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# The Emergence of a Parallel World: The Misperception Problem for Bank Balance Sheet Risk and Lending Behavior \*

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**ABSTRACT.** We examine the reason why two opposing views on distressed banks' lending behavior in Japan's postbubble period have coexisted: one is stagnant lending in a capital crunch and the other is forbearance lending to low-quality borrowers. To this end, we address the measurement problem for bank balance sheet risk. We identify the credit supply and allocation effects of bank capital in the bank loan equation specified at the loan level, thereby finding that the "parallel worlds", or the two opposing views, emerge because the regulatory capital does not reflect the actual condition of increased risk on bank balance sheets, while the market value of capital does. By uncovering banks' efforts to increase regulatory capital in Japan's postbubble period, we show that banks with low market capitalization, and which had difficulty in building up adequate equity capital for their risk exposure, decreased the overall supply of credit. Parallel worlds can emerge whenever banks are allowed to overvalue assets at their discretion, as in Japan' postbubble period.

*JEL classification:* G01, G21, G28.

*Keywords:* bank capital structure; capital crunch; forbearance lending; loan-level data; bank asset risk; bank risk taking.

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“Additional lending to low credit rating firms was a counterintuitive criticism, especially for business people involved in bank lending. Such forbearance lending was very rare. Bank loan officers, making every effort to reduce their lending, were bitterly resentful of forbearance lending. It was quite strange that two types of criticism of distressed Japanese banks’ lending behavior—stagnant lending and forbearance lending—coexisted in the post-bubble period.” Miyauchi (2015, p. 278)

**1. Introduction** Of the financial crises in developed economies, the one in Japan after the collapse of the bubble economy in the early 1990s was unprecedented in terms of the length and depth of the subsequent economic downturn.<sup>1</sup> Debates about the reasons for Japan’s prolonged stagnation have been raised accordingly (e.g., Motonishi and Yoshikawa (1999), Hayashi and Prescott (2002), and Hoshi and Kashyap (2004)), and the lending behavior of banks with impaired capital has been one of the most plausible explanations, as the postbubble period witnessed the malfunction of the banking system.

When a substantial adverse shock hits the economy and many borrowers become insolvent, banks should theoretically face impaired capital, irrespective of whether their bank capital is evaluated at regulatory or market values. The theoretical literature predicts two types of lending behaviors by such impaired banks: one is stagnant lending in a capital crunch, and the other is forbearance lending. In the former type of lending, impaired banks that are subject to capital constraints decrease credit to borrowers, irrespective of whether they are good or bad borrowers.<sup>2</sup> In the latter type, however, the impaired banks conduct window-dressing to avoid the realization of capital losses, and thus allocate more credit to insolvent borrowers, while hoping that their situations will improve.<sup>3</sup> These two practices have different theoretical backgrounds, but they have often been accused of being the

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<sup>1</sup> See, e.g., Hoshi (2001) for a discussion of Japan’s bubble economy and its collapse in the early 1990s.

<sup>2</sup> Bernanke and Lown (1991) defined a credit crunch as “a significant leftward shift in the supply curve for loans, holding constant both the safe real interest rate and the quality of potential borrowers”, and related a credit crunch to a capital crunch, providing evidence on the US economic crisis in the early 1990s. The theoretical literature on capital crunches includes Holmström and Tirole (1997), Calomiris and Wilson (2004), and Diamond and Rajan (2011).

<sup>3</sup> The theoretical literature about forbearance lending includes Diamond (2001), Caballero et al. (2008), and Bruche and Llobet (2014).

source of the prolonged stagnation experienced since the 1990s in Japan.<sup>4</sup>

The two opposing explanations of the lending practices of impaired banks share the premise that the impaired banks worried considerably about the further deterioration of their balance sheets, but these opposing views differ sharply in explaining impaired banks' lending behavior: stagnant lending in a capital crunch involves the issue of overall credit undersupply to all borrowers, whereas forbearance lending involves the issue of credit allocation to low-quality borrowers. The empirical literature, however, has surprisingly provided mixed evidence supporting the two opposing views on the lending behavior of distressed Japanese banks in the postbubble period, as in Peek and Rosengren (2005), Gan (2007), and Watanabe (2007). In this paper, we explore the reason why such parallel worlds of distressed banks' lending behavior emerged in empirical investigations, particularly focusing on the misperception problem for bank balance sheet (bank default) risk.

Models of banking under asymmetric information have emphasized the potential conflict of interest between banks and depositors (see, e.g., Diamond (1984) and Calomiris and Wilson (2004)). This information problem faced by banks encourages them to offer short-term (demandable) low-risk debt, concentrating most balance sheet risk in their capital and thus insulating depositors from this risk. Therefore, it is important to determine whether banks are well capitalized enough to absorb their balance sheet risk and stabilize the banking system. In the postbubble period in Japan, the misperception problem for bank balance sheet risk occurred simultaneously with the introduction of regulatory capital standards, although they were introduced to prevent an overall undersupply of credit in a capital crunch or prevent excessive risk taking by impaired banks in forbearance lending. Figure 1 shows the bank market capital ratio and regulatory capital surplus in the postbubble period in Japan. We observe that the regulatory capital ratio continued to increase during the 1990s, while the market value of bank capital continued to decrease. This indicates that Japanese banks window-dressed their regulatory capital ratio, although they faced substantive increases in their default risk as measured by their market value. Indeed, the correlation between the two capital measures is  $-0.83$ , and hence they imply seemingly contradicting information on bank capital deficits. The postbubble period in

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<sup>4</sup> Stagnant bank lending is well known in Japanese as *kashishiburi*, and forbearance lending as *oigashi*.

Japan saw a considerable divergence of regulatory capital from its market value; thus, this period provides a good natural experiment that allows us to investigate whether and how such a divergence between the bank regulatory and market capital measures affects our understanding of prevailing patterns of the lending behavior of troubled banks. In particular, we address the problem of the coexistence of two opposing views of the lending behavior of distressed Japanese banks in terms of the misperception problem for bank balance sheet risk, thereby demonstrating that the use of regulatory capital as a measure of bank balance sheet risk would lead to erroneous assessments of bank lending behavior.

Our study of the misperception of bank balance sheet risk and lending behavior extends recent empirical studies. Haldane (2014) and Bulow and Klemperer (2015) pointed out that regulatory measures of bank capital do not have predictive power for bank failures. Indeed, Bears Sterns, Wachovia, Washington Mutual, Fannie Mae, and Freddie Mac were all viewed by regulators as being well capitalized immediately before their failures. Haldane and Madouros (2012) and Sarin and Summers (2016) attempted to measure bank risk using both regulatory measures (e.g., the Basel III Tier I ratio) and market measures (e.g., credit default swaps and price-earnings ratios), and found that the market capital ratio (the market value of equity relative to total assets) has the most explanatory power in predicting bank failure. In addition, the market capital ratio of US major banks has declined not only in the precrisis period, but also after the crisis (Sarin and Summers (2016)).<sup>5</sup> These studies focused on the misperception problem for bank balance sheet risk. However, our study examines this issue by addressing the possibility that such a misperception problem would cause erroneous assessments of bank lending behavior and lead to the coexistence of the two opposing views about it, as in the late 1990s in Japan. Because the late 1990s in Japan was a pre-banking-crisis period as well as a postbubble period, our analysis of this period should provide rich insights into the arrival of the banking crisis.

In this paper, to investigate the coexistence problem, we use a loan-level matched dataset of Japanese banks and their listed borrowers in the postbubble period of the late

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<sup>5</sup> Adrian and Shin (2014) theoretically explained the reason for the distinction between a bank's book leverage and its market capitalization and enterprise value in terms of its value-at-risk management. In terms of banks' window-dressing of their trading books, Begley et al. (2017) empirically showed that US banks are prone to underreport the risk in their trading books when their equity capital decreases.

1990s, as in Peek and Rosengren (2005) and Gan (2007). This is partially because loan-level data enable us to overcome the identification problem in terms of the controllability of demand factors in specifying the bank loan equation, and partially because testing the forbearance lending by lowly capitalized banks to their low-quality borrowers requires the inclusion of a firm performance variable in the bank loan equation. Loan-level data are superior to bank- and firm-level panel data in terms of data structure for overcoming the omitted-variable problem because of the difficulty of controlling borrower-side factors in the bank loan equation (see Khwaja and Mian (2008) and Jiménez et al. (2012; 2014)).

Our analytical focus is on the effect of changes in bank capital (regulatory capital or market capital)  $BCAP_{it}$  on the “allocation” of bank credits  $\Delta LOAN_{it}^j$  among good and bad borrowers as well as on the “supply” of credits to those borrowers. The novelty of our analysis is that we strictly define the credit supply and the allocation effect as the first and the second derivative effects in the bank loan equation specified at the loan level. More concretely, the credit supply effect of bank capital involves the first derivative  $\partial \Delta LOAN_{it}^j / \partial BCAP_{it}$  in the bank loan equation, which is the focus of previous studies that found the existence of a capital crunch, irrespective of whether they used loan-level (Gan (2007)) or bank-level data (Watanabe (2007)). The credit allocation effect, however, involves the coefficient of an interaction term between the bank capital ratio and a firm performance variable  $FIRM_t^j$ , or the second derivative  $\partial^2 \Delta LOAN_{it}^j / \partial FIRM_t^j \partial BCAP_{it}$ , which Peek and Rosengren (2005) used to show that forbearance lending prevailed in Japan’s postbubble period using loan-level matched data.

A positive first derivative implies that a capital crunch, or stagnant lending by lowly capitalized banks, prevailed in the postbubble/precrisis period of the late 1990s. Conversely, if the first derivative is negative for low-quality borrowers and the second derivative is positive (where the firm performance variable is defined so that its value become larger as the firm’s performance improves), credit misallocation from lowly capitalized banks to low-quality borrowers occurred. We focus on the signs of the two derivatives, and especially whether and how the divergence of regulatory capital from its market value produces the two opposing views on distressed banks’ lending behavior.

We find that the use of regulatory capital as a proxy of bank balance sheet risk pro-

vides evidence supporting forbearance lending in which lowly capitalized banks did not increase or decrease credits, but the credits were allocated more to low-quality borrowers in the postbubble period, as demonstrated by Peek and Rosengren (2005); that is, regulatory capital produces insignificant and significantly positive estimates for the first and second derivatives, respectively. This result is observed only in the bank group with a larger regulatory capital buffer, and accordingly, it is quite consistent with the hypothesis of Peek and Rosengren (2005) that Japanese banks engaged in the window-dressing and patching-up of regulatory capital or the bank capital ratio. Conversely, the use of the market value of bank capital provides evidence for the existence of a capital crunch, in which lowly market-capitalized banks decreased credit to all borrowers even if they were good borrowers, as demonstrated by Gan (2007) and Watanabe (2007); that is, market capital produces significantly positive and insignificant estimates for the first and second derivatives, respectively. In contrast to the result for the regulatory capital measure, this result for the market measure does not qualitatively differ among bank groups (with lower, medium, and higher market capital ratios), but does quantitatively differ in that equity capital constraints in lending are more pronounced for banks in the lower market capital group. The above findings are robust even if we control for the survivorship bias for bank–firm relationships, employ the same type of nonlinear specification as Peek and Rosengren (2005), and use banks’ lending exposure to real estate in the bubble period instead of the market capital measure, as in Gan (2007) and Watanabe (2007).

The above findings reveal the true lending behavior of Japanese banks in the postbubble (pre-banking-crisis) period of the late 1990s. By simultaneously controlling for the two bank capital measures and their interaction effects in the bank loan model, we find that the supply and allocation effects (the first and second derivative effects) of the regulatory capital ratio completely vanish, and that only the supply effect of the market capital ratio survives; that is, in reality, stagnant lending following a capital crunch occurred, and not forbearance lending. This result is robust as it is independent of the selection of firm performance variables.

Why does only the market capital ratio have an effect, but not the regulatory capital ratio? To address this question, we estimate a cross-sectional regression for bank capital

structure, which is based on the standard corporate finance theory emphasizing “normal market forces”: creditors require banks to build their capital to secure an adequate charter value, or demand more equity protection from banks with more portfolio risk (see, e.g., Flannery and Rangan (2008) and Gropp and Heider (2010) for empirical studies on bank capital structure; see, e.g., Hackbarth et al. (2006), Valencia (2016), and Corbae et al. (2017) for theoretical studies). Through this capital structure regression, we find that the market capital ratio is determined by standard corporate finance variables, whereas the regulatory capital ratio is not. This result is robust, and is independent of the levels of the two capital measures, although the market capital ratio of banks with lower market capital levels—banks facing a more severe capital crunch—is less sensitive to two determinants: profitability and asset volatility. Such insensitivity implies that lowly market-capitalized banks have difficulty increasing their market capital ratio in accordance with their profitability and uncertainty through issuing equity. Our findings from the capital structure regression suggest that in explaining bank lending behavior in relation to the capital structure, how the capital structure is determined is important. Without investigating it, we cannot identify the background mechanism through which the capital structure affects banks’ lending behavior.

Given this insight, the key drivers of a capital crunch because of insufficient market capitalization are the standard corporate finance determinants of bank capital structure. Given that banks with lower market capital ratios have greater difficulty in acquiring a level of equity capital appropriate to their profitability and asset risk, we expect that the inclusion of either or both of these two determinants of bank capital structure in the model would eliminate the significance of the market capital ratio in the bank loan equation. To examine this conjecture, we also include each of the determinants of the bank capital structure in the bank loan equation. We find that only banks’ portfolio risk eliminates the significance of the market capital ratio. This implies that a key cause of a capital crunch is lowly market-capitalized banks’ difficulty in acquiring appropriate levels of equity capital given their asset risk. This finding provides a rich insight into the fundamental causes of a capital crunch: when they try to increase risk exposure and take more risk in lending, if banks cannot increase their market value of capital enough to absorb the risk, they will



face equity capital constraints in lending. In addition, this tendency of a capital crunch is more noticeable for banks with lower market values of capital.

Our paper is organized as follows. Section 2 reviews the previous literature on distressed banks' lending behavior and financial status in Japan, and then discusses the measurement problem for bank balance sheet risk. Section 3 presents our empirical model and explains our dataset. Section 4 reports the results of our empirical analysis and then shows that the parallel worlds, or the two views of troubled banks' lending behavior, will emerge depending on whether regulatory capital or market capital is used as the proxy for bank balance sheet risk. Section 5 examines the lending behavior of Japanese distressed banks by simultaneously controlling for the two capital measures and the interaction between them. In this section, we also explore the reason why parallel worlds emerge by investigating the determinants of the two capital measures. Section 6 explores a key driver of the capital crunch among the determinants of the bank capital structure, thereby providing an insight into the lending framework of troubled banks. Section 7 offers conclusions.

**2. Bank Balance Sheet Risk and Lending Behavior** In this section, we review the literature on distressed banks' lending behavior and financial status in Japan, and then discuss the measurement problem for bank balance sheet risk in assessing those lending behaviors.

**2.1. Literature on Lending by Troubled Japanese Banks** Here, we briefly review previous research on the lending behavior of troubled Japanese banks, particularly focusing on what measures they used as a proxy of bank balance sheet risk or bank default risk. As discussed below, we focus on Peek and Rosengren (2005), Gan (2007), and Watanabe (2007), partially because they allow us to highlight the measurement problem for bank balance sheet risk in analyzing distressed banks' lending behavior, and partially because, like ours, the former two studies both used loan-level matched data, although they gave two opposing views on distressed banks' lending behavior in the postbubble (precrisis) period in Japan.

One strand of empirical research on Japan's lending by distressed banks focuses on a

capital crunch, or a debt overhang, in the postbubble period in the 1990s.<sup>6</sup> These recent studies include Gan (2007) and Watanabe (2007). These two studies used each bank's lending exposure to the real estate industry in the real estate bubble of the late 1980s as a proxy of bank balance sheet risk in the postbubble period. Watanabe (2007) used bank-level panel data from 1995 to 2000 and utilized lending exposure to the real estate industry as the instrumental variable for the regulatory capital ratio, thus providing evidence that a capital crunch existed in the late 1990s.<sup>7</sup> Like us, Gan (2007) used loan-level matched data from 1994 to 1998, and thus demonstrated that banks with greater real estate exposure in the late 1980s had larger reductions in lending to borrowers during the capital crunch of the late 1990s.

In contrast to the above studies supporting the existence of a capital crunch, Peek and Rosengren (2005) showed that banks' window-dressing to avoid the realization of losses on their balance sheets provided additional credit to low-quality firms in the postbubble period. Like our study, theirs used loan-level matched data from 1994 to 1999, and they included the regulatory capital ratio as a proxy of bank balance sheet risk in their bank loan equations. In terms of the implementation of prudential policy, Giannettie and Simonov (2013) examined the effects of Japan's three public capital injections in 1998, 1999, and 2003 on capital-injected banks' lending behavior using loan-level data from 1998 to 2004. They demonstrated that if capital-injected banks were still undercapitalized, those banks were more likely to lend to low-quality borrowers, using the regulatory capital ratio as a proxy of bank balance sheet risk.<sup>8</sup>

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<sup>6</sup> See Bernanke and Lown (1991), Peek and Rosengren (1995; 2000), Berrospide and Edge (2010), and Carlson et al. (2013) for empirical research on capital crunches in the United States.

<sup>7</sup> Using a bank-level panel dataset, Ito and Sasaki (2002) estimated a bank loan equation in Japan from 1990 to 1993, as did Woo (2003) from 1991 to 1997, Ogawa (2003, Chapter 2) from 1992 to 1999, Montgomery (2005) from 1982 to 1999, and Hosono (2006) from 1975 to 1999. They all found that a decrease in the regulatory capital ratio caused a decrease in bank loans in the 1990s by including the regulatory capital ratio in their bank loan equations. However, unlike Watanabe (2007) and Gan (2007), they did not use an instrumental variable for the regulatory capital ratio, such as lending exposure to the real estate industry in the late 1980s; hence, their empirical results appear to be less robust and dependent on the sample periods used.

<sup>8</sup> Unlike these two studies, Sekine et al. (2003) used firm-level panel data from 1986 to 1999, while Watanabe (2010) used bank-level panel data from 1995 to 2000 and then included the bank book capital ratio as a proxy of balance sheet risk in his bank loan equation. The former found that highly indebted firms belonging to nonmanufacturing industries increased bank borrowings after 1993, although this lowered

As reviewed above, previous research has focused on Japan’s bank lending behavior mainly in the late 1990s, and has provided mixed evidence on the stagnant forbearance lending of distressed banks. In this paper, we hypothesize that the coexistence of two opposing views can be ascribed to the difference in the choice of proxy for bank balance sheet risk used to assess the lending behavior of troubled banks. The research suggesting the existence of a capital crunch uses banks’ lending exposure to the real estate industry during the real estate bubble of the late 1980s as a proxy of bank balance sheet risk in the postbubble period, as in Gan (2007) and Watanabe (2007), while those suggesting the existence of forbearance lending used the regulatory capital ratio, as in Peek and Rosengren (2005). One possible reason for such a measurement problem for bank balance sheet risk in Japan is rooted in banks’ behavior under the regulatory policy implemented after the introduction of the regulatory capital standards. In the next subsection, we review this problem in the context of Japan’s regulatory policy for banks.

**2.2. Misperception Problem for Bank Balance Sheet Risk** In the postbubble/pre-crisis period in Japan of the late 1990s, the measurement problem of bank balance sheet risk emerged following the introduction of regulatory capital standards, although these standards were originally aimed at preventing stagnant lending in a capital crunch or excessive risk taking by impaired banks in forbearance lending (see also Nakashima and Takahashi (2018a) for details).

In 1988, bank regulators in major industrial countries agreed to standardize capital requirements internationally, through the so-called Basel Accord. Subsequent to this, all Japanese banks struggled to meet these capital standards in the 1990s. During this period in Japan, land and stock prices fell continuously. Consequently, many loans granted during the bubble period in the late 1980s became nonperforming. Accordingly, banks that were more impaired and had less capital issued additional subordinated debt to inflate their

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their profitability, and the latter demonstrated that a tough regulatory stance that encouraged banks to write off nonperforming loans produced a large loss of bank capital that induced bank lending to shift to low-quality borrowers. Caballero et al. (2008) addressed the more specific issue of the misallocation of bank credit toward low-quality borrowers, which is known as “zombie lending” (see also Hoshi (2006)). They used firm-level panel data from 1981 to 2002, thereby demonstrating that the increase in the number of zombie firms would suppress the investment and employment growth of nonzombies.

bank capital. They were able to do so because, under the local Japanese rules governing capital requirements, subordinated debt can be counted as Tier II capital (see, e.g., Ito and Sasaki (2002) and Montgomery (2005)). Japanese banks also used deferred tax assets to compensate for capital losses arising from unrealized losses on their holding stocks. This is because the government allowed banks to include their deferred tax assets in Tier I capital in 1998. At their discretion, bank managers estimated subjectively the total amount of deferred tax assets (see Skinner (2008)).

In the 1990s, these regulatory forbearance policies caused Japanese banks to engage in “patching up” their regulatory (that is, book) capital ratios (see, e.g., Shrieves and Dahl (2003)). In the late 1990s, the attitude of the Japanese government and regulatory authorities toward Japanese banks started to change, and they allowed them to enter bankruptcy or receive a capital injection. In 1998 and 1999, the government of Japan decided to infuse a large amount of capital into poorly capitalized banks in order to increase their capital adequacy ratios. These large-scale public capital injections allowed almost all Japanese banks to meet their capital standards (see, e.g., Watanabe (2007), Nakashima (2016), and Guizani and Watanabe (2016) on the Japanese bank recapitalization programs). However, the amount of nonperforming loans in Japanese banks only started to decrease after the Financial Revitalization Program, or the so-called Takenaka Plan, was executed in 2002 (see Sakuragawa and Watanabe (2009) for details).

Figure 1 shows the bank market capital ratio (defined as the ratio of the market value of bank equity to the market value of total assets) and the regulatory capital surplus (defined as the difference between a bank’s reported capital adequacy ratio and its regulatory target ratio, i.e., 8% for international banks and 4% for domestic banks) in the postbubble period in Japan. As shown in this figure, the regulatory capital ratio continued to increase during the 1990s because of Japan’s regulatory forbearance policies, while the market capital ratio continued to decrease because equity market participants believed that Japanese banks window-dressed their regulatory capital by overvaluing their capital and undervaluing their nonperforming loans (see Hoshi and Kashyap (2004; 2010)). In fact, the correlation coefficient of the two variables is  $-0.83$  at the aggregate level. This tendency for the market value of capital and the regulatory capital to diverge from each other, reflecting different

information on banks' risk profiles, is also clearly observed in Figure 2, where the two variables appear to be negatively correlated in the postbubble period.

To illustrate some individual cases, Figure 3 shows the market capital ratio and the regulatory capital surplus of Fukutoku Bank and the Long-Term Credit Bank (LTCB), which went bankrupt in May 1998 and October 1998, respectively. The market capital ratio of Fukutoku Bank continued to decrease during the postbubble period, while its regulatory capital surplus rose sharply before bankruptcy. The regulatory capital surplus of LTCB increased from the mid 1990s, partially because of the public capital injection in March 1998, while its market capital ratio continued to decrease until it went bankrupt. This negative correlation between the two capital measures is also observed in other banks that went bankrupt in the 1990s, including Hyogo Bank and the Nippon Credit Bank.

Such distinct differences in the information content of banks' risk profiles are also observed in the relation between banks' lending exposure to the real estate industry during the real estate bubble of 1989 and regulatory capital. The left panel of Figure 4 shows that regulatory capital has little or no correlation with bank lending exposure to the real estate industry, with a correlation coefficient of 0.06. As shown in the right panel of Figure 4 however, the market value of capital and bank lending exposure to the real estate industry are negatively correlated with a correlation coefficient of  $-0.46$ , indicating that the bank market capital ratio in the postbubble period reflects information on bank lending exposure to the real estate industry in the bubble period. Given that the decline in real estate prices in the 1990s caused a deterioration of bank balance sheets, the negative correlation indicates that the market value of bank capital is likely to capture the soundness of bank balance sheets more precisely (see Gan (2007)) and Watanabe (2007)). In Subsection 5.3, we will identify the determinants of the two capital measures in terms of standard corporate finance theory emphasizing market forces, thereby examining why and how the two measures contain different information on bank balance sheets and produce the two opposing views of troubled banks' lending behavior.

Given that large Japanese banks received capital injections around 2000, when the banking crisis occurred, the above discussion provides an insight into the measurement problem for bank balance sheet risk; that is, the market value of bank capital (or bank lending ex-

posure to the real estate industry) can capture bank default risk in the postbubble period in the 1990s, while regulatory capital cannot capture it because troubled Japanese banks were allowed to overvalue their portfolios at their partial discretion under the framework of the Basel Accords. As discussed in the Introduction, this insight is consistent with the findings of recent empirical studies on the misperception problem for bank balance sheet (or bank default) risk before and after the 2008 financial crisis (Haldane and Madouros (2012) and Sarin and Summers (2016)), which demonstrated that the market capital ratio had outstanding explanatory power in predicting bank failures before the crisis, but the regulatory capital ratio did not.

With due consideration of such a misperception problem for bank balance sheet risk, we have the legitimate expectation that any conclusion about the lending behavior of distressed banks depends heavily on which of the two measures is used as a proxy of bank balance sheet risk. In the following, we will untangle this misperception problem for bank balance sheet risk and lending behavior by analyzing the bank loan equation.

**3. Empirical Specification and Data** In this section, we start by introducing an empirical specification for bank lending to examine the measurement problem for bank balance sheet risk and bank lending behavior, and then discuss the estimation methods and our dataset.

**3.1. Specification for Bank Loan Equations and Estimation Method** As discussed in the Introduction, we use a loan-level matched dataset of Japanese banks and their listed borrowers to identify the effect of bank capital on lending in Japan’s postbubble period, as in Peek and Rosengren (2005) and Gan (2007). The loan-level matched data allow us not only to control for borrower-side factors through time\*firm fixed effects, but also to analyze the credit allocation effect through the (second derivative) effect of the interaction between bank capital and firm performance variables. To exploit these advantages of the loan-level matched data, we specify the bank loan equation as follows:

$$\Delta\text{LOAN}_{it}^j = a_0 + a_1\text{BCAP}_{it-1} + a_2\text{BCAP}_{it-1} * \text{FIRM}_{t-1}^j + v_i + u_{jt} + \varepsilon_{it}^j, \quad (1)$$

where the dependent variable,  $\Delta\text{LOAN}_{it}^j$ , indicates the growth rate of the total amount of loans outstanding between bank  $i$  and domestic listed firm  $j$  at time  $t$ .  $v_i$  denotes bank  $i$ 's time-invariant fixed effects to control for its time-invariant unobservables, while  $u_{jt}$  denotes firm  $j$ 's time-varying fixed effects, or year  $\times$   $u_j$  with time dummies (year), to control for the borrowing firm's total demand factors at each sample period  $t$ .  $\varepsilon_{it}^j$  is the stochastic disturbance term.

As for an observable explanatory variable,  $\text{BCAP}_{it}$  denotes a financial variable for bank  $i$  that is supposed to capture the adequacy of bank capital and the increase in bank default risk: either bank  $i$ 's market capital ratio ( $\text{MARCAP}_{it}$ ) or its regulatory capital surplus ( $\text{REGCAP}_{it}$ ).<sup>9</sup>  $\text{FIRM}_t^j$  is firm  $j$ 's performance variable. In this paper, instead of using conventional measures of profitability such as the return on assets and the working capital ratio, we use two equity-based measures of franchise values for a firm's business performance in the future: Tobin's  $q$  ( $\text{FQ}_t^j$ ) and the distance to default ( $\text{FDD}_t^j$ ). The reason is that these equity-based measures better capture a firm's current and future profitability than the conventional profitability measures based on its past profit.<sup>10</sup> Considering that banks tend to place more importance on a borrower's future performance when they evaluate default risk, the equity-based measures are more appropriate for examining their lending behavior. Tobin's  $q$  is defined as the ratio of the market value of firm  $i$  ( $V_A$ ) to its book value, where the market value of the borrowing firm is defined as the sum of the market value of its equity ( $V_E$ ) and the book value of its total liabilities ( $D$ ).<sup>11</sup> The distance to default is defined as

$$\text{FDD} = \left\{ \ln(V_A/D) + \left( r - \frac{1}{2}\sigma_A^2 \right) \right\} / \sigma_A,$$

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<sup>9</sup> As discussed in Subsection 2.2, the bank market capital ratio is defined as the market value of a bank's equity divided by the market value of its total assets, where the market value of a bank's total assets is defined as the sum of the market value of its equity and the book value of its total liabilities. We calculate the market value of equity by multiplying the end-of-year stock price by the number of shares. The regulatory capital surplus is defined as the difference between a bank's reported regulatory capital ratio and its regulatory target ratio (8% for international banks and 4% for domestic banks).

<sup>10</sup> We do not use the distance to default as an equity-based measure of bank default risk. This is because the usual assumption of log-normally distributed asset values in structural models of default risk is not appropriate for banks because of the special nature of their assets. See Nagel and Purnanandam (2018) for details.

<sup>11</sup> We calculate the market value of firm equity by multiplying the end-of-year stock price by the number of shares. Firm book value is the book value of total assets.

where  $r$  is the risk-free rate, and  $\sigma_A$  is the volatility of firm assets. The distance to default can be interpreted as the expected standardized difference between the market value of the firm and the book value of its liabilities. If the difference is small (large), a firm is in danger of bankruptcy (healthy). A decrease (increase) in distance-to-default implies greater (lesser) credit risk. We define the volatility of firm assets  $\sigma_A$  as  $\sigma_A = \sigma_E \times V_E/V_A$ . To estimate the volatility of equity ( $\sigma_E$ ), we calculate the standard deviation of the market value of equity for the final month of a firm's fiscal year and express the estimated volatility as an annual rate.<sup>12</sup> We use the yield on one-year Japanese government bonds as a proxy of the risk-free rate ( $r$ ). In this paper, we focus mainly on the estimation results obtained using Tobin's  $q$  because it can easily classify borrowing firms as good or bad at the reference value of 100: if Tobin's  $q$  is not less than 100, the borrowing firm is categorized as a good borrower; otherwise, it is classified as a bad one. The equation additionally includes lending exposure and borrowing exposure as relationship variables. The lending exposure is defined as loans from bank  $i$  to firm  $j$  divided by the total loans of bank  $i$ . The borrowing exposure is defined in the same manner, as loans from bank  $i$  to firm  $j$  divided by the total borrowings of firm  $j$ .

Note that to control for borrower-side factors in our bank loan equation with  $u_{jt}$ , we employ the fixed-effects approach proposed by Khwaja and Mian (2008) and Jiménez et al. (2012; 2014). The fixed-effects approach assumes that all potential borrower-side factors are embodied in time-varying firm unobservables, which are captured by time\*firm fixed effects ( $u_{jt}$ ).<sup>13</sup> This approach enables us not only to specify our lending equation in a more parsimonious way, as expressed in equation (1), but also to identify the effect of bank capital

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<sup>12</sup> More specifically, we calculate the annualized estimated volatility of the market value of equity as follows:

$$\sigma_{E,jt}^E = \sqrt{\frac{1}{D(t)-1} \sum_{d(t)=1}^{D(t)} (ret_{j,d(t)} - \overline{ret}_{j,t})^2} \times \sqrt{D(t)},$$

where  $d(t)$  ( $d(t) = 1, \dots, D(t)$ ) indexes trading days in firm  $j$ 's fiscal year  $t$ .  $ret_{j,d(t)}$  denotes the daily rate of change in equity valuation, and  $\overline{ret}_{j,d(t)}$  is the average rate of change in equity valuation during fiscal year  $t$ .

<sup>13</sup> Hosono and Miyakawa (2014) and Nakashima (2016) employed this fixed-effects approach with Japanese loan-level matched data. The former identified the effects of monetary policy on bank loan supply through the bank balance sheet channel, while the latter examined the effects of Japan's public capital injections on bank lending.



on lending more rigorously by controlling for demand factors in a more comprehensive way. In the following analyses, we use equation (1) as the benchmark model, where borrower-side factors are fully controlled with time\*firm fixed effects.

By controlling for lender-side factors as well as borrower-side ones with the fixed-effects approach through time\*bank fixed effects, one can focus on the interaction effects and examine the issue of credit allocation in a more robust way. More specifically, we introduce the following specification for bank loans:

$$\Delta\text{LOAN}_{it}^j = a_0 + a_2\text{BCAP}_{it-1} * \text{FIRM}_{t-1}^j + v_{it} + u_{jt} + \varepsilon_{it}^j, \quad (2)$$

where we control for all potential lender-side factors by utilizing time-varying unobservables  $v_{it}$ . We also examine the interaction effects, or the second derivative effects, on credit allocation using this double fixed-effects approach (see Jiménez et al. (2014) and Nakashima et al. (2018) for the double fixed-effects approach).<sup>14</sup>

Like our study, Peek and Rosengren (2005) and Gan (2007) used loan-level matched data, but their way of specifying the bank loan equation is different from ours. Peek and Rosengren (2005) transformed the growth data of bank loans into binary outcome data, and then employed a random-effects probit model. We use a linear rather than a nonlinear model of bank lending for two reasons. First, nonlinear models tend to produce biased estimates in panel datasets with many fixed effects, leading to an incidental parameters problem and inconsistent estimates. Second, nonlinear fixed-effects models generate biased estimates of interaction effects (see Ai and Norton (2003) for details). Nonetheless, we also employ their nonlinear specification, thereby attempting to conduct a robustness check for the estimation results based on our linear specification. However, like our approach, Gan (2007) specified a lending equation in a linear regression model but, unlike ours, did not control for banks' unobservables, and controlled for firms' unobservables through time-invariant fixed effects.

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<sup>14</sup> Jiménez et al. (2014) and Nakashima et al. (2018) employed the double fixed-effects approach to identify the risk-taking channel of monetary policy in bank lending, which involves the issue of whether and how monetary policy induces banks to change their credit allocation from firms with lower credit risk to ones with higher credit risk.

Note that Peek and Rosengren (2005) used regulatory capital surplus as a proxy for bank balance sheet risk and focused on the interaction terms between this bank financial variable and firm performance variables. However, instead of using the bank capital ratio, Gan (2007) used banks' lending exposures to the real estate industry in 1989 in order to identify loan supply effects of banks' impaired capital. In contrast to these two studies, Watanabe (2007) used a bank-level panel dataset and then used lending exposure to real estate as the instrumental variable of the regulatory capital ratio, thus providing evidence that a capital crunch existed in the late 1990s. In Section 4, we also apply these specifications to our data as a robustness test.

The advantage of our loan-level analysis based on equations (1) and (2) is that we identify the credit supply and the allocation effects as the first and second derivative effects, respectively. In these specifications, the first derivative,  $\partial\Delta\text{LOAN}_{it}^j/\partial\text{BCAP}_{it-1} = a_1 + a_2\text{FIRM}_{t-1}^j$ , captures the effect of bank capital changes on credit supply, and the second derivative,  $\partial^2\Delta\text{LOAN}_{it}^j/\partial\text{FIRM}_t^j\partial\text{CAP}_{it} = a_2$ , measures the bank capital effect on credit allocation among better- and worse-performing firms. If the first derivative has a positive value for all values of the firm performance variable  $\text{FIRM}_{t-1}^j$ , then a capital crunch prevails in a period of bank distress. However, if the first derivative has a negative value for low-quality firms (e.g., with a lower Tobin's  $q$ ) and the second derivative has a positive value, forbearance lending by lowly capitalized banks to low-quality firms prevails. We examine whether and how the two bank capital measures produce the two opposing views on distressed banks' lending behavior by focusing on the first and the second derivatives, or the credit supply and allocation effects of bank capital.

**3.2. Correcting for Survivorship Bias** Our matched lender–borrower sample is based on a continuation of the lending relationship. According to the literature on relationship banking, the continuation of a bank–firm relationship depends on both the bank's and the firm's characteristics (Ongena and Smith (2001) and Nakashima and Takahashi (2018b)). In other words, we must address the survivorship bias that may arise from nonrandom assortative matching between banks and firms.

To correct for survivorship bias, we employ Heckman's (1979) two-stage regression technique. The first stage is a probit regression of relationship survival; the second stage is a

regression of loan growth based on the estimation method discussed above. To the extent that credit supply/allocation is a two-step process in which a bank first decides whether to lend and then decides how much to lend, the selection model provides an insight into both decisions.

Our probit regression includes one-period lags of four banks' characteristics such as the market leverage ratio, six firms' characteristics such as the interest coverage ratio, and three relationship factors such as the duration of the relationship between lender  $i$  and borrowing firm  $j$ . We estimate the probit regression for the continuation of bank–firm relationships and then estimate the second-stage regression of the bank lending equation with the inverse Mills ratio. To take into account the possibility that the coefficients of the variables in the probit model are time-varying, as pointed out by Nakashima and Takahashi (2018b), we conduct a rolling estimation of the probit model year by year. The details of the estimation results are shown in Appendix A.

**3.3. Dataset** The empirical analysis developed in this paper uses a loan-level dataset comprising matched samples of Japanese banks and their borrowing firms listed in Japan. We construct our loan-level data using the Corporate Borrowings from Financial Institutions Database compiled by Nikkei Digital Media Inc. This database annually reports short-term (a maturity of one year or less) and long-term (a maturity of more than one year) loans from each financial institution for every listed company on any Japanese stock exchange.

The database includes some 120,000 observations, comprising more than 130 Japanese banks, 2,000 listed borrowing firms, and 17,000 relationships for our sample period from fiscal year (FY) 1992 to 1998, or the postbubble period in Japan. The reason why we set up our sample period beginning from FY 1992 is that a set of minimum capital requirements for banks, known as Basel I, was fully implemented by March 1993, or the end of FY 1992, in Japan. The reason why we end our sample period at FY 1998, or March 1999, is that important previous studies, such as Peek and Rosengren (2005) and Gan (2007), demonstrating the two opposing views—stagnant lending in a capital crunch and forbearance lending—focused on the postbubble period because the early 1990s witnessed the dysfunction of the Japanese banking system because of the severe deterioration of bank capital. Our dataset covers approximately 70% of all loans in the Japanese banking sector

for our sample period. We combined the Nikkei database with the financial statement data of Japanese banks and their listed borrowing firms, also compiled by Nikkei Digital Media Inc.<sup>15</sup>

Our chief difficulty in working with the loan-level data was sorting through various bank mergers and restructures in our data. We recorded the date of all bankruptcies and mergers that took place in the Japanese banking sector in our sample period. First, we should note that whenever a bank ceased to exist in our data because of a bankruptcy, firms ceased reporting that financial institution as a source of loans. If firms ceased reporting a bank as a lender and we could not find any information on a bankruptcy or a merger of the lending bank, we set the outstanding amount of loans from the bank equal to zero. However, if we found evidence of a bankruptcy or merger of a bank and a firm had outstanding loans from the restructured bank before that event, and from a surviving bank after that event, we calculated the growth rate of the loan from the restructured bank as if the restructured bank had made both of the loans.<sup>16</sup> In order to calculate the loan growth rate of a restructured bank, we traced to it all banks that predated it. Thus, if banks A and B merged in year  $t$  to form bank C, bank C's loans in year  $t - 1$  were set equal to the sum of the loans for banks A and B, and the growth rate of bank C's loans in year  $t$  would be calculated accordingly.

Table 1 reports summary statistics for key variables, including the two bank capital variables and the firm performance variables of Tobin's  $q$  and the distance to default.

**4. Emergence of Parallel Worlds** In this section, we report the estimation results for the two types of bank loan equations: that which uses the regulatory capital ratio and that which uses the market capital ratio. We show that the use of the two different capital measures produces the two opposing views, or parallel worlds, on lending by troubled banks: stagnant lending by banks with equity capital constraints and forbearance lending by banks

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<sup>15</sup> The end of the fiscal year for Japanese banks is March 31, but this is not necessarily the case for borrowing firms. When combining the Nikkei database for loan-level data with the financial statement data of banks and their borrowing firms, we match bank-side information to borrower-side information in the same fiscal year.

<sup>16</sup> As for exits of some firms from our loan-level dataset in the middle of our full-sample period, we cannot identify reasons for firm exit from our sample, including bankruptcy, management buyout, termination of all the firm's relationships, etc. Therefore, if a firm exited from the original data after year  $t$ , we dropped the observation for the firm from our dataset in year  $t$ . Thus, if the firm's last observation in the original dataset was in  $t$ , our adjusted sample includes the firm's observations until year  $t - 1$ .

engaging in patching-up of their regulatory capital.

**4.1. Credit Supply and Allocation Effects** We start by reporting the estimation results for the supply effect of bank capital on lending, or the first derivative effect, defined as  $\partial \Delta \text{LOAN}_{it}^j / \partial \text{BCAP}_{it-1} = a_1 + a_2 \text{FIRM}_{t-1}^j$ . Table 2 shows the estimation results for the coefficient parameters  $a_1$  and  $a_2$ , and Figure 5 shows the average supply effects for good and bad borrowers where borrowing firms are classified into two groups as follows: if Tobin’s  $q$  is not less than 100, the borrowing firm is labeled as a “good borrower”; otherwise, it is categorized as a “bad borrower”. As for the distance to default, a firm whose distance to default is higher than the sample mean is categorized as a good borrower; otherwise, it is classified as a bad one.

As shown in this figure, the use of the regulatory capital ratio yields a negative estimate for the average supply effect of a bad borrower with Tobin’s  $q$  equal to 50, although it is statistically insignificant. We also find that the regulatory capital ratio produces significantly positive estimates for good borrowers with Tobin’s  $q$  values of 125 or more. These results indicate that the decrease in regulatory capital increases credit to low-quality borrowers, while decreasing credit to good borrowers during Japan’s postbubble period. When using the distance to default, we have insignificant estimates for firms facing higher default risk (whose distance to default is less than two), but significantly positive estimates for firms facing relatively lower credit risk (whose distance to default is greater than four).

The use of the market capital ratio however, produces significantly positive values for both good and bad borrowers. Furthermore, the result does not depend on whether Tobin’s  $q$  or distance to default is used as the firm performance variable. This implies that a decrease in market capitalization would reduce credit to all borrowers irrespective of borrowers’ risk levels.

Table 2 also presents the estimation results for the credit allocation effect of bank capital, or the second derivative effect:  $\partial^2 \Delta \text{LOAN}_{it}^j / \partial \text{FIRM}_{t-1}^j \partial \text{BCAP}_{it-1} = a_2$ . This table shows the credit allocation effects for the double fixed-effects model (2) as well as the baseline model (1).

We find that the regulatory capital ratio yields significantly positive estimates, and this result is robust because both the baseline and the double fixed-effects models produce

positive estimates. This indicates that banks with less regulatory capital allocate more credit to borrowers with a lower Tobin's  $q$  or distance to default.

In contrast, the market capital ratio produces conflicting results; that is, the double fixed-effects model yields an insignificant estimate, while the baseline model yields a significantly negative one. This tendency does not change whether we use Tobin's  $q$  or the distance to default as the firm performance variable. Given that the double fixed-effects model can control for both lender- and borrower-side factors more thoroughly, we should attach more importance to the insignificant estimate based on this model. Hence, we infer that the use of the market capital ratio provides evidence supporting the existence of a capital crunch, in which banks with reduced equity capital would reduce credit to all borrowers equally, irrespective of borrowers' risk levels.

In addition, note that the inverse Mills ratio yields significantly negative estimates, implying that survivorship bias exists in such a way that we would obtain biased estimates for the parameter coefficients without including this ratio. We find that this result is quite robust to the use of alternative samples (see also Table 4).<sup>17</sup>

The above results are based on a linear specification, as expressed in equations (1) and (2). Table 3, panel (A) reports the estimation results obtained by employing the nonlinear specification of Peek and Rosengren (2005): the probit model with borrowing-firm random effects.<sup>18</sup> We observe that even if we employ the nonlinear specification, our findings are robust: the use of regulatory capital provides evidence supporting forbearance lending, while the use of the market value of bank capital provides evidence for the existence of a capital crunch.

**4.2. Lending Exposure to Real Estate in the Bubble Period** As discussed in Subsection 2.1, Gan (2007) and Watanabe (2007) assume that bank lending exposure to the real estate industry in Japan's bubble period contains important information on Japanese banks' balance sheet risk in the postbubble period. Table 3, panel (B) reports the estimation results obtained using bank lending exposure to real estate in 1989 instead of the two

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<sup>17</sup> Thus, we do not report the estimation results for the inverse Mills ratio except for Tables 2 and 4, because of lack of space.

<sup>18</sup> Note that Peek and Rosengren (2005) did not include lender-side unobservable covariates in their nonlinear model. This may be because they treated only borrower-side mergers in their data construction.

bank capital measures.<sup>19</sup>

Note that the estimation results based on the lending exposure to the real estate industry are qualitatively the same as those obtained using the market capital ratio; that is, the model produces significant and insignificant estimates for the credit supply (first derivative) and allocation (second derivative) effects, respectively. This implies not only that banks with greater exposures to the real estate industry in the bubble period were more likely to decrease credit to all borrowers, but also that the market capital ratio contains similar information on Japanese banks' lending behavior in the postbubble period to the banks' exposure to the real estate industry in the bubble period in the late 1980s. Given that the high exposure of banks to the real estate industry is considered a cause of the deterioration of their balance sheets in the postbubble period that contributed to Japan's banking crisis in the late 1990s, the market capital ratio appears to be a more appropriate indicator for capturing the relation between the condition of banks' capital and their lending behavior.

**4.3. Bank Lending with Low, Medium, and High Capital Ratios** The capital crunch and forbearance lending views involve the issue of how much (or how little) bank capital is increased. To incorporate this issue into our analysis, we cluster our loan-level sample into three subsamples for banks with high, medium, and low capital ratios for each of the two capital ratio measures (i.e., market and regulatory). To construct the three subsamples, we define banks belonging to the first tertile (below the 34th percentile), the second tertile (34th–67th percentiles), and the third tertile (above the 67th percentile) of all banks as low, medium, and high capital banks, respectively. Table 4 shows the estimation results for the bank loan equations for banks with low, medium, and high capital based on the market and regulatory capital ratios.

In the upper panel (A), we find that the estimated coefficients for the market capital ratio are significantly positive for all three levels of the market capital ratio, but the estimated values (approximately two) for banks with a low level of market capital are much larger than those for banks with high and medium levels of market capital, each having almost the same value (approximately one). These results do not depend on the choice of

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<sup>19</sup> In the specification including lending exposure to real estate in the late 1980s, we do not include bank fixed effects because the bank exposure variable is not time-varying.

the firm performance variable (Tobin's  $q$  or distance to default).

The estimation results for the regulatory capital ratio in the lower panel (B) are substantially different from those for the market capital ratio: the interaction effect, or the credit allocation effect, has significantly positive estimates for banks with a high regulatory capital ratio. Furthermore, note that the results based on the subsample regression for banks with a high regulatory capital ratio more clearly demonstrate the forbearance lending by those banks, compared with the results based on the full-sample regression. In addition, the market capital ratio of those high capital banks is much lower than those of the two other bank groups in terms of the sample mean. These findings indicate that banks that were more engaged in window-dressing and patching-up their regulatory capital provided more credit to low-quality borrowers while those banks were facing low market values of equity capital.

**4.4. Banks with Impaired Regulatory Capital** The above positive estimates for the double interaction effect, or the credit allocation effect, based on the use of the regulatory capital ratio, may only reflect that banks with increasing regulatory capital provided more credit to high-quality borrowers; that is, the positive estimates could not identify forbearance lending to low-quality borrowers by impaired banks. To further address this identification issue, we also include a triple interaction term,  $BDEC_{it-1} * REGCAP_{it-1} * FIRM_{t-1}^j$ , in the bank loan equations (1) and (2).  $BDEC_{it-1}$  is a dummy variable revealing the banks that decreased their regulatory capital from year  $t-2$  to  $t-1$ . Approximately 35% of banks in our sample were such capital-decreasing banks. If the triple interaction term has a positive coefficient—or even if it is not positive, as long as the inclusion of it does not eliminate the significantly positive effect of the double interaction term,  $REGCAP_{it-1} * FIRM_{t-1}^j$ —then this implies that banks with decreased regulatory capital provided more credit to low-quality borrowers under forbearance lending.

Table 5 reports the estimation results with the inclusion of the triple interaction term. As shown in the upper panel (A) for the full-sample regression, the triple interaction term has a positive coefficient, and the inclusion of it does not change the significantly positive effect of the double interaction term. In the subsample regression, reported in panel (B), the inclusion of the triple interaction term does not eliminate the significantly positive



effect of the double interaction term for banks with high regulatory capital. These results indicate that the positive estimates for the double interaction effect capture forbearance lending to low-quality borrowers by impaired banks.

**4.5. Parallel Worlds of Japan’s Postbubble Period** Summing up our estimation results for the postbubble period in the late 1990s, the use of the market capital ratio and bank lending exposure to the real estate industry in 1989 provides evidence supporting the existence of a capital crunch, in which banks with impaired capital decreased credit to firms irrespective of whether they were good or bad borrowers, as found by Gan (2007) and Watanabe (2007). The degree of capital constraints in bank lending was higher for banks with lower market capital; however, evidence of a capital crunch is widely observed, regardless of the value of the market capital ratio. However, the use of the regulatory capital ratio provides evidence supporting the existence of forbearance lending, in which impaired banks increased credit to low-quality borrowers, allocating more credit to those firms, as demonstrated by Peek and Rosengren (2005). In contrast to the case of market capital constraints, regulatory capital constraints in forbearance lending were observed only for banks with higher regulatory capital, which faced lower market capital ratios. Furthermore, the above findings for the market and the regulatory capital measures are observed in a robust manner when we control for the survivorship bias of bank–firm relationships, and do not depend on whether we adopt linear or nonlinear specifications. In the next section, we will explore the real world of lending by Japanese distressed banks while simultaneously controlling for the two capital measures and their interaction in the bank loan equation.

**5. Uncovering the Real World** In this section, we reveal the real world of distressed banks’ lending behavior by controlling for the interaction of the two capital measures, or the source of the misperception of bank balance sheet risk, in the bank loan equation. Thus, we answer which of the two opposing views, stagnant lending by equity-constrained banks or forbearance lending by banks with regulatory capital constraints, is a more appropriate interpretation of troubled banks’ lending behavior in Japan’s postbubble period. Moreover, we explore the determinants of the regulatory capital ratio and market capital ratio using a cross-sectional regression for bank capital structure based on standard corporate finance

theory emphasizing market forces as its determinants. By doing so, we examine the reason why the parallel worlds of the two opposing views emerged.

**5.1. Controlling for the Two Bank Capital Ratio Measures Simultaneously** In this subsection, we simultaneously control for the market and regulatory capital ratios and their interaction, thereby examining which of the two capital measures can explain bank lending behavior. As shown in Figure 1, and as pointed out by the recent empirical studies on bank balance sheet risk (Haldane and Madouros (2012), Haldane (2014), Bulow and Klemperer (2015), Sarin and Summers (2016), and Begley et al. (2017)), highly negative correlations between regulatory capital and the market value of equity capital are one piece of evidence of the misperception problem in measuring bank balance sheet risk based on the regulatory capital ratio. Taking into account that such negative correlations affect the estimation results for the bank loan equations and produce the two opposing views on troubled banks' lending behavior, we control for the source of misperception: the interaction of the two capital measures. More concretely, we introduce the two interaction terms  $REGCAP_{it} * MARCAP_{it}$  and  $REGCAP_{it} * MARCAP_{it} * FIRM_t^j$ . The double interaction term ( $REGCAP_{it} * MARCAP_{it}$ ) and the triple interaction term ( $REGCAP_{it} * MARCAP_{it} * FIRM_t^j$ ) are included to control for the interaction between the regulatory capital ratio and the market capital ratio, and for the allocation effect through the interaction of the two capital measures, respectively. By including the two interaction terms in the bank loan equation in order to investigate the source of misperception, we control for the interaction effect of the two capital measures and thus address distressed banks' lending behavior in a more comprehensive way.

Table 6 shows the estimation results obtained by simultaneously controlling for the two capital measures and the two interaction terms in bank loan equations (1) and (2). As shown in columns (1), (2), (5), and (6) of panels (A) and (B), the simultaneous inclusion of the two capital measures yields significant coefficients for the two capital measures (REGCAP and MARCAP), and for their two interaction terms with the firm variables (REGCAP \* FIRM and MARCAP \* FIRM). However, the inclusion of the interaction terms between the two capital measures (REGCAP \* MARCAP and REGCAP \* MARCAP \* FIRM) eliminates the significance of the regulatory capital ratio as well as that of the two interaction terms

between the regulatory capital ratio and the firm variables, as shown in columns (3), (4), (7), and (8). These results indicate that stagnant lending in a capital crunch, but not forbearance lending to low-quality borrowers, prevailed overall in the Japanese banking system during the postbubble period.

Tables 7 and 8 report the results based on the subsample regressions for banks with high, medium, and low levels of market and regulatory capital. As with the full-sample regression in Table 6, the subsample regressions for banks with low, medium, and high market capital ratios in panel (A) also yielded significant coefficients for the two capital measures and their two interaction terms with the firm variables. However, again, controlling for the interaction between the two capital measures eliminates the significance of the regulatory capital ratio and the two interaction terms between it and the firm variables.

However, unlike the full-sample regression, the subsample regression for banks with high regulatory capital yields positive coefficients for the double interaction terms between the regulatory capital ratio and the firm performance variable ( $\text{REGCAP} * \text{FQ}$  and  $\text{REGCAP} * \text{FDD}$ ), as shown in columns (21) to (24) of Tables 7 and 8. Furthermore, note that the market capital ratio ( $\text{MARCAP}$ ) for the banks with high regulatory capital has a significantly positive coefficient, but that for the banks with low and medium regulatory capital does not, implying that only high regulatory capital ratios have systematically negative correlations with the market capital ratio (see the sample mean of the regulatory capital ratio and the market capital ratio in panel (B) of Table 4). These results suggest that only banks with low market capital and high regulatory capital allocated more credit to low-quality borrowers, while decreasing credit overall in a capital crunch.

**5.2. Banks with a Low Market Capital Ratio and High Regulatory Capital Ratio** To further investigate the possibility that the forbearance lending view could still be accurate for banks with a low market capital ratio and high regulatory capital ratio, we estimate bank loan equations (1) and (2) using the sample of banks in the third tertile (above the 67th percentile) based on the market capital ratio and the first tertile (below the 34th percentile) for the regulatory capital ratio.

Table 9 reports the estimation results obtained by simultaneously controlling for the market and regulatory capital ratios. We observe that only the market capital ratio

(MARCAP) is significant in all specifications, but not the interaction terms of the regulatory capital ratio and the firm performance variable (REGCAP \* FQ and REGCAP \* FDD), as shown in panels (A) and (B) of Table 9.

Given that the market capital ratio remains significant, bank lending behavior in Japan's postbubble period, or pre-banking-crisis period, of the late 1990s should be characterized as stagnant lending by banks subject to equity capital constraints in a capital crunch, instead of as forbearance lending.

**5.3. Determinants of the Market and Regulatory Capital Ratios** In the previous subsection, we demonstrated that bank lending behavior in Japan's postbubble period can be characterized as a capital crunch in which banks with equity capital constraints decreased credit to borrowers irrespective of borrowers' risk levels. Here, we examine the reason why the two bank capital measures moved in opposite directions and the two opposing views emerged. To this end, we analyze the determinants of the market and regulatory capital ratios, following the empirical analyses of Flannery and Rangan (2008) and Gropp and Heider (2010). These studies attempted to identify the determinants of bank capital structures using cross-sectional regressions. Their econometric specification based on corporate finance theory are as follows:

$$\text{BCAP}_{it} = \alpha_0 + \alpha_1 \text{BQ}_{it-1} + \alpha_2 \sigma_{it-1} + \alpha_3 \text{PROF}_{it-1} + \alpha_4 \ln \text{SIZE}_{it-1} + \alpha_5 \text{COL}_{it-1} + \epsilon_{it}, \quad (3)$$

where BCAP is the regulatory capital ratio or market capital ratio. The explanatory variables are the bank's Tobin's  $q$ , or the bank charter value (BQ), the logarithmic value of the bank's asset volatility, or the bank's total risk exposure ( $\sigma$ ), profitability (PROF), the logarithmic value of total assets (SIZE), and the value of collateral assets (COL). We include the bank's Tobin's  $q$  and asset volatility, defined in the same manner as the firm's Tobin's  $q$  and asset volatility (see Subsection 3.1). We define the profitability as the return on assets in percentage terms, and the collateral assets as  $100 \times (\text{Liquid Assets} + \text{Tangible Assets}) / \text{Total Assets}$ .<sup>20</sup> All variables are lagged by one year. The regression also

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<sup>20</sup> More concretely, we define Liquid Assets as Total Securities + Treasury Bills + Other Bills + Bonds + CDs + Cash and Tangible Assets such as Land and Buildings + Other Tangible Assets (see also Gropp and

includes time and bank fixed effects (year and  $u_i$ ) to control for unobserved heterogeneity across time and among banks that may be correlated with the explanatory variables. Table 10 reports the summary statistics for those variables.

In Subsection 4.3, we found that the use of the market capital ratio as a measure of bank balance sheet risk leads to evidence that banks with a lower market capital ratio were more severely capital constrained in their lending than those with a medium or higher capital ratio, although all Japanese banks faced a capital crunch. However, we found that use of the regulatory capital ratio leads to evidence that only banks with higher regulatory capital engaged in forbearance lending. To incorporate these findings into our analysis of bank capital structure, we also estimate equation (3) by additionally including interaction terms between the five explanatory variables and the lower-market-capital dummy in the regression for the market capital ratio, and interaction terms between the five explanatory variables and the higher-regulatory-capital dummy in the regression for the regulatory capital ratio. Thus, we provide a detailed analysis of why there are two opposing views regarding troubled banks' lending behavior.

The explanatory variables in equation (3) are conventional ones for explaining capital structure on the basis of standard corporate finance theory emphasizing market forces.<sup>21</sup> According to this so-called market view, banks' Tobin's  $q$  is expected to have a positive coefficient because banks would protect a valuable charter by lowering their leverage and thus by lowering their default risk. Moreover, bank profit would also have a positive coefficient, as higher profits and sticky dividends allow banks to accumulate capital. Banks' total risk exposure, defined as asset volatility, should also have a positive coefficient based on the inference that counterparties demanded more equity protection from banks with greater portfolio risk and business uncertainty. However, there is no clear prediction on how collateral and size affect capital building in terms of standard corporate finance theory. In contrast to the corporate finance view (or the market view), one alternative view places emphasis on the impact of capital regulation. It predicts that the standard corporate finance determinants have little or no explanatory power because market forces are not the

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Heider (2010)).

<sup>21</sup> Corporate finance theory regarding capital structure documents the role of dividends. However, we do not include an indicator for dividend payers because all the banks in our sample pay dividends.

main driving force for banks to build up their capital. The other alternative is the “buffer” view, according to which banks tend to hold capital buffers above minimum regulatory requirement levels to avoid the costs that arise from issuing equity at short notice (see Gropp and Heider (2010) for the buffer view). This buffer view predicts that banks with higher profits and higher Tobin’s  $q$  are likely to be more leveraged because such banks face fewer asymmetric information problems, and their costs associated with issuing equity are relatively low.

Table 11 shows the results for the regressions for the market and regulatory capital ratios. In this table, we observe that the two capital ratios have quite different results, which well characterize the capital building behavior by Japanese banks in the late 1990s. More concretely, standard corporate finance variables significantly determine the market capital ratio, while none of them determines the regulatory capital ratio. This means that during the postbubble period, or the pre-banking-crisis period, in the late 1990s, banks’ equity capital reflected normal market forces, but their regulatory capital did not. In other words, in that period, neither the market view nor the buffer view is applicable to the regulatory capital ratio.

A significantly positive estimate for the Tobin’s  $q$  (BQ) indicates that the market capital ratio is associated with banks’ charter value, or future cash flows, while the regulatory capital ratio is not. Given that the sample mean of the regulatory capital ratio continued to increase, but that of the market capital ratio continued to decrease during the late 1990s, we infer that Japanese banks were not able to maintain their market capital to protect a valuable charter given the deteriorating Japanese economic conditions, while they were able to somehow increase regulatory capital, irrespective of the decreasing charter value.<sup>22</sup> In other words, as the charter value decreases, banks tend to become more leveraged (see Calomiris and Nissim (2014) on United States banks).<sup>23</sup>

The positive coefficient for banks’ total risk exposure ( $\sigma$ ) suggests that Japanese banks were substantially subject to market forces: counterparties demanded more equity protection from banks with greater portfolio risk (see, e.g., Hackbarth et al. (2006), Flannery

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<sup>22</sup> In the late 1990s, low bank profits also contributed to the decrease in the market capital ratio.

<sup>23</sup> Calomiris and Nissim (2014) examined declines in United States banks’ Tobin’s  $q$  after the financial crisis and showed that the declines reflected the erosion of future profits.

and Rangan (2008), Valencia (2016), and Corbae et al. (2017)). However, banks facing greater business uncertainty were not able to build up equity capital during the postbubble period. Indeed, as shown in Figure 5, the market capital ratio continued to decrease during Japan’s pre-banking-crisis period in the late 1990s, while banks’ asset volatility remained stable. By contrast, the insignificant estimate for the regulatory capital ratio implies that Japanese banks built up regulatory book capital without being exposed to market forces. The estimation results for Tobin’s  $q$  and risk exposure highlight the difference between the responses of the market and regulatory capital ratios to market forces.

However, even in the regression for the market capital ratio, Tobin’s  $q$  and banks’ total risk exposure have different estimates depending on whether a bank enters into the lower-market-capital group or not. More concretely, the interaction term of Tobin’s  $q$  and the lower-market-capital dummy does not have significant estimates, whereas that of banks’ risk exposure has significantly negative estimates, implying that the market capital ratio of the lower-market-capital banks reflects their portfolio risk less well. This is primarily because such banks were not able to issue equity and increase market capital, even if they faced greater portfolio risk or tried to take on more risk.

The estimation results for the other explanatory variables in the market capital equation are also quite consistent with corporate finance theory and previous research on bank capital structure (Flannery and Rangan (2008) and Gropp and Heider (2010)), but those in the regulatory capital equation are not. Also note that the insensitivity of regulatory capital to the conventional explanatory variables is observed in all Japanese banks—with lower, medium, and higher levels of regulatory capital.

We find that profitability (PROF) has a significantly positive estimate for the market capital ratio, as does Tobin’s  $q$ , indicating that banks tend to accumulate profits to increase their market capitalization (see Berger (1995)) with a view to maintaining a high charter value. However, for banks with lower market capital ratios, profitability has less effect on market capital than for those with higher market capital ratios. This pattern is observed in the estimates for the bank assets risk measure but not for Tobin’s  $q$ . One of the possible reasons for the difference in these variables’ impacts on market capital is that banks with lower market capital are more likely to face lower equity values and consequently have

difficulty in issuing equity, given the high volatility in their assets. Thus, their market capital is less sensitive to their total risk exposure and profits. Another explanation for the heterogeneity in the impacts of profits is that the “buffer” view starts to become effective as banks’ market capital ratios decrease: i.e., banks with less capital make efforts to find a way to increase their regulatory capital as a buffer against their profits decreasing, which weakens the positive association with bank market capital.

Bank size (SIZE) and collateral assets (COLL) have significantly positive coefficients for the regression with the market capital ratio, and the results do not depend on banks’ capital level because the interaction effects are not significant. The positive coefficient for bank size implies that larger banks hold more equity capital, but regulatory capital is accumulated irrespective of bank size. The positive coefficient for collateral assets (COLL) in the market capital equation implies that an increase in banks’ collateral assets induces them to increase their market capitalization. This is probably because such an increase in banks’ collateral assets is favored by market participants, and thus larger amounts of collateral may contribute to banks’ market capital.

Summing up our estimation results, the mechanisms determining the market and regulatory capital ratios are quite different. The normal market forces measured by the explanatory variables based on standard corporate finance theory— charter value, portfolio risk, profitability, bank size, and collateral assets—matter in differentiating the mechanisms that determine the two bank capital measures. The market capital ratio is strongly subject to normal market forces, but the regulatory capital ratio is not. Furthermore, for banks with low market capital, their profits and asset risk have less significant effects on market capital, although Tobin’s  $q$  has almost the same magnitude of effect across banks with different market capital levels. This result suggests that in the late 1990s in Japan, although lowly market-capitalized banks struggled to increase market capital while facing a low charter value, low profits, and high asset volatility, their market capital continued to decline as their value in capital markets deteriorated. However, Japanese banks increased their regulatory capital independently of market forces. This is probably because, as discussed in Subsection 2.2, the regulatory forbearance policy in Japan’s postbubble period allowed Japanese banks to window-dress and patch-up their regulatory (that is, book) capital by



overvaluing assets.

**5.4. The Real World of Japan's Postbubble Period** By simultaneously controlling for the market and regulatory capital ratios and the interaction of these two capital measures in the bank loan equations, we demonstrated that the significance of the regulatory capital ratio vanishes, but the significance of the market capital ratio survives. Moreover, these results are robust even if we group Japanese banks into those with lower, medium, and higher levels of market or regulatory capital and then run the subsample regressions. The results indicate that in reality, distressed Japanese banks' lending behavior should be described as stagnant lending in a capital crunch, not as forbearance lending. In particular, banks with a lower market capital ratio were more severely subject to equity capital constraints in the capital crunch.

We also identified the determinants of the market and regulatory capital ratios of Japanese banks, and thereby why the two seemingly parallel worlds of distressed banks' lending emerged, depending on which of the two bank capital measures is used in the bank loan equations. Surprisingly, none of the standard corporate finance variables explain Japanese banks' regulatory capital, while they do explain banks' market capital. This implies that Japanese banks engaged in patching-up of their regulatory capital at their discretion under the regulatory forbearance policy, completely independently of normal market forces. However, while banks were window-dressing their regulatory (or book) capital, their market capital ratio was substantively affected by normal market forces. That is, as banks can increase their regulatory capital at their discretion, or there is an opportunity for arbitrage in increasing regulatory capital, the main determinant of bank lending is market capital, which is evaluated by equity market participants and depositors, and thus is exposed to normal market forces.

As discussed above, Japanese banks faced a capital crunch. In particular, banks in the lower-market-capital group were more severely subject to equity capital constraints in lending. We demonstrated that the market capital ratio of such banks was less sensitive to their portfolio risk and profitability. This finding implies that the stagnant bank lending in a capital crunch would worsen in the situation where counterparties require more equity protection from lower-market-capital banks, but those banks are not able to build up

adequate capital relative to their portfolio risk and profitability. In the next section, we will examine the relation between the capital crunch and determinants of capital in more detail.

**6. The Key Driver in the Real World** In this section, we estimate the bank loan model by additionally controlling for the determinants of the market capital ratio—not only the two corporate finance variables, but also the other three variables—in order to identify the key driver of the observed capital crunch.

**6.1. Controlling for Determinants of Market Capital Ratios** Here, we report the estimation results for the bank loan equation including not only the market capital ratio, but also the five explanatory variables previously included in the regression for the market capital ratio (see Subsection 5.3). The purpose of this test is to identify the key driver of the observed capital crunch by examining which of the five determinants of the market capital ratio eliminates the significance of the market capital ratio.<sup>24</sup> If one of the determinants supersedes the market capital ratio, it is a key driver of the observed capital crunch. Table 12 reports the estimation results obtained by additionally including the five determinants of the market capital ratio.

We observe that only banks' portfolio risk, or banks' total risk exposure, eliminates the significance of the market capital ratio, and it has a significantly positive coefficient. Note that both portfolio risk and profitability have less explanatory power for the market capital ratio of lowly market-capitalized banks (see Subsection 5.3). However, profitability appears not to supersede the market capital ratio in the bank loan equation. This indicates that the difficulty of increasing capital corresponds to asset risk, rather than low profitability, and is the main cause of the capital crunch (see Hackbarth et al. (2006)).<sup>25</sup>

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<sup>24</sup> We do not include the interaction term of the market capital ratio and the firm performance variable—the borrower's Tobin's  $q$  or distance to default—because this interaction effect was not significant in a statistically robust manner, as demonstrated in Section 4.

<sup>25</sup> Hackbarth et al. (2006) theoretically demonstrated that firm asset volatility is the main driver of firm-value-based optimal leverage, which is endogenously determined so that an increase in asset volatility leads to a substantial decrease in optimal leverage. This theoretical view suggests that Japanese banks were not able to maintain adequate market capital relative to their asset risk in the capital crunch during Japan's postbubble period.

**7. Conclusion** We provide three substantive conclusions. First, the misperception of bank balance sheet risk leads to a misunderstanding of distressed banks' lending behavior by generating "parallel worlds." This problem of misunderstanding is exacerbated when a proxy for bank balance sheet risk contains no information about bank balance sheet risk, as in the Japanese economy in the late 1990s. The use of regulatory capital, which reflects neither bank balance sheet risk nor normal market forces, provides evidence of forbearance lending in which lowly capitalized banks allocated more credit to low-quality borrowers, as demonstrated by Peek and Rosengren (2005). However, the use of the market value of bank capital, which correctly reflects bank balance sheet risk and normal market forces, provides evidence of the existence of a capital crunch in which lowly capitalized banks decreased credit to all borrowers even if they were good borrowers, as demonstrated by Gan (2007) and Watanabe (2007). These results are robust even if we employ the same type of nonlinear specification as Peek and Rosengren (2005) and if we use each bank's lending exposure to real estate in the bubble period instead of the market capital measure, as in Gan (2007) and Watanabe (2007).

Second, we find that the "real world" of distressed banks' lending behavior should be elucidated in terms of whether a proxy of bank balance sheet risk correctly reflects normal market forces emphasized in the literature on capital structure: creditors demand more equity from banks with greater uncertainty to secure an acceptable charter value. By simultaneously controlling for the regulatory and market capital ratios, and the interaction between them, in the bank loan equation, we demonstrated that only the coefficient of the market capital ratio, which is determined by normal market forces, remained significant in a robust manner. This indicates that distressed Japanese banks' lending behavior should be characterized as stagnant lending in a capital crunch, not forbearance lending.

Lastly, banks facing lower market capital levels and more severe equity capital constraints in lending are less sensitive to normal market forces, because such lowly capitalized banks have more difficulty in maintaining adequate equity capital relative to their total risk exposure and business uncertainty. In other words, a capital crunch is attributable to the uncertainty faced by lowly capitalized banks and their difficulty in increasing their equity capital.

Our findings suggest that the “parallel worlds,” or two opposing views on the lending behavior of troubled banks, emerged because regulatory capital does not reflect the actual condition of increased risk on bank balance sheets, while market capital does. In Japan’s postbubble period, banks with lower market capital levels decreased their supply of credit, and engaged in the patching-up of their regulatory capital (i.e. book capital) under regulatory forbearance policy. Such a capital crunch and regulatory arbitrage can occur simultaneously whenever a bank is allowed to overvalue its portfolio and capital at its partial discretion, although it shows up in Japan’s postbubble (pre-banking-crisis) period as one of the most typical cases (see also, e.g., Haldane and Madouros (2012), Sarin and Summers (2016), and Begley et al. (2017) on the United States case).

In stagnant lending because of a capital crunch, distressed banks with impaired capital decreased credit whether their borrowing firms were low-quality or not. In contrast, in forbearance lending, such distressed banks do not decrease credit, but reallocate credit from good borrowers to bad borrowers. In other words, forbearance lending involves a certain amount of risk-taking by the distressed banks, by betting on the future revival of low-quality borrowers (see Fukuda and Nakamura (2008)), but in stagnant lending in a capital crunch, distressed banks are involved in the process of credit contraction not only for bad borrowers, but also for good borrowers. From this viewpoint, a capital crunch is a more urgent situation for policy makers, and one in which restoring banks’ impaired capital would bring about substantial improvement to the economy. If one uses regulatory capital to specify the bank loan equation despite its weak link with bank balance sheet risk, it would lead policy makers to implement the wrong policy based on a misunderstanding of distressed banks’ lending behavior. In other words, our results suggest that it is important to design policy requiring banks to increase their capital based on a substantive measure, not a spurious one.

**Appendix A: Estimation Results for Relation Survival Probability** In Subsection 3.2, we included the inverse Mills ratio in the bank loan model to control for survival bias. In this appendix, we show the estimation results of the probit model, which is used to calculate the inverse Mills ratio.

As the literature on relationship banking pointed out, the continuation of a bank–

firm relationship depends on both the bank’s and the firm’s characteristics. Our probit regression includes one-period lags of banks’ market leverage ratio ( $\text{MARCAP}_{it-1}$ ), return on assets ( $\text{BROA}_{it-1}$ ), size ( $\text{BSIZE}_{it-1}$ ), and the number of firm that have lending–borrowing relationships with bank  $i$  ( $\text{NUMBB}_{it-1}$ ). Firm characteristics include one-period lags of firms’ book leverage ratio ( $\text{FBLEV}_{jt-1}$ ), return on assets ( $\text{FROA}_{jt-1}$ ), interest coverage ratio ( $\text{FICR}_{jt-1}$ ), size ( $\text{FSIZE}_{jt-1}$ ), and the number of banks that have relationships with firm  $j$  ( $\text{NUMBF}_{jt-1}$ ). To control for the firm-level attributes, we also include dummy variables for the industries to which firms belong. In addition to the bank–firm characteristics, our probit regression includes one-period lags of bank  $i$ ’s lending exposure to firm  $j$  ( $\text{EXPL}_{it-1}^j$ ), firm  $j$ ’s borrowing exposure to bank  $i$  ( $\text{EXPB}_{it-1}^j$ ), and the duration of the relationship between lender  $i$  and borrowing firm  $j$  ( $\text{DURAT}_{it-1}^j$ ) as relationship factors.<sup>26</sup> We conduct rolling estimation of the probit model year-by-year to incorporate time-varying effects of each variable. This year-by-year estimation means that we do not need to include time dummies

Table A.1 shows the estimation results and indicates that a higher borrowing and lending exposure and a longer duration of relationships are associated with a higher probability of the continuation of relationships. Furthermore, firms with higher profitability tend to continue their relationships with lending banks. A lower firm’s interest coverage ratio implies a higher probability of the continuation of the relationship, which suggests that firms with a high dependence on debt funding tend to continue their relationships with banks. We should also note that higher bank leverage was associated with a lower probability of the continuation of relationships in the late 1990s. This suggests that in the late 1990s, a capital crunch occurred in terms of relationship termination, as pointed out by Nakashima and Takahashi (2018b). Overall, dependence on debt finance and higher firm profitability, and higher borrowing and lending exposure are associated with higher probability of relationship continuation.

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<sup>26</sup> Borrowing exposure is calculated as bank  $i$ ’s loans to firm  $j$  as a percentage of the total loans to firm  $j$ , while lending exposure is calculated as firm  $j$ ’s loans from bank  $i$  as a percentage of the total loans from bank  $i$ .

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**Table 1: Summary Statistics for Bank Loan Equations**

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
<b>Dependent Variables</b>					
Growth Rate of Loans ( $\Delta\text{LOAN}_{it}^j$ )	120557	-2.141	27.588	-99.67	100
Loan Dummy	120557	.247	.431	0	1
<b>Bank Capital Variables (BCAP<math>_{it-1}</math>)</b>					
Market Capital Ratio	119380	6.434	3.315	.602	15.723
Regulatory Capital Ratio	120557	1.503	1.111	-5.01	9.48
Lending Exposure to Real Estate	120530	9.285	3.79	2.865	30.667
<b>Firm Performance Variables (FIRM<math>_{t-1}^j</math>)</b>					
Tobin's $q$ (FQ $_{t-1}^j$ )	118643	126.399	37.563	41.436	892.367
Distance to Default (FDD $_{t-1}^j$ )	118643	4.189	2.623	.625	134.772
<b>Relationship Variables</b>					
Lending Exposure	120557	.034	.093	.000	1.987
Borrowing Exposure	120192	9.611	12.271	.000	100
<b>Dummy Variable</b>					
Banks with Decreasing Regulatory Capital (BDEC $_{it-1}$ )	120557	.345	.475	0	1

*Notes:* The sample period for estimation is from March 1994 to March 1999. Lagged variables, and all explanatory variables, are from March 1993 to March 1998. We exclude the top five percentiles of the growth rate of loans outstanding as extreme values. The loan dummy equals one if  $\Delta\text{LOAN}$  is positive, and zero otherwise.

**Table 2: Estimation Results for Bank Loan Equations**

	Regulatory Capital				Market Capital			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
BCAP ( $a_1$ )	-0.513* (0.273)		0.104 (0.145)		0.411*** (0.111)		0.260*** (0.0790)	
BCAP · FQ ( $a_2$ )	0.00687*** (0.00216)	0.00461** (0.00223)			-0.00158** (0.000634)	0.000284 (0.000643)		
BCAP · FDD ( $a_2$ )			0.0505* (0.0293)	-0.00373 (0.0313)			-0.0149 (0.00909)	-0.0113 (0.00928)
Lending Exposure	5.549*** (0.890)	5.642*** (0.894)	5.544*** (0.890)	5.640*** (0.894)	6.144*** (0.901)	6.266*** (0.910)	6.121*** (0.901)	6.283*** (0.910)
Borrowing Exposure	0.0358*** (0.00808)	0.0330*** (0.00808)	0.0358*** (0.00808)	0.0329*** (0.00808)	0.0355*** (0.00809)	0.0324*** (0.00809)	0.0353*** (0.00809)	0.0324*** (0.00809)
Inverse Mills Ratio	-82.18*** (2.239)	-98.00*** (2.431)	-82.21*** (2.239)	-97.96*** (2.431)	-81.15*** (2.241)	-98.47*** (2.459)	-81.09*** (2.241)	-98.51*** (2.460)
Firm-Year Fix. Eff.	yes	yes	yes	yes	yes	yes	yes	yes
Bank Fix. Eff.	yes		yes		yes		yes	
Bank-Year Fix. Eff.		yes		yes		yes		yes
Obs.	118285	118285	118285	118285	117139	117139	117139	117139

*Notes:* Robust standard errors are in parentheses. \*, \*\*, and \*\*\* denote significance at levels of 0.10, 0.05, and 0.01, respectively. The dependent variable is  $\Delta\text{LOAN}$ , which indicates the growth rate of the total amount of loans outstanding. BCAP denotes the regulatory capital ratio of a lending bank in columns (1) to (4), while it denotes the market capital ratio in columns (5) to (8). FQ and FDD denote Tobin's  $q$  and the distance to default of borrowing firms, respectively. The results in columns (1), (3), (5), and (7) are obtained using the baseline model, and those in columns (2), (4), (6), and (8) are obtained using the double fixed-effects model.

**Table 3: Estimation Results for Alternative Specifications of Bank Loan Equations**

**(A) Nonlinear Specification**

	Regulatory Capital		Market Capital	
	(1)	(2)	(3)	(4)
BCAP	-0.00285 (0.0111)	-0.0176*** (0.00579)	0.0357*** (0.00321)	0.0191*** (0.00196)
BCAP · FQ	-0.0000596 (0.0000875)		-0.000145*** (0.0000226)	
BCAP · FDD		0.00212* (0.00112)		-0.000475 (0.000331)
Lending Exposure	0.342*** (0.0555)	0.344*** (0.0555)	0.445*** (0.0575)	0.446*** (0.0575)
Borrowing Exposure	0.0146*** (0.000387)	0.0146*** (0.000387)	0.0138*** (0.000391)	0.0137*** (0.000391)
Firm Fix. Eff.	yes	yes	yes	yes
Obs.	123648	123648	122453	122453

**(B) Use of Lending Exposure to Real Estate as the Bank Capital Variable**

	Lending Exposure to Real Estate			
	(5)	(6)	(7)	(8)
BCAP	-0.535*** (0.0657)		-0.399*** (0.0361)	
BCAP · FQ	0.000686 (0.000499)	-0.000212 (0.000568)		
BCAP · FDD			-0.0121 (0.00776)	-0.00850 (0.00953)
Lending Exposure	4.472*** (0.936)	5.645*** (0.894)	4.435*** (0.936)	5.638*** (0.893)
Borrowing Exposure	0.0527*** (0.00712)	0.0329*** (0.00808)	0.0526*** (0.00712)	0.0329*** (0.00808)
Firm-Year Fix. Eff.	yes	yes	yes	yes
Bank-Year Fix. Eff.		yes		yes
Obs.	118261	118261	118261	118261

*Notes:* Robust standard errors are in parentheses. \*, \*\*, and \*\*\* denote significance at levels of 0.10, 0.05, and 0.01, respectively. In panel (A), BCAP denotes the regulatory capital ratio of a lending bank in columns (1) and (2), while it denotes the market capital ratio in columns (3) and (4). In panel (B), BCAP denotes banks' lending exposure to real estate in 1989. FQ and FDD denote Tobin's  $q$  and the distance to default of borrowing firms, respectively. In the nonlinear specification, we run a probit regression with borrowing-firm random effects, as in Peek and Rosengren (2005), whose dependent variable is an indicator variable that equals one if  $\Delta\text{LOAN}$  is positive, and zero otherwise. The probit regression also includes time dummy variables. In the linear regression in panel (B), we do not include bank fixed effects because lending exposure to real estate is a time-invariant bank variable.

**Table 4: Estimation Results for Bank Loan Equations Based on Three Subsamples and Two Bank Capital Ratios**

**(A) Market Capital Ratio**

	Low Market Capital				Medium Market Capital				High Market Capital			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
MARCAP	2.510*** (0.571)		1.683*** (0.352)		1.755*** (0.607)		0.936*** (0.358)		1.180*** (0.311)		0.851*** (0.188)	
MARCAP · FQ	-0.00367 (0.00382)	0.000537 (0.00386)			-0.00761* (0.00428)	-0.00652 (0.00434)			-0.00270 (0.00217)	-0.00235 (0.00224)		
MARCAP · FDD			0.0881* (0.0510)	0.0668 (0.0510)			-0.0371 (0.0594)	-0.0507 (0.0579)			-0.00363 (0.0309)	-0.0126 (0.0311)
Inverse Mills Ratio	-63.14*** (4.561)	-88.55*** (5.170)	-62.96*** (4.556)	-88.47*** (5.168)	-82.06*** (4.304)	-90.69*** (4.692)	-82.10*** (4.308)	-90.72*** (4.695)	-92.78*** (5.378)	-100.0*** (5.753)	-92.81*** (5.376)	-100.1*** (5.751)
Firm-Year Fix. Eff.	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Bank Fix. Eff.	yes		yes		yes		yes		yes		yes	
Bank-Year Fix. Eff.		yes		yes		yes		yes		yes		yes
Regulatory Capital												
Mean		1.669				1.405				1.451		
Std. Dev.		1.371				0.881				0.972		
Market Capital												
Mean		3.079				6.396				10.013		
Std. Dev.		1.280				1.306				2.425		
Obs.	39719	39719	39719	39719	39884	39884	39884	39884	37536	37536	37536	37536

**(B) Regulatory Capital Ratio**

	Low Regulatory Capital			Medium Regulatory Capital				High Regulatory Capital				
	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
REGCAP	0.619 (0.794)		1.691*** (0.613)		-0.509 (2.373)		0.442 (1.243)		-0.569 (0.623)		-0.171 (0.298)	
REGCAP · FQ	0.00878 (0.00552)	0.00994* (0.00561)			-0.00520 (0.0187)	0.00893 (0.0191)			0.00877* (0.00512)	0.00801 (0.00517)		
REGCAP · FDD			0.00653 (0.123)	0.00916 (0.123)			-0.434* (0.252)	-0.316 (0.255)			0.187*** (0.0601)	0.149** (0.0647)
Inverse Mills Ratio	-68.76*** (4.421)	-90.37*** (4.827)	-68.75*** (4.420)	-90.35*** (4.827)	-90.14*** (4.637)	-99.41*** (5.012)	-90.13*** (4.633)	-99.42*** (5.011)	-74.17*** (4.465)	-82.70*** (4.990)	-74.07*** (4.465)	-82.59*** (4.990)
Firm-Year Fix. Eff.	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Bank Fix. Eff.	yes		yes		yes		yes		yes		yes	
Bank-Year Fix. Eff.		yes		yes		yes		yes		yes		yes
Regulatory Capital												
Mean		0.714				1.334				2.470		
Std. Dev.		0.712				0.382				1.236		
Market Capital												
Mean		6.763				7.362				5.095		
Std. Dev.		3.110				3.123				3.264		
Obs.	38331	38331	38331	38331	41489	41489	41489	41489	38465	38465	38465	38465

Notes: Robust standard errors are in parentheses. \*, \*\*, and \*\*\* denote significance at levels of 0.10, 0.05, and 0.01, respectively. MARCAP and REGCAP denote the market capital ratio in columns (1) to (12) and the regulatory capital ratio in columns (13) to (24), respectively. FQ and FDD denote Tobin's  $q$  and the distance to default of borrowing firms, respectively. To construct three subsamples based on bank capitalization, we define a bank in the top 33 percentiles, middle 34 percentiles, or bottom 33 percentiles of banks based on the market (regulatory) capital ratio as high, medium, or low market (regulatory) capital, respectively. Estimated coefficients for lending and borrowing exposures are not reported.

Table 5: Estimation Results for Bank Loan Equations: Banks with Decreasing Regulatory Capital

(A) Full-Sample Regression

	(1)	(2)	(3)	(4)
REGCAP	-0.474* (0.271)		0.131 (0.148)	
REGCAP · FQ	0.00626*** (0.00215)	0.00457* (0.00235)		
BDEC · REGCAP · FQ	0.00378*** (0.00101)	0.000212 (0.00353)		
REGCAP · FDD			0.0366 (0.0310)	0.0106 (0.0317)
BDEC · REGCAP · FDD			0.0515* (0.0282)	-0.0678 (0.0487)
Firm-Year Fix. Eff.	yes	yes	yes	yes
Bank Fix. Eff.	yes		yes	
Bank-Year Fix. Eff.		yes		yes
Obs.	118285	118285	118285	118285

(B) Subsample Regressions

	Low Regulatory Capital				Medium Regulatory Capital				High Regulatory Capital			
	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
REGCAP	0.606 (0.682)		1.719*** (0.424)		-0.750 (2.188)		0.426 (1.224)		-0.581 (0.538)		-0.200 (0.270)	
REGCAP · FQ	0.00272 (0.00623)	0.0185* (0.0107)			-0.00278 (0.0177)	0.00850 (0.0181)			0.00867** (0.00439)	0.00797* (0.00446)		
BDEC · REGCAP · FQ	0.00713* (0.00426)	-0.00998 (0.0110)			0.00527 (0.00357)	-0.00645 (0.00867)			-0.000618 (0.00164)	0.00309 (0.00563)		
REGCAP · FDD			-0.124 (0.127)	0.200 (0.182)			-0.418 (0.269)	-0.320 (0.275)			0.172*** (0.0578)	0.135** (0.0595)
BDEC · REGCAP · FDD			0.143 (0.111)	-0.213 (0.185)			0.168* (0.0874)	0.0765 (0.141)			-0.0716* (0.0419)	-0.0921 (0.0676)
Firm-Year Fix. Eff.	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Bank Fix. Eff.	yes		yes		yes		yes		yes		yes	
Bank-Year Fix. Eff.		yes		yes		yes		yes		yes		yes
Obs.	38331	38331	38331	38331	41489	41489	41489	41489	38465	38465	38465	38465

Notes: Robust standard errors are in parentheses. \*, \*\*, and \*\*\* denote significance at levels of 0.10, 0.05, and 0.01, respectively. BDEC is the dummy variable indicating banks that decreased their regulatory capital. REGCAP denotes the regulatory capital ratio in columns (1) to (16). FQ and FDD denote Tobin's  $q$  and the distance to default of borrowing firms, respectively. To construct three subsamples based on bank capitalization, we define a bank in the top 33 percentiles, middle 34 percentiles, or bottom 33 percentiles of banks based on the regulatory capital ratio as high, medium, or low regulatory capital. Estimated coefficients for lending and borrowing exposures and the inverse Mills ratio are not reported.



**Table 6: Estimation Results for Bank Loan Equations Simultaneously Controlling for the Two Bank Capital Ratio Measures**

**(A) Tobin's  $q$  (FQ)**

	(1)	(2)	(3)	(4)
REGCAP	-0.555** (0.283)		-0.438 (0.492)	
REGCAP · FQ	0.00676*** (0.00224)	0.00495** (0.00229)	0.00803** (0.00391)	0.00116 (0.00403)
MARCAP	0.379*** (0.112)		0.413** (0.176)	
MARCAP · FQ	-0.00130** (0.000644)	0.000523 (0.000652)	-0.00101 (0.00120)	-0.000625 (0.00124)
REGCAP · MARCAP			-0.0419 (0.0885)	
REGCAP · MARCAP · FQ			-0.000202 (0.000668)	0.000755 (0.000701)
Firm-Year Fix. Eff.	yes	yes	yes	yes
Bank Fix. Eff.	yes		yes	
Bank-Year Fix. Eff.		yes		yes
Obs.	117139	117139	117139	117139

**(B) Distance to Default (FDD)**

	(5)	(6)	(7)	(8)
REGCAP	0.0576 (0.144)		0.257 (0.259)	
REGCAP · FDD	0.0493* (0.0286)	-0.00984 (0.0305)	0.0633 (0.0531)	-0.0476 (0.0659)
MARCAP	0.250*** (0.0784)		0.304*** (0.0981)	
MARCAP · FDD	-0.0145* (0.00870)	-0.0117 (0.00919)	-0.0115 (0.0137)	-0.0242 (0.0148)
REGCAP · MARCAP			-0.0537 (0.0427)	
REGCAP · MARCAP · FDD			-0.00231 (0.00655)	0.00704 (0.00837)
Firm-Year Fix. Eff.	yes	yes	yes	yes
Bank Fix. Eff.	yes		yes	
Bank-Year Fix. Eff.		yes		yes
Obs.	117139	117139	117139	117139

*Notes:* Robust standard errors are in parentheses. \*, \*\*, and \*\*\* denote significance at levels of 0.10, 0.05, and 0.01, respectively. REGCAP and MARCAP denote the regulatory and market capital ratios of lending banks, respectively. FQ denotes the Tobin's  $q$  of borrowing firms in panel (A) and FDD denotes the distance to default in panel (B). Estimated coefficients for lending and borrowing exposures and the inverse Mills ratio are not reported.

**Table 7: Estimation Results Based on Subsample Regressions Simultaneously Controlling for the Two Bank Capital Ratio Measures: Using Tobin's  $q$  as the Firm Variable**

**(A) Market Capital Ratio**

	Low Market Capital				Medium Market Capital				High Market Capital			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
REGCAP	0.0232 (0.457)		1.005 (1.235)		-1.393** (0.696)		-3.852 (2.608)		-2.214*** (0.702)		-0.982 (2.465)	
REGCAP · FQ	0.00512 (0.00354)	0.00339 (0.00367)	0.00245 (0.0100)	-0.00880 (0.00993)	0.00931* (0.00548)	0.00893 (0.00567)	0.0305 (0.0203)	0.0310 (0.0204)	0.0117** (0.00530)	0.0114** (0.00546)	0.00589 (0.0212)	0.00518 (0.0211)
MARCAP	2.060*** (0.612)		2.617*** (0.924)		1.914*** (0.612)		1.314 (0.848)		1.211*** (0.311)		1.397*** (0.450)	
MARCAP · FQ	-0.00140 (0.00416)	0.00192 (0.00423)	-0.00338 (0.00695)	-0.00470 (0.00695)	-0.00823* (0.00430)	-0.00713 (0.00436)	-0.00335 (0.00612)	-0.00201 (0.00618)	-0.00260 (0.00217)	-0.00219 (0.00225)	-0.00347 (0.00329)	-0.00294 (0.00332)
REGCAP · MARCAP			-0.345 (0.380)				0.456 (0.465)				-0.128 (0.232)	
REGCAP · MARCAP · FQ			0.00101 (0.00302)	0.00406 (0.00301)			-0.00385 (0.00344)	-0.00404 (0.00347)			0.000572 (0.00191)	0.000594 (0.00192)
Obs.	39719	39719	39719	39719	39884	39884	39884	39884	37536	37536	37536	37536

**(B) Regulatory Capital Ratio**

	Low Regulatory Capital				Medium Regulatory Capital				High Regulatory Capital			
	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
REGCAP	0.465 (0.802)		1.642 (2.000)		-0.159 (2.509)		-0.599 (3.860)		-0.571 (0.622)		-0.942 (0.942)	
REGCAP · FQ	0.00946* (0.00558)	0.0107* (0.00564)	0.00742 (0.0142)	0.00218 (0.0143)	-0.00950 (0.0201)	0.00360 (0.0207)	-0.00984 (0.0314)	0.00510 (0.0323)	0.00797 (0.00511)	0.00655 (0.00521)	0.0141* (0.00764)	0.00868 (0.00779)
MARCAP	0.642** (0.325)		0.825 (0.542)		-0.147 (0.265)		-0.270 (0.672)		1.340*** (0.319)		1.316** (0.525)	
MARCAP · FQ	-0.00173 (0.00156)	-0.00113 (0.00158)	-0.00221 (0.00361)	-0.00298 (0.00364)	0.00180 (0.00160)	0.00202 (0.00162)	0.00202 (0.00500)	0.00229 (0.00510)	0.000714 (0.00146)	0.00289** (0.00147)	0.00330 (0.00324)	0.00387 (0.00330)
REGCAP · MARCAP			-0.343 (0.532)				0.102 (0.462)				0.0352 (0.161)	
REGCAP · MARCAP · FQ			0.000611 (0.00381)	0.00247 (0.00384)			-0.000143 (0.00344)	-0.000218 (0.00353)			-0.00104 (0.00123)	-0.000382 (0.00128)
Obs.	37532	37532	37532	37532	41383	41383	41383	41383	38224	38224	38224	38224

*Notes:* Robust standard errors are in parentheses. \*, \*\*, and \*\*\* denote significance at levels of 0.10, 0.05, and 0.01, respectively. REGCAP and MARCAP denote the regulatory and market capital ratios of lending banks, respectively. FQ denotes the Tobin's  $q$  of borrowing firms. Estimated coefficients for lending and borrowing exposures, the inverse Mills ratio, and the presence or absence of fixed effects are not reported.

**Table 8: Estimation Results Based on Subsample Regressions Simultaneously Controlling for the Two Bank Capital Ratio Measures: Using Distance-to-Default as the Firm Variable**

**(A) Market Capital Ratio**

	Low Market Capital				Medium Market Capital				High Market Capital			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
REGCAP	0.529* (0.274)		1.300* (0.701)		-0.198 (0.342)		0.318 (1.375)		-1.268*** (0.396)		-1.655 (1.150)	
REGCAP · FDD	0.0274 (0.0591)	-0.0540 (0.0623)	-0.0374 (0.158)	-0.201 (0.168)	-0.0366 (0.0548)	-0.0536 (0.0543)	-0.242 (0.269)	-0.299 (0.276)	0.123*** (0.0471)	0.0881* (0.0467)	0.359 (0.224)	0.202 (0.234)
MARCAP	1.473*** (0.359)		1.900*** (0.507)		0.991*** (0.352)		1.080*** (0.419)		0.889*** (0.191)		0.833*** (0.257)	
MARCAP · FDD	0.0982* (0.0522)	0.0488 (0.0523)	0.0531 (0.0949)	-0.0306 (0.0984)	-0.0350 (0.0560)	-0.0464 (0.0539)	-0.0701 (0.0664)	-0.0895 (0.0666)	-0.00844 (0.0319)	-0.0185 (0.0319)	0.0208 (0.0432)	-0.00350 (0.0438)
REGCAP · MARCAP			-0.265 (0.226)				-0.0991 (0.252)				0.0326 (0.108)	
REGCAP · MARCAP · FDD			0.0230 (0.0517)	0.0504 (0.0547)			0.0381 (0.0475)	0.0459 (0.0491)			-0.0220 (0.0192)	-0.0106 (0.0199)
Obs.	39719	39719	39719	39719	39884	39884	39884	39884	37536	37536	37536	37536

**(B) Regulatory Capital Ratio**

	Low Regulatory Capital				Medium Regulatory Capital				High Regulatory Capital			
	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
REGCAP	1.555** (0.619)		0.898 (1.321)		0.335 (1.264)		1.447 (1.911)		-0.293 (0.296)		-0.139 (0.458)	
REGCAP · FDD	0.0231 (0.124)	0.0196 (0.124)	0.402 (0.254)	0.338 (0.252)	-0.425 (0.259)	-0.303 (0.263)	-0.869** (0.419)	-0.765* (0.428)	0.197*** (0.0588)	0.150** (0.0630)	0.251*** (0.0888)	0.187* (0.0966)
MARCAP	0.609** (0.266)		0.377 (0.359)		0.106 (0.171)		0.346 (0.351)		1.467*** (0.268)		1.635*** (0.387)	
MARCAP · FDD	-0.0445** (0.0215)	-0.0424** (0.0215)	0.0372 (0.0541)	0.0272 (0.0534)	-0.00355 (0.0183)	-0.00667 (0.0185)	-0.0886 (0.0608)	-0.0998 (0.0621)	-0.00434 (0.0166)	-0.00492 (0.0179)	0.0272 (0.0421)	0.0179 (0.0428)
REGCAP · MARCAP			0.197 (0.338)				-0.200 (0.250)				-0.0506 (0.0843)	
REGCAP · MARCAP · FDD			-0.111* (0.0653)	-0.0933 (0.0648)			0.0717 (0.0492)	0.0772 (0.0504)			-0.0108 (0.0126)	-0.00753 (0.0132)
Obs.	37532	37532	37532	37532	41383	41383	41383	41383	38224	38224	38224	38224

*Notes:* Robust standard errors are in parentheses. \*, \*\*, and \*\*\* denote significance at levels of 0.10, 0.05, and 0.01, respectively. REGCAP and MARCAP denote the regulatory and market capital ratios of lending banks, respectively. FDD denotes the distance to default of borrowing firms. Estimated coefficients for lending and borrowing exposures, the inverse Mills ratio, and the presence or absence of fixed effects are not reported.

**Table 9: Estimation Results for Bank Loan Equations for Banks with Low Market and High Regulatory Capital**

**(A) Tobin's  $q$  (FQ)**

	(1)	(2)	(3)	(4)
REGCAP	-1.366 (0.915)		3.629* (1.878)	
REGCAP · FQ	0.0167** (0.00733)	0.0146* (0.00750)	-0.0113 (0.0150)	-0.0148 (0.0149)
MARCAP	3.304*** (0.974)		9.243*** (2.048)	
MARCAP · FQ	-0.00612 (0.00614)	-0.0000720 (0.00627)	-0.0371** (0.0150)	-0.0313** (0.0150)
REGCAP · MARCAP			-2.059*** (0.670)	
REGCAP · MARCAP · FQ			0.0113** (0.00529)	0.0123** (0.00524)
Firm-Year Fix. Eff.	yes	yes	yes	yes
Bank Fix. Eff.	yes		yes	
Bank-Year Fix. Eff.		yes		yes
Obs.	20435	20435	20435	20435

**(B) Distance to Default (FDD)**

	(5)	(6)	(7)	(8)
REGCAP	-0.249 (0.494)		2.146* (1.099)	
REGCAP · FDD	0.250** (0.110)	0.180 (0.110)	0.0513 (0.237)	-0.0211 (0.244)
MARCAP	2.518*** (0.667)		5.602*** (1.249)	
MARCAP · FDD	0.00899 (0.0907)	0.0124 (0.0924)	-0.218 (0.217)	-0.214 (0.225)
REGCAP · MARCAP			-0.982** (0.387)	
REGCAP · MARCAP · FDD			0.0709 (0.0843)	0.0921 (0.0875)
Obs.	20435	20435	20435	20435

*Notes:* Robust standard errors are in parentheses. \*, \*\*, and \*\*\* denote significance at levels of 0.10, 0.05, and 0.01, respectively. REGCAP and MARCAP denote the regulatory and market capital ratios of lending banks, respectively. FQ denotes the Tobin's  $q$  of borrowing firms in panel (A) and FDD denotes the distance to default in panel (B). Estimated coefficients for lending and borrowing exposures, the inverse Mills ratio, and the presence or absence of fixed effects are not reported.

**Table 10: Summary Statistics for Bank Capital Equations**

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Market Capital Ratio	710	5.359	2.273	.602	15.723
Regulatory Capital Ratio	824	1.388	1.391	-5.01	9.48
Bank Charter Value ( $BQ_{it-1}$ )	704	102.24	2.136	98.272	114.997
Profitability ( $PROF_{it-1}$ )	824	.066	.298	-2.61	.598
Log (Total Assets) ( $SIZE_{it-1}$ )	824	14.727	1.365	12.303	18.171
Collateral Assets ( $COL_{it-1}$ )	824	23.409	5.943	11.596	44.308
Log (Asset Volatility) ( $\sigma_{it-1}$ )	704	.225	.697	-4.531	2.62

*Notes:* Estimation samples are from March 1993 to March 1998. Lagged variables, and all explanatory variables, are from March 1992 to March 1997.

**Table 11: Estimation Results for the Market and Regulatory Capital Ratios Using Market-Based Explanatory Variables**

(A) Market Capital Ratio			(B) Regulatory Capital Ratio		
	(1)	(2)		(3)	(4)
BQ	0.259*** (0.0431)	0.226*** (0.0523)	BQ	0.0695 (0.0447)	0.0703 (0.0427)
PROF	0.315** (0.145)	1.200*** (0.300)	PROF	0.325 (0.242)	0.0635 (0.160)
SIZE	1.997** (0.959)	1.931** (0.957)	SIZE	1.003 (1.204)	1.105 (1.065)
COL	0.0813*** (0.0245)	0.0799*** (0.0262)	COL	0.0151 (0.0231)	0.0127 (0.0235)
$\sigma$	0.204** (0.0959)	0.419** (0.161)	$\sigma$	0.0675 (0.0847)	0.0809 (0.0863)
$D_{low}^M \cdot BQ$		0.0811 (0.0944)	$D_{high}^R \cdot BQ$		-0.0840 (0.0799)
$D_{low}^M \cdot PROF$		-1.145*** (0.315)	$D_{high}^R \cdot PROF$		1.031*** (0.357)
$D_{low}^M \cdot SIZE$		-0.0606 (0.165)	$D_{high}^R \cdot SIZE$		-0.0526 (0.164)
$D_{low}^M \cdot COL$		-0.0264 (0.0218)	$D_{high}^R \cdot COL$		0.00190 (0.0237)
$D_{low}^M \cdot \sigma$		-0.244* (0.141)	$D_{high}^R \cdot \sigma$		0.0795 (0.241)
$D_{low}^M$		-6.604 (9.783)	$D_{high}^R$		9.212 (8.682)
Constant	-52.88*** (15.94)	-48.60*** (17.28)	Constant	-21.54 (19.36)	-23.04 (17.40)
Obs.	701	701	Obs.	704	704

*Notes:* Robust standard errors are in parentheses. \*, \*\*, and \*\*\* denote significance at levels of 0.10, 0.05, and 0.01, respectively. The dependent variable is the market capital ratio in panel (A), and the regulatory capital ratio in panel (B).  $D_{low}^M$  denotes a dummy variable that equals one if a bank is classified as having a low market capital ratio, and zero otherwise.  $D_{high}^R$  denotes a dummy variable that equals one if a bank is classified as having a high regulatory capital ratio, and zero otherwise. Estimated equations also include time dummy variables and bank fixed effects.

**Table 12: Estimation Results for Bank Loan Equations with Determinants of the Market Capital Ratio**

	(1)	(2)	(3)	(4)	(5)	(6)
MARCAP	0.224*** (0.0676)	1.380*** (0.245)	0.193*** (0.0685)	0.315*** (0.0678)	0.252*** (0.0726)	-0.00746 (0.0728)
BQ		-1.061*** (0.215)				
PROF			0.564** (0.247)			
SIZE				13.09*** (1.080)		
COL					-0.0319 (0.0326)	
$\sigma$						3.045*** (0.364)
Firm-Year Fix. Eff.	yes	yes	yes	yes	yes	yes
Bank Fix. Eff.	yes	yes	yes	yes	yes	yes
Obs.	119018	119018	119018	119018	119018	119018

*Notes:* Robust standard errors are in parentheses. \*, \*\*, and \*\*\* denote significance at levels of 0.10, 0.05, and 0.01, respectively. The dependent variable is  $\Delta$ LOAN, which indicates the growth rate of the total amount of loans outstanding. Estimated coefficients for lending and borrowing exposures and the inverse Mills ratio are not reported.

**Table A.1: Estimation Result for the Survival Model of Borrower–Lender Relationships**

Fiscal Year	1992	1993	1994	1995	1996	1997	1998
MARCAP	−0.00442*** (−3.52)	−0.0299*** (−3.46)	−0.0590*** (−6.03)	−0.0222* (−1.69)	−0.0114*** (−3.19)	−0.0127*** (−3.25)	−0.0100*** (−3.02)
BFSIZE	−0.0379 (−0.90)	0.0481 (1.14)	0.212*** (5.16)	0.0997** (2.17)	−0.0320 (−0.91)	−0.0327 (−0.79)	−0.0735* (−1.88)
BROA	0.0600*** (5.03)	−0.00920 (−0.66)	0.128*** (4.97)	0.0539** (2.54)	0.0834*** (4.47)	0.0133*** (3.15)	0.101*** (2.93)
FLEV	−0.00533** (−2.00)	−0.00102 (−0.40)	0.0145*** (5.97)	0.000600 (0.24)	0.00173 (0.66)	−0.00350*** (−3.31)	−0.00681*** (−2.72)
Fysize	0.0369 (0.32)	0.852*** (7.51)	0.106 (1.31)	0.364*** (3.91)	0.108 (1.12)	0.231** (2.47)	−0.0156 (−0.20)
FROA	0.00525** (2.13)	0.0154*** (6.32)	0.00908*** (3.34)	0.00101 (0.62)	0.00771*** (3.20)	0.00522*** (2.59)	0.00405** (2.24)
FICR	0.00000957*** (3.72)	0.00000129 (0.41)	0.00000177** (2.34)	−0.000000292 (−0.22)	0.00000476** (2.26)	−0.00000275 (−1.42)	0.00000221** (2.12)
DURAT	0.0104*** (7.09)	0.0116*** (6.70)	0.0127*** (7.79)	0.00977*** (6.20)	0.0126*** (7.93)	0.0130*** (7.52)	0.0173*** (10.17)
EXPL	0.0233*** (4.35)	0.0328*** (3.89)	0.000290 (0.05)	0.0732*** (6.44)	0.0119* (1.82)	0.0964*** (6.78)	0.0291*** (3.25)
EXPB	0.0114*** (11.41)	0.0139*** (11.90)	0.0142*** (12.92)	0.00871*** (8.71)	0.0122*** (12.15)	0.0101*** (9.63)	0.00979*** (9.24)
NUMBL	0.158*** (5.43)	0.267*** (8.06)	0.299*** (9.54)	0.231*** (7.43)	0.260*** (7.94)	0.342*** (9.75)	0.366*** (10.66)
NUMBB	0.136*** (2.98)	−0.0153 (−0.35)	−0.187*** (−4.35)	−0.00246 (−0.05)	0.0348 (0.95)	0.116*** (2.75)	0.136*** (3.40)
<i>N</i>	21747	18169	18298	16710	14653	13763	13799

*Notes:* This table shows the estimation results of the model with industry fixed effects. The dependent variable is the survival dummy variable, which equals one if the borrower–lender relationship continues in year  $t$ , and otherwise zero. We also include five-year moving average values of the firm ROA, interest coverage ratio, book leverage ratio, and size to control for time-varying firm fixed effects. The estimated coefficients are not shown in the table. \*\*\*, \*\*, \* indicate 1%, 5%, and 10% levels of significance, respectively.  $t$  statistics are in parentheses.



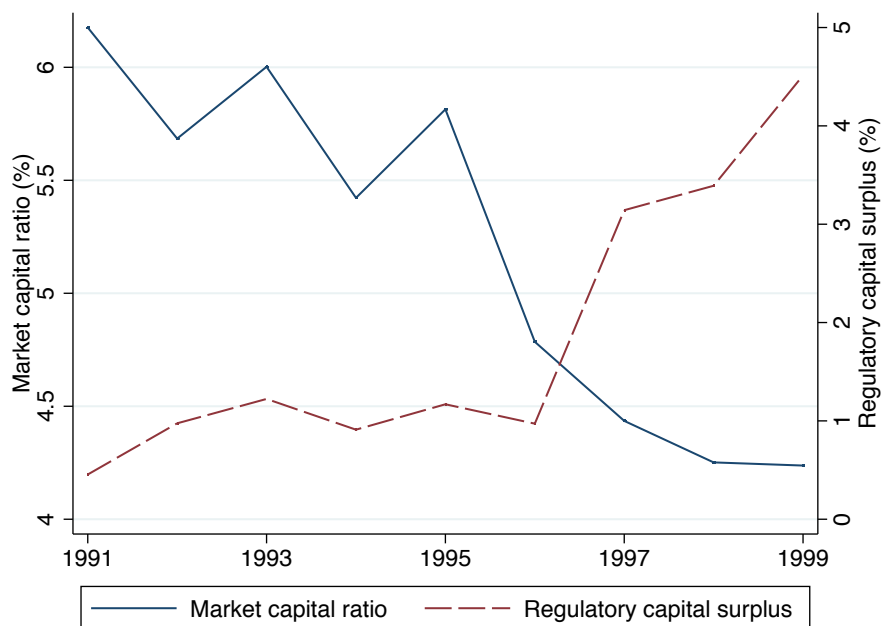


Figure 1: **The Bank Market Capital Ratio and Regulatory Capital Surplus**

Notes: The solid line represents the mean bank market capital ratio in each year, and the dashed line represents the mean bank regulatory capital surplus in each year.

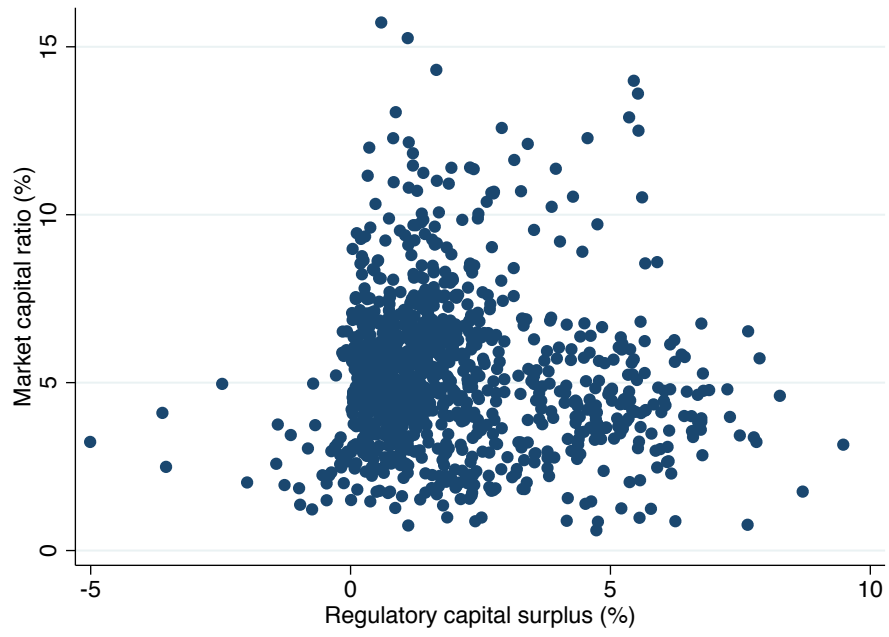


Figure 2: Scatterplot of the Bank Market Capital Ratio and Regulatory Capital Surplus

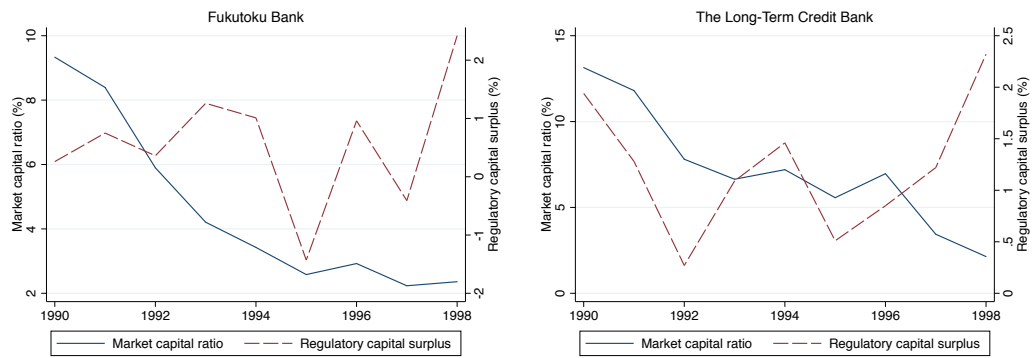


Figure 3: The Market and Regulatory Capitals of Banks That Went Bankrupt

Notes: The left panel shows the market capital ratio and regulatory capital surplus of Fukutoku Bank, which went bankrupt in May 1998. The right panel shows the two capital measures for the Long-Term Credit Bank (LTCB), which went bankrupt in October 1998. In both panels, the solid line represents the market capital ratio (which corresponds to the left axis), while the dashed line represents the regulatory capital surplus (which corresponds to the right axis).

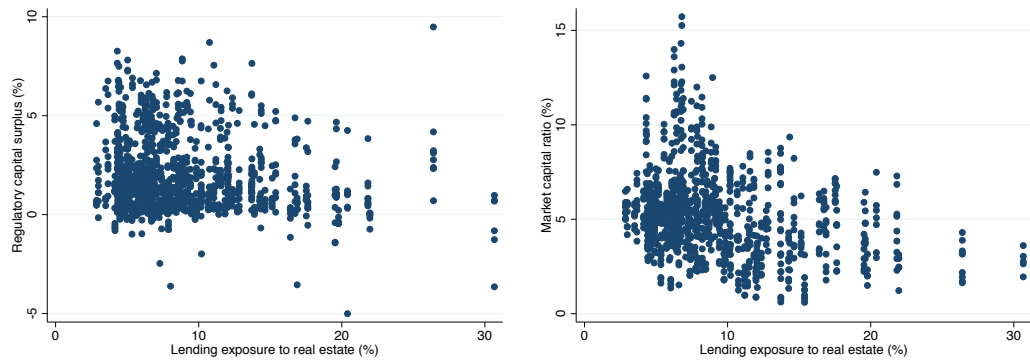
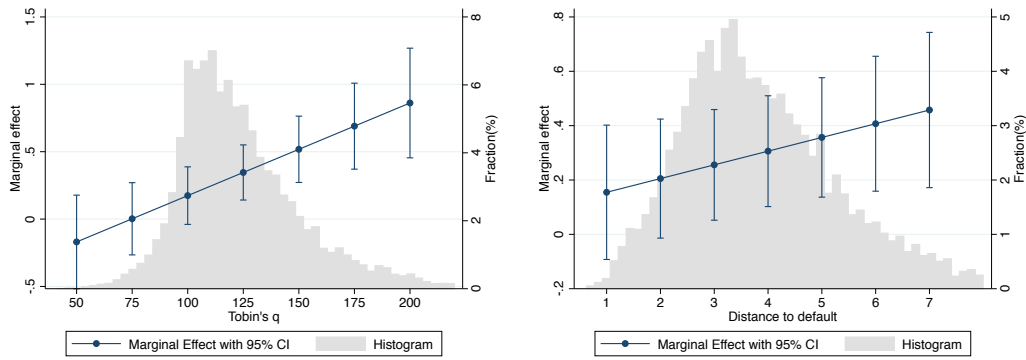


Figure 4: **Lending Exposure to Real Estate and the Two Bank Capital Ratios**

Notes: The left panel is a scatterplot of lending exposure to real estate and the regulatory capital surplus, and the right panel is that of lending exposure to real estate and the market capital ratio.

### (A) Regulatory Capital



### (B) Market Capital

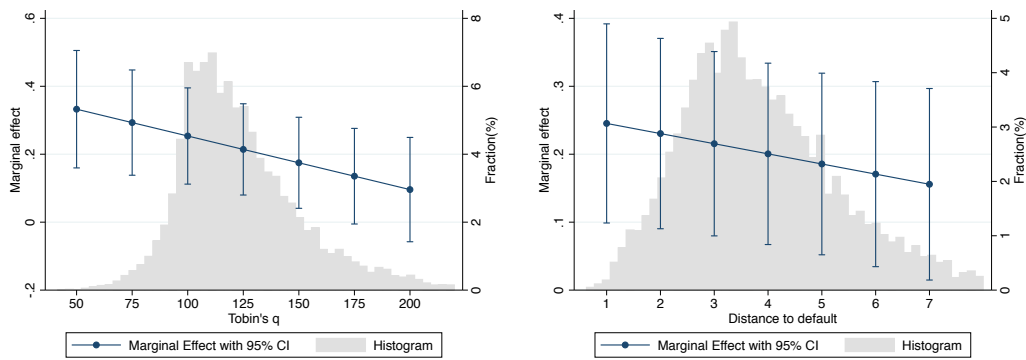


Figure 5: Average Supply Effects of Bank Capital on Lending

Notes: Dots represent point estimates of the average marginal effects of the bank capital measure, BCAP, at a representative value of the firm performance variables in the bank loan equations reported in Table 2. The capped vertical lines represent 95 % confidence intervals calculated by the delta method. Shaded areas are histograms of the firm performance variables corresponding to the right axis.



Figure 6: **The Bank Market Capital Ratio and Asset Volatility**

Notes: The solid line represents the mean bank market capital ratio in each year, as in Figure 1, and the dashed line represents the mean logarithmic value of bank asset volatility in each year.