ratio of liquidity assets to liquidity liabilities, the ratio of total debt to total assets, the ratio of short-term to long-term liabilities, the ratio of bank borrowing to total liabilities, and the ratio of fixed assets to total assets.[10] The results for the estimation of (3.2) are shown in the columns labeled "With Firm Characteristics" in Table 8 and have the same implications as the estimation results for (3.1). That is, even when we include a considerable range of firm characteristics in the estimation, the results still appear to be biased. Moreover, given that the inclusion of this long list of firm characteristics rules out most other potential sources of bias, we can be fairly confident that the source of the bias is firms' loan demand, which is taken account of by allowing for time-variant firm-specific effects.

To illustrate the importance of controlling for loan demand, let us compare the economic impact of liquidity on loan provision implied in the baseline model and the incorrect specification. Specifically, we focus on the estimation that does not control for firms' unobservable loan demand but does include the various firm characteristics and that uses MPTIGHTENING as the POLICY variable (i.e., the fourth set of columns in Table 8). The coefficient estimates for BLIQ and the interaction term of BLIQ and MPTIGHTENING are 0.102 (not significantly different from 0) and 0.378 respectively, while in the baseline case (the last set of columns in Table 8), they are 0.695 and 0.288. Suppose that the liquidity ratio of lender bank i for firm j declines by one standard deviation (i.e., 0.068) in year t-1 and that monetary policy is tightened (i.e., MPTIGHTENING=1), while GDPGROWTH=0 in year t. Based on the parameter estimates from the correct specification, loans would fall by 6.7% (i.e., $\Delta\,\mathrm{LOANS(i,j,t)} = 0.695 \times (-0.068) + 0.288 \times (-0.068) \times 1 = -6.7\%$). Given that the sample mean of $\Delta\,\mathrm{LOANS(I,j,t)}$ is -0.4%, this is an economically sizable impact. On the other hand, the incorrectly specified model predicts that loans would fall by only 2.6% (assuming that the coefficient on BLIQ is zero given the insignificant coefficient, $\Delta\,\mathrm{LOANS(i,j,t)} = 0 \times (-0.068) + 0.378 \times (-0.068) \times 1 = -2.6\%$). This means that the bias gives rise to a substantial underestimation of the economic impact of the deterioration in the balance sheet and the tightening

[10] The estimation results for these variables are suppressed in Table 8 to conserve space. They are available from the authors upon request.

of monetary policy.

5.5. Impact of Bank Balance Sheets on Firm-Level Borrowing and Investment

The results obtained so far imply that changes in the real GDP growth rate and monetary policy are transmitted to firms through a change in bank lending especially when the bank has scarce capital or liquid assets. However, a decrease in loans from banks with weak balance sheets may be offset by an increase in loans from banks with strong balance sheets. If such credit substitution fully occurs, firms' overall borrowing and real economic activities is unlikely to be affected by the decrease in loans from weak banks. In this section, we look at this possible substitution mechanism by examining how the bank balance sheet channel affects firms' overall borrowing and investment.

We start by estimating two equations which use the change in firm j's total borrowing between t-1 to t as the dependent variable. We regress this firm-level variable taken from firms' balance sheet information on the average level of BCAP in the first equation and BLIQ in the second equation (both computed over the lender banks to firm j at the end of t-1), the interaction terms between these two variables and GDPGROWTH and MPTIGHTENING, and various firm characteristics, $\mathbf{F\_CHAR}(\mathbf{j},\mathbf{t}-\mathbf{1})$. Specifically, we include the price-to-book ratio (FPBR), its squared value (FPBR_SQ), the natural logarithm of the firm's total assets (FSIZE), the ratio of current profits to total assets (FROA), and the ratio of fixed assets to total assets (FTANGIBLE). Since the average BCAP and BLIQ are highly correlated (with a correlation coefficient of around 0.8), we include only one of these variables in each equation.

We use the average BCAP and BLIQ of a firm's lender banks to measure the extent to which the bank balance sheet channel affects firms. For example, suppose a firm is borrowing from one bank with low BLIQ and another bank with high BLIQ. In this case, even if the former bank cannot extend a loan to the firm in an economic downturn, the latter might be able to do so to meet the firm's loan demand. However, if the latter bank's BLIQ is also low and it therefore, too, cannot lend to the firm, this would affect the firm's ability to borrow. Thus, we expect that (i) the coefficients on the average BLIQ and BCAP are positive, (ii) the coefficients on the interaction terms of these two variables with GDPGROWTH are negative, and (iii) the coefficients on the interaction terms on these two variables with MPTIGHTENING, which we use as the POLICY variables, are positive. Concretely, the specifications we estimate are as follows:

$$\begin{aligned}\Delta\,\mathrm{LOAN}(\mathrm{j},\mathrm{t}) = {} & \alpha_1\overline{\mathrm{BCAP}}(\mathrm{j},\mathrm{t}-1) + \alpha_2\overline{\mathrm{BCAP}}(\mathrm{j},\mathrm{t}-1)\mathrm{GDPGROWTH}(\mathrm{t}) \\ & + \alpha_2\overline{\mathrm{BCAP}}(\mathrm{j},\mathrm{t}-1)\mathrm{POLICY}(\mathrm{t}) + \mathrm{YEAR}(\mathrm{t}) + \boldsymbol{\lambda}\mathbf{F\_CHAR}(\mathbf{j},\mathbf{t}-\mathbf{1}) + \epsilon(\mathrm{t}) \qquad (4.1)\end{aligned}$$

$$\begin{aligned}\Delta\,\mathrm{LOAN}(\mathrm{j},\mathrm{t}) = {} & \alpha_1\overline{\mathrm{BLIQ}}(\mathrm{j},\mathrm{t}-1) + \alpha_2\overline{\mathrm{BLIQ}}(\mathrm{j},\mathrm{t}-1)\mathrm{GDPGROWTH}(\mathrm{t}) \\ & + \alpha_2\overline{\mathrm{BLIQ}}(\mathrm{j},\mathrm{t}-1)\mathrm{POLICY}(\mathrm{t}) + \mathrm{YEAR}(\mathrm{t}) + \boldsymbol{\lambda}\mathbf{F\_CHAR}(\mathbf{j},\mathbf{t}-\mathbf{1}) + \epsilon(\mathrm{t}) \qquad (4.2)\end{aligned}$$

Column (i) in Tables 9(a) and (b) show the estimation results for equations (4.1) and (4.2) respectively. We find that the coefficients on the interaction terms of the average BCAP and BLIQ with GDPGROWTH are negative, meaning that firms whose banks are less well capitalized or less liquid (i.e., lower average BCAP or BLIQ) obtain fewer loans in a recession. Moreover, this tendency is more pronounced for firms facing better investment opportunities, as shown in column (ii) in Tables 9(a) and (b), where equations (4.1) and (4.2) are estimated separately for firms whose price-to-book ratio (FPBR), used to proxy investment opportunities, falls below or above the median. Specifically, Table 9(b) indicates that for firms with an FPBR above the median, the liquidity of their lending banks has a greater impact on their borrowing than for other firms. Moreover, this link is significantly stronger when the economy is in downturn and/or monetary policy is tightened. On the other hand, as shown in column (ii) in Table 9(a), no similar link is observed when using BCAP instead of BLIQ. In both panels, most of the results for the control variables are consistent with preceding studies. For instance, FPBR takes a positive and significant coefficient, suggesting that firms with better investment opportunities demand more loans.

Finally, we apply the same framework to the determination of firms' capital investment ratio. Using the same specification as in (4.1) and (4.2) except that the dependent variable now is the ratio of gross investment to the capital stock at the end of the previous period, we estimate the following equations:[11]

$$\begin{aligned}\Delta\,\mathrm{INVETMENTRATIO}(j,t) \\ &= \alpha_1\overline{\mathrm{BCAP}}(j,t-1) + \alpha_2\overline{\mathrm{BCAP}}(j,t-1)\mathrm{GDPGROWTH}(t) \\ &+ \alpha_2\overline{\mathrm{BCAP}}(j,t-1)\mathrm{POLICY}(t) + \mathrm{YEAR}(t) + \boldsymbol{\lambda}\mathbf{F\_CHAR}(\mathbf{j},\mathbf{t-1}) + \epsilon(t) \qquad (5.1)\end{aligned}$$

$$\begin{aligned}\Delta\,\mathrm{INVESTMENTRATIO}(j,t) \\ &= \alpha_1\overline{\mathrm{BLIQ}}(j,t-1) + \alpha_2\overline{\mathrm{BLIQ}}(j,t-1)\mathrm{GDPGROWTH}(t) \\ &+ \alpha_2\overline{\mathrm{BLIQ}}(j,t-1)\mathrm{POLICY}(t) + \mathrm{YEAR}(t) + \boldsymbol{\lambda}\mathbf{F\_CHAR}(\mathbf{j},\mathbf{t-1}) + \epsilon(t) \qquad (5.2)\end{aligned}$$

Columns (iv), (v), and (vi) in Tables 9(a) and (b) show the results for (5.1) and (5.2) respectively for all firms, firms with an above median FPBR, and firms with an FPBR equal to or lower than the median. Similar to the results for $\Delta\,\mathrm{LOAN}(j,t)$, firms with better investment opportunities tend to invest more when their lender banks are more liquid, and this link is stronger during an economic downturn. These results show that the bank balance sheet channel examined in this paper has a significant impact on firm borrowing and investment activities. Again, most of the control variables are consistent with many preceding studies.

[11] To compute gross investment in t, we add depreciation during t to the change in the stock of tangible assets from t-1 to t.

6. Conclusion

This paper examined the impact of changes in economic growth and monetary policy on banks' supply of loans. To do so, we used a unique firm-bank match-level dataset of listed firms in Japan that allows us to control for firms' time-varying unobservable loan demand and endogenous bank-firm matching, so that we can identify the effects of monetary policy and economic growth on loan supply through the bank balance sheet channel. The estimation results indicate that banks with more liquidity or capital tended to lend more to their client firms. The quantitative impact of bank liquidity and capital on loan supply was economically sizable and larger when economic growth was lower. Furthermore, the quantitative impact of bank liquidity on the growth rate of loans more than doubled when quantitative easing was terminated. Overall, these results imply that changes in economic growth and monetary policy significantly affected loan supply through the bank balance sheet channel. We also find evidence that fluctuations in economic growth and monetary policy are transmitted to capital investment through the bank balance sheet channel in the case of firms with better investment opportunities

The research presented in this study could be expanded in a number of directions. One such direction would be to extend our analysis to examine various other kinds of firm dynamics such as those with regard to market exit and overseas investment. A further potentially interesting extension would be to use the model in this study to analyze changes in the list of banks that firms borrow from. Firms may stop transacting with some banks – maybe because such banks no longer want to lend to them – and may start transaction with banks from which they have never borrowed before. Such changes in lender banks potentially represent the transmission of shocks through the bank balance sheet channel, but because we focused on loans from banks with which firms had loans outstanding for at least two consecutive years, our analysis does not cover this aspect. Examining this aspect as well would further deepen our understanding of the bank balance sheet channel. We believe all of these extensions would provide further insights to gain a better understanding of the bank balance sheet channel of business cycle and monetary policy on firm activities.

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Figure 1. Change in Loans Outstanding and GDP Growth

The figure shows the change in loans outstanding and the nominal GDP growth rate.

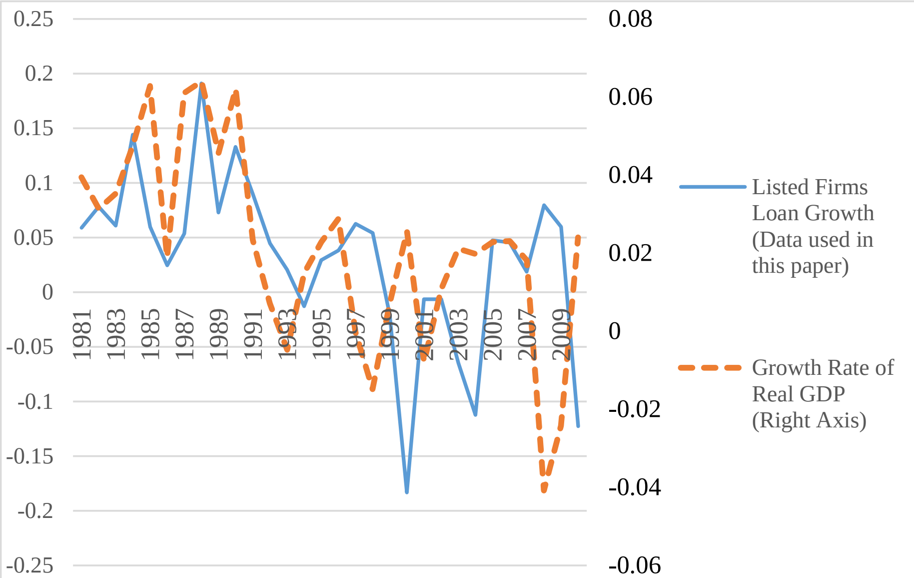

Figure 2. Change in Loans Outstanding and the Policy Rate

The figure shows the change in loans outstanding and the policy rate.

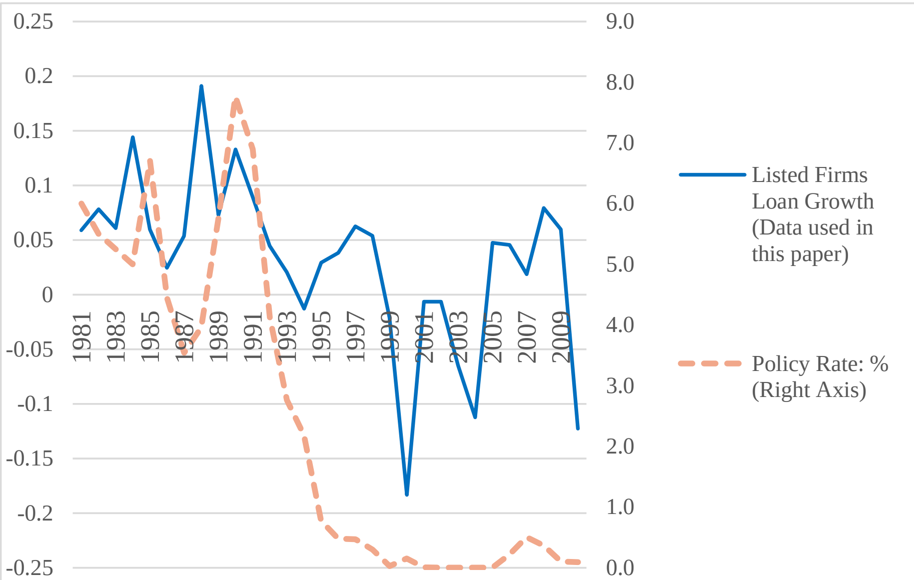

Figure 3. Changes in Loans Outstanding for Listed and All Firms

The figure shows the changes in loans outstanding for listed firms and all (i.e., listed and unlisted) firms.

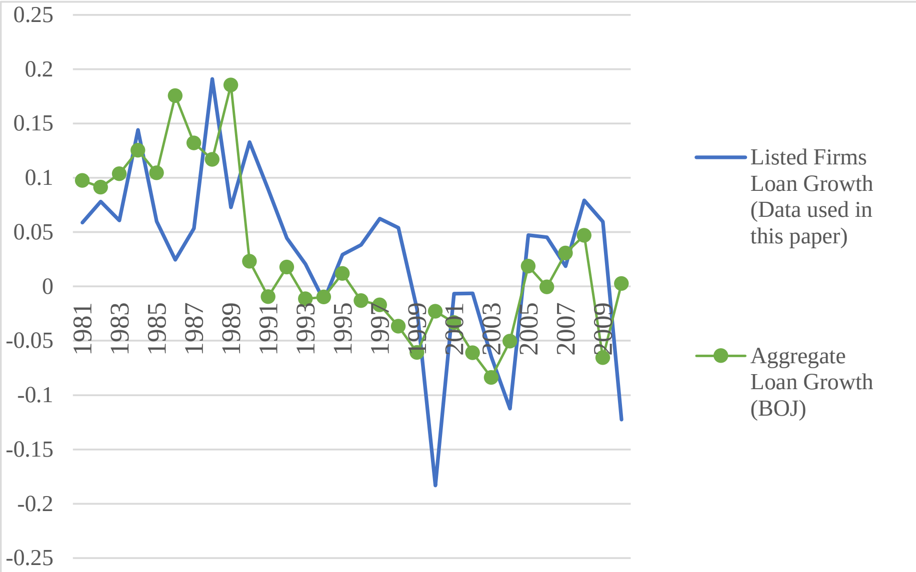

Figure 4. Distribution of the Change in Firm and Bank Match-Level Loans Outstanding

The figure shows the distribution of the change in loans outstanding measured at the firm-bank match-level.

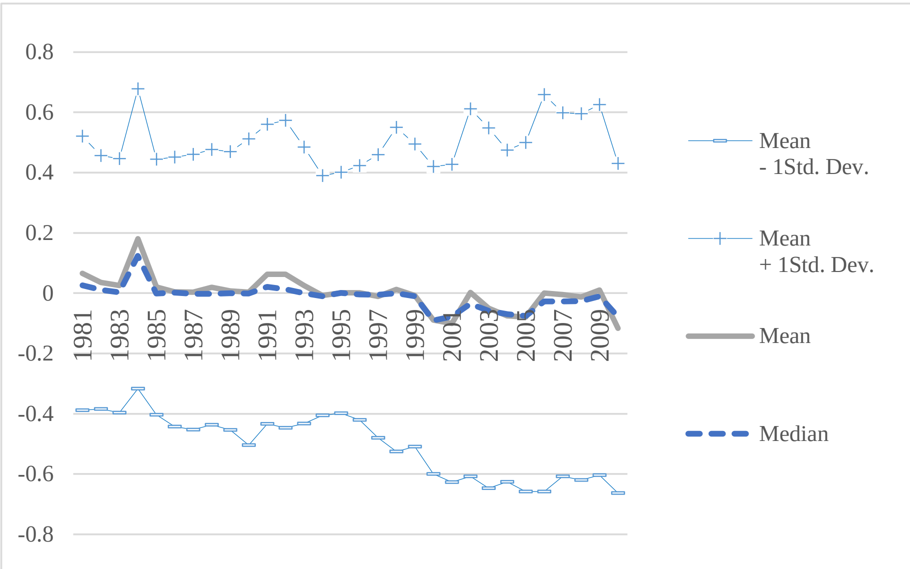

Table. 1 Aggregate-Level and Policy Variables

The change in the policy rate (ΔPolicy Rate) is the difference of the policy target rate (i.e., either the Koteibuai or the O/N call rate) from the previous year. The change in the policy rate is measured using the Koteibuai until FY1984 and the O/N rate thereafter. The target rate for each year is calculated as the average over each period. The extent of quantitative easing (QE target) is measured as the average of the BOJ's target volume of reserves. In the calculation of this average, we use the number of months for each target level as a weight and compute the weighted average of the QE target. POLRATE_UP (POLRATE_DOWN) is a dummy variable taking a value of one when the policy rate becomes strictly lower (higher) than in the previous year. QE_LOOSENING (QE_TIGHTENING) is a dummy variable taking a value of one when the QE target becomes strictly larger (smaller) than in the previous year. MPLOOSENING (MPTIGHTENING) is a dummy variable taking a value of one when the BOJ strictly relaxes (tightens) monetary policy in terms of the policy rate or the QE target.

FY	Growth Rate of Real GDP	Policy Rate Koteibuai: %	Policy Rate O/N Call Rate %	ΔPolicy Rate from Previous FY: %	QE Target (Weight Average): Trillion Yen	POLRATE _UP	POLRATE _DOWN	QE _LOOSE NING	QE _TIGHT ENING	MP LOOSE NING	MP TIGHT ENING
1981	0.0394	6.0000	n.a.	-2.0000	0	0	1	0	0	1	0
1982	0.0314	5.5000	n.a.	-0.5000	0	0	1	0	0	1	0
1983	0.0353	5.2500	n.a.	-0.2500	0	0	1	0	0	1	0
1984	0.0476	5.0000	n.a.	-0.2500	0	0	1	0	0	1	0
1985	0.0628	4.8333	6.7010	-0.1667	0	0	1	0	0	1	0
1986	0.0189	3.2083	4.4424	-1.6250	0	0	1	0	0	1	0
1987	0.0610	2.5000	3.5403	-0.7083	0	0	1	0	0	1	0
1988	0.0640	2.5000	3.9572	0.0000	0	0	0	0	0	0	0
1989	0.0457	3.6875	5.7432	1.1875	0	1	0	0	0	0	1
1990	0.0620	5.7500	7.7656	2.0625	0	1	0	0	0	0	1
1991	0.0234	5.2500	6.8928	-0.5000	0	0	1	0	0	1	0
1992	0.0071	3.2500	4.1228	-2.0000	0	0	1	0	0	1	0
1993	-0.0048	2.0625	2.7596	-1.1875	0	0	1	0	0	1	0
1994	0.0150	1.7500	2.1819	-0.3125	0	0	1	0	0	1	0
1995	0.0228	0.7083	0.7746	-1.0417	0	0	1	0	0	1	0
1996	0.0288	0.5000	0.4800	-0.2083	0	0	1	0	0	1	0
1997	-0.0002	0.5000	0.4683	-0.0117	0	0	1	0	0	1	0
1998	-0.0148	0.5000	0.3008	-0.1675	0	0	1	0	0	1	0
1999	0.0073	0.5000	0.0267	-0.2742	0	0	1	0	0	1	0
2000	0.0255	0.4667	0.1533	0.1267	0	1	0	0	0	0	1
2001	-0.0079	0.1625	0.0080	-0.1453	7.1	0	0	1	0	1	0
2002	0.0108	0.1000	0.0019	-0.0061	15.0	0	0	1	0	1	0
2003	0.0211	0.1000	0.0011	-0.0008	28.7	0	0	1	0	1	0
2004	0.0198	0.1000	0.0009	-0.0002	32.5	0	0	1	0	1	0
2005	0.0228	0.1000	0.0011	0.0002	32.5	0	0	0	0	0	0
2006	0.0230	0.3833	0.2186	0.2175	0.0	0	0	0	1	0	1
2007	0.0182	0.7500	0.5047	0.2861	0	1	0	0	0	0	1
2008	-0.0408	0.5583	0.3627	-0.1420	0	0	1	0	0	1	0
2009	-0.0242	0.3000	0.1022	-0.2605	0	0	1	0	0	1	0
2010	0.0240	0.3000	0.0909	-0.0113	0	0	1	0	0	1	0

Table 2. Summary Statistics

This table shows the summary statistics for the variables we use in the regression analysis. For the first group of variables (i), the statistics are computed over all firm-bank matches and years. For the second group of variables (ii), the statistics are computed over all firms and years. ΔLOANS is the log-difference of the outstanding loan amount from each lender bank to each firm. BSIZE is the natural logarithm of banks' total assets. BROA is the ratio of banks' operating profits to total assets. BJGB and BLOCALBOND are the ratio of banks' JGB and local municipal bond holdings to total assets, respectively. BTETA is the ratio of banks' total equity to total assets. REGCAP is the capital adequacy ratio taken from data provided by the Japan Bankers Association. For REGCAP, we subtract 4% in the case of domestically operating banks and 8% in the case of internationally operating banks. BLIQ is the ratio of (i) the sum of banks' cash and deposits, loans outstanding in the call market, securities for selling, and JGBs and local bonds minus required reserve at the BOJ, to (ii) total assets.

Variable		Obs.	Mean	Std. Dev.	Min.	Max.
ΔLOANS	(i) Computed over all firm-bank matches and years	425,415	-0.003	0.488	-7.931	7.585
BSIZE		459,272	16.153	1.358	10.904	18.852
BROA		459,272	0.002	0.009	-0.252	0.027
BJGB		459,272	0.066	0.046	0	0.278
BLOCALBOND		459,272	0.014	0.016	0	0.119
BLTD		459,272	0.607	0.499	0	4.030
BTETA		459,272	0.037	0.016	-0.491	0.127
REGCAP		243,989	3.921	2.671	0.010	20.450
BLIQ		459,272	0.191	0.068	0.020	0.485
FPBR	(ii) Computed over all firms and years	29,693	2.090	18.455	0.001	1220.000
FSIZE		30,028	10.718	1.536	5	16.722
FROA		29,820	0.019	0.059	-1.962	0.945
FTANGIBLE		29,749	0.458	0.194	0	0.989
ΔFLOAN1		25,218	-0.004	0.306	-3.405	4.135
ΔFLOAN2		30,196	-0.011	0.483	-6.223	6.097
FINVRATIO		29,602	0.121	0.434	-0.954	30.024

Table 3. Estimation Results Including Four Monetary Policy Variables

This table shows the estimation results for equation (2). Heteroskedasticity-robust standard errors are reported. ***, **, and * indicate significance at the 1, 5, and 10% level, respectively. The dependent variable (ΔLOANS(t)) is the log difference between t-1 and t of the total loans outstanding for each firm-bank pair. The columns labeled "BCAP=BTETA" are for the case where the ratio of banks' equity to total assets (BTETA) is used as banks' capital ratio (BCAP), while the columns labeled "BCAP=BREGCAP" are for the case where banks' capital adequacy ratio (BREGCAP) is used as BCAP.

Dependent Variable: ΔLOANS(t)	BCAP = BTETA						BCAP = REGCAP					
	(i)		(ii)		(iii)		(i)		(ii)		(iii)	
	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD
BSIZE(t-1)	0.015	0.001 ***	0.069	0.005 ***	0.124	0.007 ***	0.015	0.002 ***	0.098	0.008 ***	0.164	0.012 ***
BROA(t-1)	1.687	0.155 ***	1.306	0.162 ***	1.354	0.177 ***	1.742	0.161 ***	1.442	0.175 ***	1.416	0.190 ***
BJGB(t-1)	-0.190	0.039 ***	-0.324	0.048 ***	-0.352	0.057 ***	-0.429	0.056 ***	-0.673	0.068 ***	-0.717	0.084 ***
BLOCALBOND(t-1)	0.376	0.067 ***	-0.186	0.105 *	-0.353	0.119 ***	0.188	0.087 **	-0.054	0.160	-0.133	0.187
BLTD(t-1)	-0.038	0.003 ***	-0.001	0.007	0.020	0.008 **	-0.037	0.004 ***	-0.027	0.011 **	0.016	0.015
BCAP(t-1)	0.377	0.382	1.384	0.395 ***	1.759	0.511 ***	-0.002	0.003	0.008	0.004 **	0.016	0.005 ***
BLIQ(t-1)	0.246	0.085 ***	0.285	0.088 ***	0.213	0.095 **	0.388	0.137 ***	0.370	0.143 ***	0.382	0.186 **
BCAP(t-1)×GDPGROWTH(t)	-13.505	4.379 ***	-19.547	4.749 ***	-14.452	5.557 ***	-0.118	0.046 ***	-0.206	0.047 ***	-0.216	0.055 ***
BCAP(t-1)×POLRATE_UP(t)	-0.086	0.421	-0.501	0.428	-1.201	0.519 **	0.010	0.004 ***	0.010	0.004 ***	0.002	0.005
BCAP(t-1)×POLRATE_DOWN(t)	-0.198	0.385	-0.813	0.398 **	-1.221	0.501 **	-0.002	0.004	-0.007	0.004 *	-0.014	0.005 ***
BCAP(t-1)×QE_LOOSENING(t)	-1.669	0.423 ***	-1.495	0.427 ***	-0.858	0.545	-0.005	0.003	-0.006	0.004	-0.009	0.005 *
BCAP(t-1)×QE_TIGHTENING(t)	-0.869	0.570	-0.887	0.569	-1.382	0.639 **	-0.019	0.005 ***	-0.019	0.005 ***	-0.029	0.005 ***
BLIQ(t-1)×GDPGROWTH(t)	-8.306	0.745 ***	-8.081	0.778 ***	-7.395	0.881 ***	-7.935	1.429 ***	-7.400	1.491 ***	-5.781	1.728 ***
BLIQ(t-1)×POLRATE_UP(t)	-0.060	0.085	-0.077	0.085	-0.065	0.089	-0.252	0.144 *	-0.163	0.148	-0.208	0.186
BLIQ(t-1)×POLRATE_DOWN(t)	-0.106	0.079	-0.057	0.080	-0.073	0.086	-0.114	0.135	-0.084	0.141	-0.198	0.182
BLIQ(t-1)×QE_LOOSENING(t)	-0.404	0.099 ***	-0.402	0.101 ***	-0.276	0.110 **	-0.324	0.139 **	-0.334	0.144 **	-0.298	0.182
BLIQ(t-1)×QE_TIGHTENING(t)	0.602	0.179 ***	0.573	0.179 ***	0.513	0.204 **	0.683	0.197 ***	0.589	0.198 ***	0.504	0.244 **
CONSTANT	0.002	0.004	-0.190	196.848	0.032	0.005 ***	0.013	0.010	0.249	0.125 **	0.087	0.016 ***
Year Effect	Yes		Yes		Yes		Yes		Yes		Yes	
Firm Time-Variant FE	Yes		Yes		Yes		Yes		Yes		Yes	
Bank-Level Time-Invariant FE	No		Yes		Yes		No		Yes		Yes	
Match-Level Time-Invariant FE	No		No		Yes		No		No		Yes	
Number of Obs.			299,196						156,722			
Number of Groups	N.A.		N.A.		52,109		N.A.		N.A.		40,374	
F-Value	19.71		.		13.03		23.24		.		14.34	
R-Squared (Overall)	0.0038		0.0078		0.0009		0.0062		0.0131		0.0018	

Table 4. Estimation Results Including Dummy for Loosening Monetary Policy

This table shows the estimation results for equation (2). Heteroskedasticity-robust standard errors are reported. ***, **, and * indicate significance at the 1, 5, and 10% level, respectively. The dependent variable (ΔLOANS(t)) is the log difference between t-1 and t of the total loans outstanding for each firm-bank pair. The columns labeled "BCAP=BTETA" are for the case where the ratio of banks' equity to total assets (BTETA) is used as banks' capital ratio (BCAP), while the columns labeled "BCAP=BREGCAP" are for the case where banks' capital adequacy ratio (BREGCAP) is used as BCAP.

	BCAP = BTETA						BCAP = REGCAP					
Dependent Variable:	(i)		(ii)		(iii)		(i)		(ii)		(iii)	
ΔLOANS(t)	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD
BSIZE(t-1)	0.016	0.001 ***	0.070	0.005 ***	0.123	0.007 ***	0.016	0.002 ***	0.101	0.008 ***	0.168	0.012 ***
BROA(t-1)	1.589	0.154 ***	1.290	0.161 ***	1.373	0.176 ***	1.689	0.160 ***	1.480	0.174 ***	1.476	0.189 ***
BJGB(t-1)	-0.195	0.038 ***	-0.355	0.046 ***	-0.374	0.056 ***	-0.451	0.052 ***	-0.677	0.064 ***	-0.667	0.081 ***
BLOCALBOND(t-1)	0.405	0.067 ***	-0.221	0.104 **	-0.366	0.119 ***	0.208	0.086 **	-0.070	0.159	-0.139	0.186
BLTD(t-1)	-0.038	0.003 ***	0.004	0.007	0.021	0.008 ***	-0.037	0.004 ***	-0.018	0.011 *	0.022	0.014
BCAP(t-1)	0.062	0.218	0.836	0.227 ***	0.530	0.277 *	-0.003	0.002 *	0.006	0.002 ***	0.006	0.003 **
BLIQ(t-1)	0.251	0.049 ***	0.276	0.052 ***	0.204	0.058 ***	0.448	0.075 ***	0.462	0.078 ***	0.373	0.091 ***
BCAP(t-1)×GDPGROWTH(t)	-15.917	4.408 ***	-21.062	4.784 ***	-12.200	5.645 **	-0.165	0.042 ***	-0.199	0.043 ***	-0.160	0.051 ***
BCAP(t-1)×MPLOOSENING(t)	-0.324	0.222	-0.499	0.230 **	0.057	0.261	-0.002	0.002	-0.004	0.002 **	-0.001	0.002
BLIQ(t-1)×GDPGROWTH(t)	-8.189	0.734 ***	-7.901	0.770 ***	-7.346	0.872 ***	-8.638	1.437 ***	-8.393	1.496 ***	-6.103	1.732 ***
BLIQ(t-1)×MPLOOSENING(t)	-0.158	0.042 ***	-0.098	0.043 **	-0.086	0.046 *	-0.218	0.070 ***	-0.234	0.073 ***	-0.220	0.080 ***
CONSTANT	0.003	0.004	-0.196	.	0.032	0.005 ***	0.012	0.010	0.251	0.123 **	0.074	0.015 ***
Year Effect	Yes		Yes		Yes		Yes		Yes		Yes	
Firm Time-Variant FE	Yes		Yes		Yes		Yes		Yes		Yes	
Bank-Level Time-Invariant FE	No		Yes		Yes		No		Yes		Yes	
Match-Level Time-Invariant FE	No		No		Yes		No		No		Yes	
Number of Obs.			299,196						156,722			
Number of Groups	N.A.		N.A.		52,109		N.A.		N.A.		40,374	
F-Value	21.07		.		14.36		25.31		.		14.77	
R-Squared (Overall)	0.0033		0.0075		0.0009		0.0052		0.0122		0.0016	

Table 5. Estimation Results Including Dummy for Tightening Monetary Policy

This table shows the estimation results for equation (2). Heteroskedasticity-robust standard errors are reported. ***, **, and * indicate significance at the 1, 5, and 10% level, respectively. The dependent variable (ΔLOANS(t)) is the log difference between t-1 and t of the total loans outstanding for each firm-bank pair. The columns labeled "BCAP=BTETA" are for the case where the ratio of banks' equity to total assets (BTETA) is used as banks' capital ratio (BCAP), while the columns labeled "BCAP=BREGCAP" are for the case where banks' capital adequacy ratio (BREGCAP) is used as BCAP.

Dependent Variable: ΔLOANS(t)	BCAP = BTETA						BCAP = REGCAP					
	(i)		(ii)		(iii)		(i)		(ii)		(iii)	
	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD
BSIZE(t-1)	0.016	0.001 ***	0.070	0.005 ***	0.124	0.007 ***	0.016	0.002 ***	0.100	0.008 ***	0.167	0.012 ***
BROA(t-1)	1.584	0.154 ***	1.279	0.161 ***	1.372	0.176 ***	1.673	0.160 ***	1.472	0.174 ***	1.474	0.189 ***
BJGB(t-1)	-0.191	0.037 ***	-0.362	0.046 ***	-0.378	0.056 ***	-0.430	0.051 ***	-0.656	0.064 ***	-0.655	0.080 ***
BLOCALBOND(t-1)	0.404	0.067 ***	-0.226	0.104 **	-0.370	0.119 ***	0.207	0.086 **	-0.075	0.159	-0.151	0.186
BLTD(t-1)	-0.038	0.003 ***	0.004	0.007	0.022	0.008 ***	-0.037	0.004 ***	-0.018	0.011 *	0.023	0.014
BCAP(t-1)	-0.218	0.123 *	0.424	0.141 ***	0.642	0.174 ***	-0.006	0.001 ***	0.002	0.001 *	0.005	0.001 ***
BLIQ(t-1)	0.090	0.026 ***	0.178	0.030 ***	0.118	0.034 ***	0.231	0.032 ***	0.228	0.042 ***	0.156	0.051 ***
BCAP(t-1)×GDPGROWTH(t)	-14.060	4.311 ***	-17.451	4.643 ***	-8.514	5.450	-0.151	0.041 ***	-0.176	0.042 ***	-0.121	0.050 **
BCAP(t-1)×MPTIGHTENING(t)	0.087	0.242	0.104	0.247	-0.516	0.267 *	0.001	0.002	0.002	0.002	-0.002	0.002
BLIQ(t-1)×GDPGROWTH(t)	-7.841	0.708 ***	-7.700	0.742 ***	-7.100	0.828 ***	-8.134	1.412 ***	-8.034	1.465 ***	-5.901	1.707 ***
BLIQ(t-1)×MPTIGHTENING(t)	0.156	0.045 ***	0.099	0.046 **	0.081	0.048 *	0.207	0.075 ***	0.244	0.077 ***	0.221	0.086 ***
CONSTANT	0.003	0.004	-0.195	.	0.032	0.005 ***	0.007	0.010	0.243	0.123 **	0.068	0.015 ***
Year Effect	Yes		Yes		Yes		Yes		Yes		Yes	
Firm Time-Variant FE	Yes		Yes		Yes		Yes		Yes		Yes	
Bank-Level Time-Invariant FE	No		Yes		Yes		No		Yes		Yes	
Match-Level Time-Invariant FE	No		No		Yes		No		No		Yes	
Number of Obs.			299,196						156,722			
Number of Groups	N.A.		N.A.		52,109		N.A.		N.A.		40,374	
F-Value	20.86		.		14.42		25.08		.		14.71	
R-Squared (Overall)	0.0033		0.0074		0.0009		0.0052		0.0122		0.0016	

Table 6. Subperiod Estimation Results

This table shows the estimation results for equation (2). Heteroskedasticity-robust standard errors are reported. ***, **, and * indicate significance at the 1, 5, and 10% level, respectively. The dependent variable (ΔLOANS(t)) is the log difference between t-1 and t of the total loans outstanding for each firm-bank pair.

BCAP = REGCAP Dependent Variable: ΔLOANS(t)	(i) t= 1993-2004				(ii) t= 2001-2010			
	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD
BSIZE(t-1)	0.180	0.014 ***	0.180	0.014 ***	0.232	0.026 ***	0.225	0.026 ***
BROA(t-1)	1.422	0.200 ***	1.422	0.200 ***	2.348	0.379 ***	2.321	0.379 ***
BJGB(t-1)	-0.582	0.096 ***	-0.582	0.096 ***	-1.279	0.146 ***	-1.265	0.146 ***
BLOCALBOND(t-1)	-0.365	0.218 *	-0.365	0.218 *	0.194	0.373	0.164	0.373
BLTD(t-1)	0.000	0.016	0.000	0.016	0.083	0.052	0.075	0.052
BCAP(t-1)	0.006	0.004	0.000	0.002	0.017	0.004 ***	0.015	0.002 ***
BLIQ(t-1)	0.159	0.112	0.032	0.057	0.937	0.166 ***	0.695	0.128 ***
BCAP(t-1)×GDPGROWTH(t)	-0.031	0.088	-0.031	0.088	-0.312	0.058 ***	-0.262	0.056 ***
BCAP(t-1)×MPLOOSENING(t)	-0.006	0.004 *			-0.003	0.003		
BCAP(t-1)×MPTIGHTENING(t)			0.00634	0.004 *			-0.003	0.003
BLIQ(t-1)×GDPGROWTH(t)	-5.800	2.179 ***	-5.800	2.179 ***	-2.211	2.640	-1.849	2.523
BLIQ(t-1)×MPLOOSENING(t)	-0.127	0.100			-0.249	0.130 *		
BLIQ(t-1)×MPTIGHTENING(t)			0.127	0.100			0.288	0.146 **
CONSTANT	0.046	0.010 ***	0.046	0.010 ***	0.092	0.015 ***	0.088	0.015 ***
Year Effect	Yes		Yes		Yes		Yes	
Firm Time-Variant FE	Yes		Yes		Yes		Yes	
Bank-Level Time-Invariant FE	Yes		Yes		Yes		Yes	
Match-Level Time-Invariant FE	Yes		Yes		Yes		Yes	
Number of Obs.	121,977				65,592			
Number of Groups	31,771				24,415			
F-Value	14.92		14.92		14.19		14.17	
R-Squared (Overall)	0.0014		0.0014		0.0017		0.0017	

Table 7(a). Subsample Estimation: Firm Size

This table shows the estimation results for equation (2). Heteroskedasticity-robust standard errors are reported. ***, **, and * indicate significance at the 1, 5, and 10% level, respectively. The dependent variable (ΔLOANS(t)) is the log difference between t-1 and t of the total loans outstanding for each firm-bank pair. We use observations from FY2001 to FY2010 for this estimation. The first subsample consists of firms with total assets that are equal to or smaller than the median of all firms. The second subsample consists of firms with total assets that are larger than the median.

BCAP = REGCAP Dependent Variable: ΔLOANS(t)	(i) LN(Total Assets) <= Median						(ii) LN(Total Assets) > Median					
	Coef.	SD		Coef.	SD		Coef.	SD		Coef.	SD	
BSIZE(t-1)	0.165	0.018	***	0.163	0.018	***	0.185	0.016	***	0.184	0.016	***
BROA(t-1)	1.609	0.283	***	1.604	0.283	***	1.329	0.258	***	1.330	0.258	***
BJGB(t-1)	-0.908	0.124	***	-0.885	0.123	***	-0.398	0.108	***	-0.396	0.107	***
BLOCALBOND(t-1)	0.007	0.313		-0.007	0.313		-0.230	0.228		-0.241	0.228	
BLTD(t-1)	0.041	0.023	*	0.043	0.023	*	0.006	0.019		0.007	0.019	
BCAP(t-1)	0.012	0.004	***	0.009	0.002	***	0.004	0.003		0.001	0.002	
BLIQ(t-1)	0.473	0.141	***	0.237	0.082	***	0.242	0.121	**	0.087	0.067	
BCAP(t-1)×GDPGROWTH(t)	-0.247	0.076	***	-0.191	0.074	***	-0.137	0.068	**	-0.109	0.066	*
BCAP(t-1)×MPLOOSENING(t)	-0.003	0.004					-0.003	0.003				
BCAP(t-1)×MPTIGHTENING(t)				-0.0023	0.004					0.001	0.003	
BLIQ(t-1)×GDPGROWTH(t)	-4.499	2.592	*	-4.102	2.549		-6.937	2.333	***	-6.946	2.297	***
BLIQ(t-1)×MPLOOSENING(t)	-0.243	0.123	**				-0.156	0.106				
BLIQ(t-1)×MPTIGHTENING(t)				0.225	0.134	*				0.169	0.111	
CONSTANT	0.074	0.019	***	0.071	0.019	***	0.103	0.021	***	0.098	0.021	***
Year Effect	Yes			Yes			Yes			Yes		
Firm Time-Variant FE	Yes			Yes			Yes			Yes		
Bank-Level Time-Invariant FE	Yes			Yes			Yes			Yes		
Match-Level Time-Invariant FE	Yes			Yes			Yes			Yes		
Number of Obs.	73,806						82,916					
Number of Groups	21,671						20,354					
F-Value	7.74			7.65			8.27			8.26		
R-Squared (Overall)	0.0012			0.0012			0.0023			0.0023		

Table 7(b). Subsample Estimation: Standardized Number of Lender Banks

This table shows the estimation results for equation (2). Heteroskedasticity-robust standard errors are reported. ***, **, and * indicate significance at the 1, 5, and 10% level, respectively. The dependent variable (ΔLOANS(t)) is the log difference between t-1 and t of the total loans outstanding for each firm-bank pair. We use observations from FY2001 to FY2010 for this estimation. The first subsample (i) consists of firms whose number of lender banks divided by the firm's total assets is smaller than or equal to the median, while the second subsample (ii) consists of firms with a ratio above the median. The group of columns labeled (ii.a) is for firms in subsample (ii) for which the loan share of the top lender bank is smaller than or equal to the median, while the group of columns labeled (ii.b) is for firms in subsample (ii) for which the loan share of the top lender bank is above the median.

BCAP = REGCAP	(i) No. of Lender Banks / LN(Total Assets) <= Median				(ii) No. of Lender Banks / LN(Total Assets) > Median											
Dependent Variable: ΔLOANS(t)									(ii a) Main bank share <= Median				(ii b) Main bank share > Median			
	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD
BSIZE(t-1)	0.164	0.017 ***	0.163	0.017 ***	0.176	0.017 ***	0.176	0.017 ***	0.221	0.031 ***	0.222	0.031 ***	0.176	0.023 ***	0.175	0.023 ***
BROA(t-1)	1.329	0.267 ***	1.326	0.267 ***	1.597	0.268 ***	1.597	0.267 ***	0.987	0.386 **	0.992	0.385 ***	2.098	0.383 ***	2.092	0.382 ***
BJGB(t-1)	-0.764	0.116 ***	-0.748	0.116 ***	-0.579	0.113 ***	-0.570	0.113 ***	-0.489	0.183 ***	-0.510	0.183 ***	-0.625	0.161 ***	-0.604	0.160 ***
BLOCALBOND(t-1)	-0.645	0.258 **	-0.646	0.257 **	0.468	0.277 *	0.447	0.277	0.318	0.400	0.284	0.401	0.318	0.435	0.301	0.435
BLTD(t-1)	0.011	0.021	0.013	0.021	0.034	0.020 *	0.034	0.020 *	0.000	0.031	-0.001	0.031	0.054	0.030 *	0.055	0.030 *
BCAP(t-1)	0.007	0.004 *	0.007	0.002 ***	0.006	0.004	0.003	0.002	0.005	0.005	0.001	0.003	0.007	0.005	0.002	0.003
BLIQ(t-1)	0.328	0.124 ***	0.178	0.070 **	0.475	0.136 ***	0.145	0.076 *	0.036	0.189	-0.105	0.120	0.703	0.189 ***	0.266	0.109 **
BCAP(t-1)×GDPGROWTH(t)	-0.107	0.069	-0.086	0.067	-0.248	0.077 ***	-0.187	0.075 **	-0.317	0.136 **	-0.264	0.131 **	-0.226	0.102 **	-0.159	0.099
BCAP(t-1)×MPLOOSENING(t)	0.000	0.003			-0.004	0.004			-0.005	0.005			-0.005	0.005		
BCAP(t-1)×MPTIGHTENING(t)			-0.002	0.003			-0.002	0.004			0.001	0.006			-0.001	0.005
BLIQ(t-1)×GDPGROWTH(t)	-6.280	2.325 ***	-5.500	2.294 **	-6.485	2.597 **	-6.874	2.561 ***	-1.716	3.954	-3.359	3.944	-9.132	3.548 ***	-8.864	3.509 **
BLIQ(t-1)×MPLOOSENING(t)	-0.158	0.108			-0.327	0.119 ***			-0.126	0.166			-0.441	0.166 ***		
BLIQ(t-1)×MPTIGHTENING(t)			0.092	0.117			0.399	0.126 ***			0.297	0.170 *			0.469	0.178 ***
CONSTANT	0.054	0.021 ***	0.051	0.021 **	0.060	0.018 ***	0.058	0.018 ***	0.052	0.033	0.051	0.033	0.096	0.023 ***	0.092	0.024 ***
Year Effect	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Firm Time-Variant FE	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Bank-Level Time-Invariant FE	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Match-Level Time-Invariant FE	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Number of Obs.	86,964				69,758				30,935				38,823			
Number of Groups	23,882				17,445				8,884				11,874			
F-Value	7.66		7.63		8.17		8.14		3.42		3.39		4.92		4.85	
R-Squared (Overall)	0.0014		0.0014		0.0026		0.0021		0.0033		0.0053		0.0015		0.0015	

Table 8. Endogeneity Bias

This table shows the estimation results for equation (2) and (3). Heteroskedasticity-robust standard errors are reported. ***, **, and * indicate significance at the 1, 5, and 10% level, respectively. The dependent variable (ΔLOANS(t)) is the log difference between t-1 and t of the total loans outstanding for each firm-bank pair. We use observations from FY2001 to FY2010 for this estimation. In the column labeled "(i.b) With Firm Characteristics," we control for firms' price-to-book ratio, the number of lender banks, the natural logarithm of total assets, the ratio of current profits to total assets, the ratio of liquidity assets to liquidity liabilities, the ratio of total debts to total assets, the ratio of short-term to long-term liabilities, the ratio of bank borrowing to total liabilities, and the ratio of fixed assets to total assets, while in the column labeled "(i.a) Without Firm Characteristics" we do not.

BCAP = REGCAP	Not Controlling for Loan Demand								(ii) Controlling for Loan Demand			
Dependent Variable:	(i a) Without Firm Characteristics				(i b) With Firm Characteristics				(From Table 6)			
ΔLOANS(t)	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD
BSIZE(t-1)	0.250	0.018 ***	0.239	0.018 ***	0.253	0.019 ***	0.241	0.019 ***	0.232	0.026 ***	0.225	0.026 ***
BROA(t-1)	1.871	0.313 ***	1.824	0.313 ***	1.607	0.308 ***	1.566	0.308 ***	2.348	0.379 ***	2.321	0.379 ***
BJGB(t-1)	-0.438	0.130 ***	-0.460	0.130 ***	-0.507	0.129 ***	-0.533	0.128 ***	-1.279	0.146 ***	-1.265	0.146 ***
BLOCALBOND(t-1)	-0.044	0.370	-0.111	0.369	0.103	0.379	0.031	0.378	0.194	0.373	0.164	0.373
BLTD(t-1)	0.028	0.034	0.016	0.034	0.024	0.034	0.011	0.034	0.083	0.052	0.075	0.052
BCAP(t-1)	0.018	0.003 ***	0.018	0.002 ***	0.019	0.003 ***	0.019	0.002 ***	0.017	0.004 ***	0.015	0.002 ***
BLIQ(t-1)	0.156	0.140	0.060	0.112	0.199	0.139	0.102	0.111	0.937	0.166 ***	0.695	0.128 ***
BCAP(t-1)×GDPGROWTH(t)	-0.260	0.058 ***	-0.195	0.054 ***	-0.271	0.059 ***	-0.207	0.055 ***	-0.312	0.058 ***	-0.262	0.056 ***
BCAP(t-1)×MPLOOSENING(t)	-0.002	0.003			-0.002	0.003			-0.003	0.003		
BCAP(t-1)×MPTIGHTENING(t)			-0.006	0.003 **			-0.006	0.003 **			-0.003	0.003
BLIQ(t-1)×GDPGROWTH(t)	-0.199	2.168	-1.354	2.035	-0.038	2.164	-1.413	2.023	-2.211	2.640	-1.849	2.523
BLIQ(t-1)×MPLOOSENING(t)	-0.080	0.099			-0.080	0.098			-0.249	0.130 *		
BLIQ(t-1)×MPTIGHTENING(t)			0.338	0.117 ***			0.378	0.120 ***			0.288	0.146 **
CONSTANT	-4.318	0.305 ***	-4.051	0.303 ***	-2.611	0.356 ***	-2.367	0.355 ***	0.092	0.015 ***	0.088	0.015 ***
Year Effect	Yes		Yes		Yes		Yes		Yes		Yes	
Firm Time-Variant FE	No		No		No		No		Yes		Yes	
Firm Time-Invariant FE	Yes		Yes		Yes		Yes		Yes		Yes	
Bank-Level Time-Invariant FE	Yes		Yes		Yes		Yes		Yes		Yes	
Match-Level Time-Invariant FE	Yes		Yes		Yes		Yes		Yes		Yes	
Number of Obs.	89,557				85,852				65,592			
Number of Groups	22,136				21,256				24,415			
F-Value	36.16		36.32		47.74		48.10		14.19		14.17	
R-Squared (Overall)	0.0008		0.0009		0.0009		0.0010		0.0017		0.0017	

Table 9(a). Firm Level Estimation

This table shows the estimation results for equations (4) and (5). Heteroskedasticity-robust standard errors are reported. ***, **, and * indicate significance at the 1, 5, and 10% level, respectively. The dependent variables (ΔBorrowing(t) and Investment Ratio (t)) are the log difference between t-1 and t of the total loans outstanding for each firm and the capital investment ratio of each firm. We use observations from FY2001 to FY2010 for this estimation. The columns labeled (i) and (ii) are for all firm observations. The columns labeled (iii) and (iv) are for firms whose price-to-book ratio (FPBR) is above the median, while the columns labeled (v) and (vi) are for firms whose FPBR is equal to or smaller than the median.

BCAP = REGCAP	(i) Δ Borrowing (t) Full sample		(ii) ΔBorrowing (t) FPBR>Median		(iii) ΔBorrowing (t) FPBR<=Median		(iv) Investment Ratio (t) Full sample		(v) Investment Ratio (t) FPBR>Median		(vi) Investment Ratio (t) FPBR<=Median	
	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD
BCAP(t-1)	0.002	0.002	0.006	0.004	-0.002	0.003	0.002	0.002	0.005	0.005	-0.002	0.002
BCAP(t-1)×GDPGROWTH(t)	-0.146	0.075 *	-0.244	0.129 *	-0.060	0.093	0.005	0.062	-0.132	0.098	0.053	0.058
BCAP(t-1)×MPTIGHTENING(t)	0.005	0.004	0.009	0.006	0.000	0.005	-0.003	0.004	0.000	0.006	-0.004	0.003
FPBR(t-1)	3.140E-03	8.11E-04 ***	2.08E-03	7.85E-04 ***	3.36E+00	1.75E+00 *	3.92E-03	1.26E-03 ***	2.63E-03	1.10E-03 **	2.09E-01	3.24E+00
FPBR_SQ(t-1)	-4.120E-06	9.42E-07 ***	-3.17E-06	8.97E-07 ***	1.86E-04	2.80E-03	-3.32E-06	1.42E-06 **	-2.09E-06	1.21E-06 *	2.96E-03	4.76E-03
FSIZE(t-1)	-0.187	0.021 ***	-0.285	0.035 ***	-0.139	0.031 ***	-0.316	0.068 ***	-0.495	0.119 ***	-0.200	0.096 **
FROA(t-1)	0.831	0.108 ***	1.349	0.215 ***	0.403	0.129 ***	0.482	0.096 ***	0.918	0.190 ***	0.106	0.112
FTANGIBLE(t-1)	0.174	0.079 **	0.201	0.150	0.204	0.092 **	-1.612	0.164 ***	-2.123	0.316 ***	-1.198	0.159 ***
CONSTANT	1.840	0.231 ***	2.906	0.389 ***	1.234	0.326 ***	4.198	0.734 ***	6.385	1.305 ***	2.700	0.922 ***
Year Effect	Yes		Yes		Yes		Yes		Yes		Yes	
Firm Time-Invariant FE	Yes		Yes		Yes		Yes		Yes		Yes	
Number of Obs.	15,257		7,135		8,122		18,611		9,257		9,354	
Number of Groups	2,401		1,695		1,474		2,730		2,017		1,635	
R-Squared (Overall)	0.0032		0.0042		0.0039		0.0169		0.0225		0.0051	

Table 9(b). Firm Level Estimation

This table shows the estimation results for equations (4) and (5). Heteroskedasticity-robust standard errors are reported. ***, **, and * indicate significance at the 1, 5, and 10% level, respectively. The dependent variables (ΔBorrowing(t) and Investment Ratio (t)) are the log difference between t-1 and t of the total loans outstanding for each firm and the capital investment ratio of each firm. We use observations from FY2001 to FY2010 for this estimation. The columns labeled (i) and (ii) are for firm observations. The columns labeled (iii) and (iv) are for firms whose price-to-book ratio (FPBR) is above the median, while the columns labeled (v) and (vi) are for firms whose FPBR is equal to or smaller than the median.

BCAP = REGCAP	(i) Δ Borrowing (t) Full sample		(ii) ΔBorrowing (t) FPBR>Median		(iii) ΔBorrowing (t) FPBR<=Median		(iv) Investment Ratio (t) Full sample		(v) Investment Ratio (t) FPBR>Median		(vi) Investment Ratio (t) FPBR<=Median	
	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD
BLIQ(t-1)	0.062	0.080	0.237	0.139 *	-0.112	0.097	0.100	0.088	0.281	0.158 *	-0.145	0.087 *
BLIQ(t-1)×GDPGROWTH(t)	-5.959	2.459 **	-8.247	3.996 **	-3.260	2.972	-1.484	1.825	-6.412	3.035 **	2.931	1.638 *
BLIQ(t-1)×MPTIGHTENING(t)	0.172	0.112	0.311	0.176 *	-0.074	0.148	-0.015	0.107	0.102	0.176	-0.174	0.077 **
FPBR(t-1)	3.14E-03	8.12E-04 ***	2.07E-03	7.85E-04 ***	3.36E+00	1.75E+00 *	3.92E-03	1.27E-03 ***	2.64E-03	1.10E-03 **	1.84E-01	3.24E+00
FPBR_SQ(t-1)	-4.12E-06	9.42E-07 ***	-3.15E-06	8.92E-07 ***	1.50E-04	2.80E-03	-3.32E-06	1.42E-06 **	-2.10E-06	1.21E-06 *	2.99E-03	4.75E-03
FSIZE(t-1)	-0.187	0.021 ***	-0.283	0.035 ***	-0.139	0.031 ***	-0.315	0.068 ***	-0.492	0.119 ***	-0.202	0.096 **
FROA(t-1)	0.832	0.107 ***	1.350	0.215 ***	0.404	0.128 ***	0.482	0.096 ***	0.913	0.190 ***	0.106	0.112
FTANGIBLE(t-1)	0.177	0.079 **		***	0.204	0.092 **	-1.611	0.164 ***	-2.121	0.316 ***	-1.199	0.159 ***
CONSTANT	1.898	0.230 ***	0.206	0.150	1.251	0.325 ***	4.159	0.733 ***	6.294	1.290 ***	2.731	0.918 ***
Year Effect	Yes		Yes		Yes		Yes		Yes		Yes	
Firm Time-Invariant FE	Yes		Yes		Yes		Yes		Yes		Yes	
Number of Obs.	15,257		7,135		8,122		18,611		9,257		9,354	
Number of Groups	2,401		1,695		1,474		2,730		2,017		1,635	
R-Squared (Overall)	0.0032		0.0041		0.0041		0.017		0.0226		0.0052	