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Abstract

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. 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. In this paper, using a loan-level matched sample of Japanese banks and their listed borrowers from 1992 to 2010, we examine how unviable relationships between lowly capitalized banks and their low-quality borrowers such as zombie firms played in the supply of bank credits. More concretely, we employ the three-way fixed-effects linear regression model with time-varying coefficients, thereby drawing two main conclusions. First, forbearance lending by lowly capitalized banks in the middle 1990s would be followed by their stagnant lending to low-quality borrowers in capital crunches from the late 1990s to the middle 2000s and in FY 2008 after the collapse of Lehman Brothers.

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Second, in the repeated crunches, lowly capitalize banks concentrated credits more toward good borrowers; therefore, a "flight to quality" by lowly capitalized banks emerged in the capital crunches.

JEL classification: G01, G21, G28.
Keywords: close relationship, forbearance lending, zombie firm, loan-level data.

1. Introduction

Among financial crises in developed economies, the one in Japan after the burst of the bubble economy in the 1990s was unprecedented in terms of the length and depth of the subsequent economic downturn. Debates about Japan's prolonged stagnation have been raised accordingly, and the issue concerning the misallocation of bank credit has been the most active one, such as in Peek and Rosengren (2005) and Caballero et al. (2008). In this paper, we examine how and when bank-borrower unviable relationships involving low-quality borrowers induced the increase in the supply of credits to them.

When many borrowers become insolvent, a bank becomes financial-distress. Such a financial-distress bank has incentives to continue to lend toward insolvent borrowers in order to conceal the fact that the bank becomes financially distressed, while hoping that the insolvent borrowers will improve. This type of bank lending with hope for revival is called "forbearance lending". If many banks engage in the forbearance lending, the resulting misallocation of credits towards low-quality borrowers that should go bankrupt would damage macroeconomic situation more. This practice has often been accused of being the source of the prolonged stagnation experienced after the 1990s in Japan.

The forbearance lending, involved by an unviable relationship between a financial-distress bank and a low-quality borrower, is well known in Japanese as *oigashi*. After the burst of the bubble economy, many Japanese banks faced insolvent borrowers and their capital condition deteriorated severely. Facing the coexistence of the macroeconomic stagnation and the deteriorated bank capital condition, empiri-

cal researches came into existence for *oigashi* in the context of Japanese economy.

Empirical researches on the forbearance lending in Japan include Sekine et al. (2003), Peek and Rosengren (2005) and Watanabe (2010)[1]. The period to be inspected by the empirical studies is from the early to the late 1990s. They addressed the issue of whether the deterioration of Japanese banks' capital conditions, caused by the burst of the asset-price and real-estate bubble economy in the early 1990s, led to increases in bank loans to low-quality firms[2]. Sekine et al. (2003) used firm-level panel data from 1986 to 1999, and found that highly-indebted firms belonging to nonmanufacturing industries were more likely to increase their bank borrowings for the sample period after 1993, albeit their low profitability. Watanabe (2010) used bank-level panel data from 1995 to 2000, thereby demonstrating that regulatory tough stance which urged banks to write off nonperforming loans would produce a large loss of bank capital; consequently, such a loss of capital would induce bank lending to be shifted to low-quality borrowers with a higher concentration of nonperforming loans. Unlike these two studies, but like us, Peek and Rosengren (2005) used loan-level data. For sample periods from 1994 to 1999, they found that banks' window-dressing motives to avoid the realization of losses on their balance sheet were more likely to provide additional credit to firms with low profitability.

Caballero et al. (2008) addressed a more specific issue of the misallocation of bank credit toward low-quality borrowers as "zombie lending" (see also Hoshi (2006)). They defined zombies as firms whose interest payments were lower than the hypothetical minimum interest. This idea is based on the assumption that distressed firms must have received interest relief from banks and hence their interest payments should have been lower than those of non-distressed firms. They used firm-level panel data form 1981 to 2002, thereby demonstrating that the increase in zombies would distress the investment and employment growth of non-zombies.

Fukuda and Nakamura (2011), however, pointed out that zombies identified by

the method based on interest payments would result in identifying many profitable firms, in particular, after 2000s. They extended the method to identify zombies by incorporating profitability in definition of zombies; thus they found that the main reason for reviving zombie firms to non-zombie ones was corporate restructuring.

The previous researches assume that the deterioration of bank financial health is a prerequisite for the further lending toward low-quality borrowers, whereas the other ones, including Giannettie and Simonov (2013) and Duchin and Sosyura (2014), pointed out the possibility that the improvement in its capital condition would induce lending more toward low-quality borrowers. The latter carries the implication that the increase in bank capital buffers triggered by the implementation of prudential policy, such as public capital injections into banks, would be a substantial driver of lending toward low-quality borrowers[3].

The thing to be suggested by all the previous researches is that two types of lending toward low-quality borrowers would exist. One is the forbearance lending by banks with severe financial distress, and the other is the more active lending by banks with the improvement in their financial health. The chief difficulty in disentangling the two types of lending toward low-quality borrowers lies in identifying "unviable" bank-borrower relationships involving in the low-quality ones. One cannot examine precisely how and when which types of lending prevailed without identifying the unviable relationships. To deal with that difficulty, we exploit a unique data set consisting of a matched sample of Japanese banks and their listed borrowers. Our matched sample allows us to identify what firms and banks had relationships and to uncover the effect of the unviable relationship on bank lending.

Note also that, as reviewed above, all the above researches did not use samples after 2000s, but instead focused on a particular sample period for their analysis. We inspect the matched sample for the period from 1993 to 2011 and add depth to the existing literature by investigating whether and when the unviable relationship induced further lending toward low-quality borrowers.

The novel issue addressed in this paper is what factors are responsible for the

unviable relationship. To explore a background mechanism of bank lending toward low-quality borrowers and present an insight into that lending, we detect factors determining the unviable relationships. Such detection will reveal how the unviable relationship with low-quality borrowers drove lending toward them.

Our key findings are as follows: first, two types of bank lending toward low-quality borrowers would exist: the more active lending due to the improvement in bank capital positions and the forbearance lending due to the increase in nonperforming loans. In particular, the two types of lending involve Japanese major banks. The former type of lending would exist in the two periods of the late 1990s and the middle 2000s, in which major banks' capital buffers increased due to the concurrent increase and decrease in the numerator and denominator, or the regulatory capitals and risk-weighted assets, of their capital adequacy ratios. The latter type of lending would exist in the period from the late 1990s to the early 2000s, in which major banks' nonperforming loans were continuously increasing. In the late 1990s, therefore, the two types of lending would coexist.

Second, the quality of the unviable relationship would change according to the strength of the ties between banks and their low-quality borrowers with a limited access to external debt-funding sources. That closeness effect involves major banks with larger market shares more. As the tie between a major bank and its low quality borrower with a limited access to external debt-funding sources becomes stronger in that the bank locks in the low-quality borrower and the borrower consequently depends more on the bank, the relationship quality would fluctuated more through the changes in major bank's financial health. Therefore the changes in its financial health would induce or prevent lending more toward low-quality borrowers through the further cementing of the unviable, albeit close, bank-borrower relationships.

Our paper is organized as follows. Sections 2 and 3 present empirical specifications to examine lending to low-quality borrowers and estimation results, respectively. Section 4 explores a background mechanism of the lending by detecting

factors that determines an unviable relationship between a bank and its low-quality borrower. Section 5 offers conclusions. Appendix explains construction of our matched sample.

2. Empirical Specifications for Lending to Low-quality Borrowers and Data Set

In this section, we introduce empirical specifications for bank lending toward low-quality borrowers, and discuss methods to estimate the lending functions. We also explain our data set and covariates included into the lending functions.

2-1. Econometric Specification and Estimation Method

This subsection adopts two econometric specifications for bank lending in reduced forms. As expressed below in specifications (1) and (2) for bank lending, we include, as proxies of lender-side financial health, bank's nonperforming loan ratios (NPL_{it}), insufficiency ratios of capital buffers (ICAP_{it}) defined as 100 minus the difference between bank's reported capital ratios and its regulatory target capital ratio, and a switching dummy indicating whether a bank switched the international standard on capital adequacy to the domestic one after the revision of Article 26 of the Banking Act in 1996, thus increasing its capital buffers by 4% (SWITCH_{it})[4]. In addition to the three lender-side financial variables, we include an indicator variable for low-qualify borrowers (FIRM_t^j), such as financial-distress borrowers and zombie ones, as a borrower-side determinant of bank loans. If borrower j is low-quality one, the firm indicator is set as $\mathrm{FIRM}_t^j=1$; otherwise as $\mathrm{FIRM}_t^j=0$. Considering an endogenous determination of bank loans and the above covariates, we use the one-period lags of each covariate[5].

More specifically, we introduce two bank lending functions as follows:

$$\begin{aligned}\Delta\mathrm{LOAN}_{it}^j=&\mathrm{const}+\alpha(\mathrm{NPL}_{it-1})+\beta(\mathrm{ICAP}_{it-1})+\gamma(\mathrm{SWITCH}_{it})\\&+\delta(\mathrm{FIRM}_{t-1}^j)+\theta(\mathrm{NPL}_{it-1}\cdot\mathrm{FIRM}_{t-1}^j)+\lambda(\mathrm{ICAP}_{it-1}\cdot\mathrm{FIRM}_{t-1}^j)\\&+\mu(\mathrm{CONSO}_{it})+time_t+v_i+v^j+\varepsilon_{it}^j,\end{aligned}\tag{1}$$

and

$$\Delta LOAN_{it}^{j} = const + \alpha(NPL_{it-1}) + \beta(ICAP_{it-1}) + \gamma(SWITCH_{it}) + \theta(NPL_{it-1} \cdot FIRM_{t-1}^{j}) + \lambda(ICAP_{it-1} \cdot FIRM_{t-1}^{j}) + \mu(CONSO_{it}) + v_i + v^j \cdot time_t + \varepsilon_{it}^{j}. \quad (2)$$

$\Delta LOAN_{it}^{j}$ indicates the growth rate of the total amount of loans outstanding between domestic listed firm j and bank i at time t. $time_t$ denotes the time dummy to capture market-wide effects at time t. v_i and v^j represent bank i's and firm j's unobservable fixed effects, respectively. ε_{it}^{j} indicates the stochastic disturbance term.

$CONSO_{it}$ denotes a bank consolidation dummy, indicating whether a bank performed M & A, business transfer and divestiture activities at time t. As discussed in the next subsection, we take into account the consolidations of Japanese banks occurred from the late 1990s to the early 2000s to carefully construct our loan-level data set. We include the bank consolidation dummy, thereby controlling for the pure consolidation effects on bank lending.

Equations (1) and (2) contain two crossed variables consisting of bank financial health measures and the indicator of low-quality borrowers: $NPL_{it-1} \cdot FIRM_{t-1}^{j}$ and $ICAP_{it-1} \cdot FIRM_{t-1}^{j}$. The crossed variables characterize the two lending equations as a switching regression model. In those equations, the semielasticity of bank lending with respect to the nonperforming loans ratios (NPL_{it-1}) can be expressed as follows:

$$\frac{\partial \Delta LOAN_{it}^{j}}{\partial NPL_{it-1}} = \begin{cases} \alpha, & \text{if} \quad FIRM_{t-1}^{j} = 0, \\ \alpha + \theta, & \text{if} \quad FIRM_{t-1}^{j} = 1. \end{cases}$$

The semielasticity with respect to the inefficiency ratios of capital buffers ($ICAP_{it-1}$) can be expressed as β if $FIRM_{t-1}^{j} = 0$ or $\beta + \lambda$ if $FIRM_{t-1}^{j} = 1$. The semielasticity with respect to the inefficiency ratios has the same implication as that with respect to the nonperforming loans discussed below.

The above equation for the semielasticity with respect to the nonperforming loans indicates that if the crossed variable, $NPL_{it-1} \cdot FIRM_{t-1}^{j}$, is zero (that is,

$FIRM^j_{t-1}=0$), the semielasticity measures how much bank lending toward non-low-quality borrowers is affected through the change in the nonperforming loans. On the other hand, if the crossed variable is greater than zero (that is, $FIRM^j_{t-1}=1$) and an unviable relationship with a low-quality borrower exists, the semielasticity allows us to measure how much bank lending toward low-quality borrowers is affected by the development (mitigation) in the relationship inferiority caused by the increase (decrease) in the nonperforming loans.

For the qualitative implications of an estimated semielasticity, $\hat{\alpha}+\hat{\theta}$, in the case of $FIRM^j_{t-1}=1$, a significantly positive estimate implies that the development (mitigation) in the relationship inferiority due to the increase (decrease) in the nonperforming loans would induce credit expansion toward low-quality borrowers. If the estimated semielasticity is significantly smaller than zero, on the other hand, it would induce the decrease in credits toward low-quality borrowers. This paper focuses particularly on the estimated semielasticity, $\hat{\alpha}+\hat{\theta}$ and $\hat{\beta}+\hat{\lambda}$, in the case of $FIRM^j_{t-1}=1$, thus examining whether and when an "unviable relationship" with a "bad firm" resulted in the expansion of bank credit or not.

The difference between equations (1) and (2) involves the issue of how we control for unobservable effects. Equation (1) considers, as unobservable effects, bank and firm fixed effects v_i and v^j as well as time-varying market-wide effects captured by time-dummy variables $time_t$. On the other hand, equation (2) considers all potential borrower-side factors, including the indicator variable for low-quality borrowers $FIRM^j_{t-1}$, as time-varying borrower-side unobservables $v^j_t=v^j\cdot time_t$, but instead it did not include time-varying market-wide effects $time_t$ as well as the indicator variable. In order to conduct robustness checks on estimation results, we employ the two specifications for bank lending in the following analyses.

Loan supply equations (1) and (2) is the three-way fixed-effects linear regression model. Unlike our specifications, Peek and Rosengren (2005) transformed growth data of bank loans into binary outcome data, and then employed the random effect probit model. Our choice of a linear rather than nonlinear model of bank

lending is motivated by two reasons. First, nonlinear models tend to produce biased estimates in panel data sets with a short time series and many fixed effects, leading to an incidental parameters problem and inconsistent estimates. Second, nonlinear fixed effects models generate biased estimates for interaction terms (see Ai and Norton (2003)), the main coefficients of interest. Indeed, from this econometric point of view, Inoue et al. (2015b) rigorously discussed that Peek and Rosengren (2005) would draw an erroneous conclusion of Japan's bank lending behavior in the late 1990s.

To estimate the three-way fixed-effects linear regression models of bank lending, we employ the estimation method developed by Abowd et al. (1999) and Andrews et al. (2008). This estimation method gives consistent and unbiased parameter estimates not only for time-varying observables of both lender-side and borrower-side factors but also for their two types of unobserved fixed effects[6].

When estimating equations (1) and (2), we incorporate the three-way fixed-effects estimation method into a rolling-window estimation method with the window width of three years[7]. By observing changes in estimated coefficients, we attempt to identify a period during which lending toward low-quality borrowers prevailed as well as to examine how unviable relationships with those low-quality ones, defined as the crossed variables ($NPL_{it-1}\cdot FIRM^{j}_{t-1}$ and $ICAP_{it-1}\cdot FIRM^{j}_{t-1}$), determine lending in that period.

2-2. Data Set

This subsection explains our data construction of the bank distress measures, the indicator for distressed firms and unviable relationship variables.

2-2-1. Data Set Construction

The empirical analysis developed in this paper rests on a loan-level dataset comprising a matched sample of Japanese banks and their borrowing firms listed in Japan. We construct our loan-level data based on the Corporate Borrowings from

Financial Institutions Database compiled by Nikkei Digital Media Inc. This database assembles information on the outstanding amounts of bank loans classified by maturity (long-term debt with a maturity of more than one year and short-term debt with a maturity of one year or less) and by each bank. The database includes some 350,000 observations, comprising more than 130 Japanese banks, 2,000 listed borrowing firms and 17,000 relationships for our sample period from March 1993 to March 2011 (see Table 1). We combined the Nikkei database with the financial statement data of the Japanese banks and their listed borrowing firms, also compiled by Nikkei Digital Media Inc[8].

The chief difficulty of constructing our loan-level dataset involves identifying accurately the termination of a bank-borrower relationship. The Japanese banking sector experienced extensive M&A, business transfer, and divestiture activity from the late 1990s to the early 2000s. Consequently, some Japanese banks are missing from the original Nikkei database at the end of our sample period. When defining a terminated relationship, we must take into account those eliminations and consolidations of Japanese banks. More precisely, we thoroughly scrutinized whether succeeding banks took over the credit claims of eliminated or consolidated banks on their borrowing firms before and after the relevant restructuring event. The Appendix details how we define a terminated relationship in the cases of M&A, business transfer, and divestiture[9].

2-2-2. Bank Loans

We define the total amount of loans outstanding ($LOAN_{it}^{j}$) as the total amount of loans outstanding by adding short-term debt with a maturity of one year or less to long-term debt with a maturity of more than one year, and then define its growth rate as $\Delta LOAN_{it}^{j}=(LOAN_{it}^{j}-LOAN_{it-1}^{j})/LOAN_{it-1}^{j}$. As discussed in Subsection 2.2.1, we obtain the annual amount of total loans outstanding for each listed company from the Corporate Borrowings from Financial Institutions Database compiled by Nikkei Digital Media Inc.

2-2-3. Measures for Bank's Financial Health

We include, as measure for bank's financial health, three covariates: nonperforming loan ratios (NPL_{it}), insufficiency ratios of capital buffers ($ICAP_{it}$), and the switching dummy ($SWITCH_{it}$) indicating whether a bank increased its capital buffers by 4% by shifting to the domestic standard on capital adequacy.

Nonperforming loan ratios (NPL_{it}) are defined as the ratio of the reported amount of nonperforming loans to total loans and expressed in percentage terms.

Insufficiency ratios of capital buffers ($ICAP_{it}$) are defined by subtracting the target capital ratio−8% for international banks and 4% for domestic banks−from a reported capital ratio and then are expressed by 100 minus the resulting capital buffer. Its higher values imply that a bank faces a smaller amount of capital buffers.

The switching indicator ($SWITCH_{it}$) is defined by setting $SWITCH_{it}=1$ when bank i switched the international standard on capital adequacy to the domestic one after the revision of Article 26 of the Banking Act in 1996, and setting $SWITCH_{it}=0$ otherwise.

2-2-4. Indicators for Low-quality Borrowers

For a borrower-side determinant of bank loans ($FIRM_t^i$) included into equations (1) and (2), we consider four indicator variables indicating low-quality borrowers: (i) the indicator of financial-distress firms ($FDIST_t^i$); (ii) the indicator of operational-distress firms ($ODIST_t^i$); (iii) the indicator of lowly interest-paying zombie firms ($ZOMBIE_t^i$), and (iv) the indicator of lowly-profitable zombie firms ($FN\text{-}ZOMBIE_t^i$). The first and second indicators of distressed firms were suggested by Hoshi et al. (1990). The third and fourth indicators of zombie firms were suggested by Caballero et al. (2008) and Fukuda and Nakamura (2011), respectively.

The indicator of financial-distress firms ($FDIST_t^i$) is based on firms' default risks represented in the interest coverage ratio. We define the interest coverage ratio by dividing EBIT, or borrower's earnings before interest and taxes, by its total

interest payments and is expressed in percentage terms. Having an interest coverage ratio less than one hundred indicates that the firm faces financial distress in the sense that it has an immediate problem in earning not enough to cover its interest obligations. To enter financial distress, a firm must have an interest coverage ratio for one year that is greater than one hundred, followed by two consecutive years in which its interest coverage ratio is less than one hundred. The borrowing firm is deemed to become distressed in that second consecutive year with a coverage ratio less than one hundred. A given firm may enter distress more than one time during our sample period. In order to qualify as a repeater, a firm must first recover from its earlier episode of distress, where recovery is defined as experiencing two consecutive years with an interest coverage ratio greater than one hundred.

The indicator of operational-distress firms ($ODIST_t^j$) is constructed based on a firm's net income. To enter the situation of operational distress, a firm must experience a year of positive net income followed by two consecutive years in which its net income is negative. The firm becomes operationally distressed in that second consecutive year with negative net income. To qualify as a repeater, a firm must first recover from its earlier episode of distress, where recovery is defined as experiencing two consecutive years with positive net income.

A first indicator of zombie firms ($ZOMBIE_t^j$) is based on the interest payment gap between the actual interest payments made by the firms and the hypothetical minimum interest payments proposed by Caballero et al. (2008)[10]. If the interest payment gap of borrowing firm j takes a negative value, the firm is defined as a zombie: $ZOMBIE_t^j=1$. If the interest payment gap takes a positive value, the zombie indicator is set as $ZOMBIE_t^j=0$.

A second indicator of zombies ($FN\text{-}ZOMBIE_t^j$) proposed by Fukuda and Nakamura (2011) involves firm's profitability. As discussed above, the interest payment-based method identifies firms that make lower interest payments granted by their lending banks; however, as criticized by Fukuda and Nakamura (2011), the method results in identifying not only "bad borrowers" that make lower

interest payments due to their low performance, but also "good ones" that make those due to their high performance. Their alternative method to identify zombies incorporates firm's profitability, proxied by EBIT, into the original method of Caballero et al. (2008). If an lower-interest-rate paying zombie j's EBIT is lower than the hypothetical minimum interest payments proposed by Caballero et al. (2008), the zombie is defined as a lowly-profitable zombie, FN-ZOMBIE$_t^j$=1; otherwise as a non-zombie, FN-ZOMBIE$_t^j$=0. We also use this zombie indicator as an alternative one of low-quality firms.

2-2-5. Unviable Relationship Variables

The measure for the inferiority of lender-borrower relationships is a key variable in our analysis. As discussed in subsection 2.1, we define an unviable relationship as multiplying the two measures for bank's financial health, nonperforming loan ratios (NPL$_{it}$) and insufficiency ratios of capital buffers (ICAP$_{it}$), with one of the four indicators for low-quality firms (FIRM$_t^j$=either FDIST$_t^j$, ODIST$_t^j$, ZOMBIE$_t^j$, or FN-ZOMBIE$_t^j$). All the crossed variables are defined in each bank-borrower relationship.

Each crossed variable consisting of a measure for bank's financial distress and an indicator for low-quality borrowers (NPL$_{it}$・FIRM$_t^j$ and ICAP$_{it}$・FIRM$_t^j$) have the feature that its higher (lower) values, as long as over zero, imply that the inferiority of lender-borrower relationships developed (was mitigated). As expressed in lending equations (1) and (2), we include the mixed variable as a proxy for the deterioration of a relationship, and thereby examine the effects of the unviable relationship on bank lending.

2-2-6. Consolidation Effects

In order to control for the effects of banks' M & A, business transfer and divestiture activity, we include a consolidation dummy CONSO$_{it}$. We consider three types of consolidation dummies: the merger dummy (MERGE$_{it}$), the business

transfer dummy (BT_{it}) and the divestiture dummy ($DIVEST_{it}$). Each dummy variable is defined as one if a bank entered into a consolidation at a time, and zero otherwise.

2-2-7. Summary Statistics

Table 1 reports summary statistics for each variable used for estimation[11]. The growth rate of loan ($\Delta LOAN_{it}^{j}$) has a negative mean in our whole sample period from 1993 to 2011. When splitting the sample period into four subsample ones from 1993 to 1996, from 1997 to 2000, from 2000 to 2005 and from 2006 to 2011, the negative mean of the loan growth rate appear to decrease further from the early 2000s. The nonperforming loan ratios (NPL_{it}) have higher means in the late 1990s and in the early 2000s than in the other period. The means of the insufficiency ratios of capital buffer ($ICAP_{it}$) clearly show a gradually decreasing trend. At least judging from the sample means, bank financial condition improved in the 2000s, while bank lending was not activated in that period. A feature in the indicator of low-quality firm ($FDIST_{t}^{j}$, $ODIST_{t}^{j}$, $ZOMBIE_{t}^{j}$ and $FN\text{-}ZOMBIE_{t}^{j}$) is that their sample means does not have a simple trend, but appear to increase or a decrease in each subsample period.

Figure 1 shows the historical path of each crossed variable, a proxy for an unviable relationship involving a low-quality borrower. The sample mean of the cross variable is calculated by excluding the zero value at each year because the zero value implies that all borrowing firms are not low-quality ones irrespective of bank's financial-health condition; that is, it has a different implication from the case of more than zero.

The crossed variable consisting of the insufficiency ratios of bank's capital buffers and the indicator of financial-distress borrowers ($ICAP_{it} \cdot FDIST_{t}^{j}$) has relatively higher values from the early to the late 1990s, while, since around 2000s, continues to decline, though the number of low-quality borrowers such as the financial- and operational-distress ones did not necessarily decrease. Each crossed variable

Table 1: Summary Statistics

	March 1993－March 2011					1993－1996		1997－2000		2000－2005		2006－2011	
Variable	Mean	S.D.	Min.	Max.	Obs.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
$\Delta LOAN_{it}^{j}$	-3.978	29.912	-99.930	100.000	297719	-1.616	25.870	-2.609	29.017	-6.039	30.335	-5.728	33.363
NPL_{it}	3.243	1.979	0.038	11.188	318052	3.095	1.909	3.959	1.997	4.121	1.863	1.878	1.188
$ICAP_{it}$	96.357	2.418	88.810	100.190	332556	98.598	0.730	97.109	1.886	95.786	1.787	93.771	1.958
$FDIST_{t}^{j}$	0.229	0.420	0	1	327360	0.243	0.429	0.217	0.412	0.270	0.444	0.185	0.388
$ODIST_{t}^{j}$	0.226	0.419	0	1	335654	0.175	0.380	0.217	0.412	0.295	0.456	0.216	0.412
$ZOMBIE_{t}^{j}$	0.521	0.500	0	1	334528	0.829	0.377	0.520	0.500	0.306	0.461	0.427	0.495
$FN\text{-}ZOMBIE_{t}^{j}$	0.286	0.452	0	1	334528	0.658	0.474	0.292	0.455	0.084	0.277	0.112	0.315
$NPL_{it} \cdot FDIST_{t}^{j}$	0.777	1.721	0	11.188	309650	0.752	1.633	0.868	1.905	1.165	2.132	0.361	0.911
$NPL_{it} \cdot ODIST_{t}^{j}$	0.768	1.709	0	11.188	317469	0.568	1.463	0.889	1.929	1.240	2.165	0.420	0.958
$NPL_{it} \cdot ZOMBIE_{t}^{j}$	1.670	2.103	0	11.188	316442	2.564	2.100	1.958	2.317	1.235	2.131	0.818	1.222
$NPL_{it} \cdot FN\text{-}ZOMBIE_{t}^{j}$	0.945	1.799	0	11.188	316442	2.010	2.134	1.074	1.954	0.365	1.320	0.224	0.748
$ICAP_{it} \cdot FDIST_{t}^{j}$	22.021	40.480	0	100.190	323915	23.948	42.280	20.943	39.886	25.861	42.542	17.273	36.277
$ICAP_{it} \cdot ODIST_{t}^{j}$	21.773	40.249	0	100.190	331921	17.293	37.505	21.023	39.938	28.223	43.693	20.179	38.465
$ICAP_{it} \cdot ZOMBIE_{t}^{j}$	50.427	48.473	0	100.190	330798	81.707	37.151	50.624	48.805	29.282	44.142	39.958	46.341
$ICAP_{it} \cdot FN\text{-}ZOMBIE_{t}^{j}$	27.923	44.158	0	100.190	330798	64.902	46.757	28.559	44.489	8.031	26.558	10.441	29.472
$SHARE_{it}$	3.878	3.613	0.013	15.718	335318	2.778	1.956	3.202	2.305	4.109	3.355	5.321	5.266
$MAJOR_{i}$	0.645	0.479	0	1	336274	0.679	0.467	0.680	0.467	0.653	0.476	0.573	0.495
CB_{t}^{j}	0.494	0.500	0	1	336290	0.660	0.474	0.483	0.500	0.426	0.495	0.407	0.491
$NUMBER_{t}^{j}$	13.842	13.080	1	106	336290	19.101	15.916	15.349	13.422	11.439	9.774	9.745	10.254
$MAIN_{t}^{j}$	34.112	15.134	4.637	100	336225	28.415	12.629	32.032	14.025	36.495	15.143	39.027	16.091
$CONSTRUCT^{j}$	0.100	0.300	0	1	336290	0.130	0.336	0.118	0.322	0.091	0.288	0.063	0.243
$TRADE^{j}$	0.176	0.381	0	1	336290	0.145	0.352	0.177	0.381	0.192	0.394	0.191	0.393
$ESTATE^{j}$	0.043	0.204	0	1	336290	0.037	0.189	0.035	0.185	0.041	0.197	0.060	0.238
$SERVICE^{j}$	0.092	0.289	0	1	336290	0.045	0.207	0.079	0.269	0.108	0.310	0.133	0.340
$BORROWEXP_{it}^{j}$	12.640	15.579	0	100	336287	8.584	11.505	10.911	13.779	13.871	16.175	16.933	18.426
$LENDEXP_{it}^{j}$	0.698	2.965	0	100	336287	0.683	3.051	0.587	2.596	0.690	2.796	0.826	3.372
$DURATION_{it}^{j}$	11.653	9.039	1	34	336290	11.905	6.577	11.645	8.463	11.766	9.580	11.385	10.856

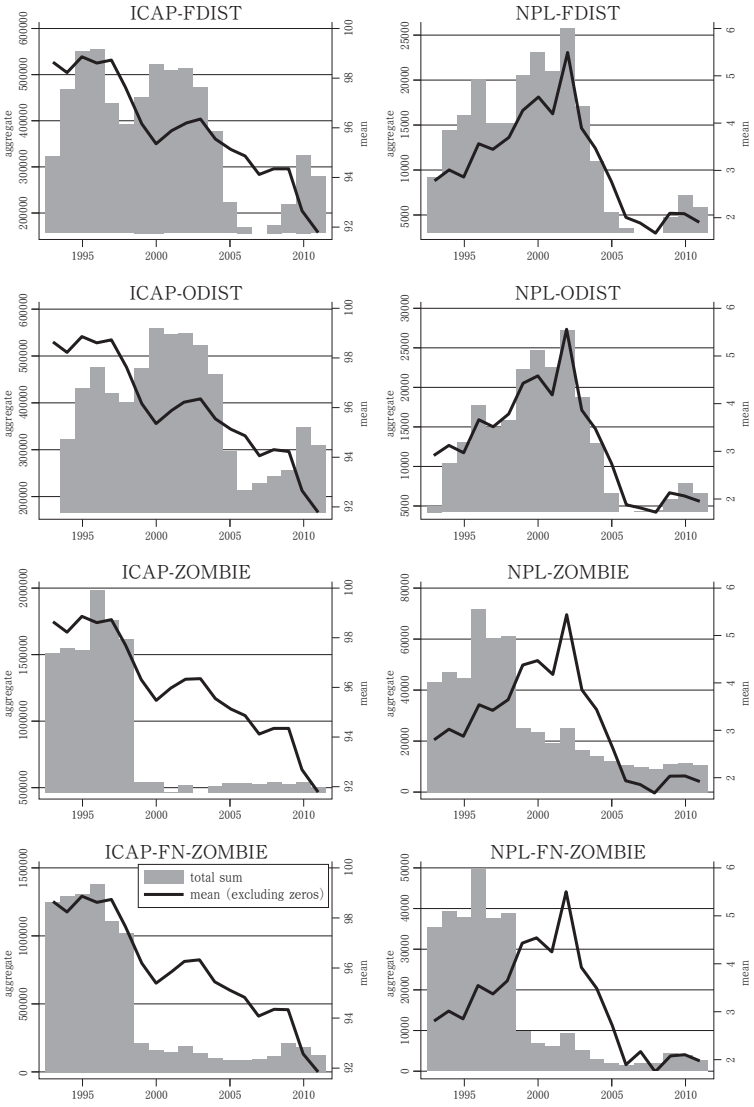

Figure 1: Historical paths of the total sum (measured by the left axes) and the sample mean excluding zeros (measured by the right axes) of the eight crossed variables

consisting of the insufficiency ratios and the other indicators for low-quality borrowers ($ICAP_{it}$・$FDIST_t^j$, $ICAP_{it}$・$ZOMBIE_t^j$ and $ICAP_{it}$・$FN\text{-}ZOMBIE_t^j$) also appears to have the same tendency for our whole sample period. These facts would be mainly attributed to the improvement in bank capital buffers triggered by Japan's prudential policies such as large-scale public capital injections into Japanese large banks in 1998, 1999 and 2003 (see Watanabe (2007) and Hoshi and Kashyap (2010) for the effects of the Japanese bank recapitalization programs on bank capital ratios).

As for the four crossed variables defined with bank's nonperforming loan ratios (NPL_{it}・$FDIST_t^j$, NPL_{it}・$ODIST_t^j$, NPL_{it}・$ZOMBIE_t^j$ and NPL_{it}・$FN\text{-}ZOMBIE_t^j$), their sample means appear to increase continuously from the early 1990s to 2002, and turn to decrease from 2002. This would be because the amount of nonperforming loans in Japanese banks 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).

The above observations show that measuring the inferiority of relationships depends on which variable is used as a proxy for bank financial health, the nonperforming loan ratios or the inefficiency ratios of capital buffers. In the following sections, we use the two types of mixed variables, as expressed in lending equations (1) and (2), and carefully interpret estimated coefficients on them.

3. Estimation Results for Lending Equations

In this section, we report rolling-window estimation results for lending equations (1) and (2), each introduced in the previous section. In the following subsections, we focus on estimation results based on lending equation (1) because those obtained by using the two lending equations did not qualitatively differ. Figures 2 to 5 show estimation results. In these figure, solid lines indicate point estimates, while shaded areas indicate their 90% confidence intervals. A year number in each figure denotes a starting point at which a rolling estimation is conducted with the

window width of three years (for instance, an estimate at 1994 indicates the one obtained using the subsample from March 1994 to March 1996).

3-1. Measures for Bank's Financial Health

As discussed in Subsection 2.1, estimated coefficients on the bank financial distress variables (NPL_{it} and $ICAP_{it}$) allow us to measure how the change in the variables affects bank lending toward non-low-quality borrowers (firms of $FIRM_t^j = 0$). Figure 2 shows estimated coefficients, $\hat{\alpha}$ and $\hat{\beta}$, on the nonperforming loan ratios (NPL_{it}) and the inefficiency ratios of capital buffers ($ICAP_{it}$). Those estimates are obtained by including the indicator of financial-distress borrowers ($FDIST_t^j$) into bank lending equation (1). Estimation results reported below are qualitatively the same as those obtained not only by using bank lending equation (2), but also by including the other indicators of low-quality borrowers.

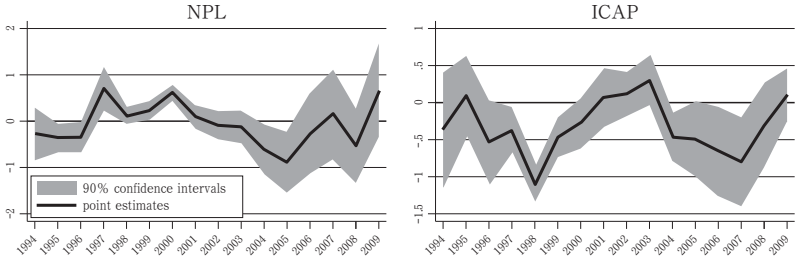

Figure 2: Estimated coefficients $\hat{\alpha}$ and $\hat{\beta}$ on the variables NPL_{it-1} and $ICAP_{it-1}$ respectively from rolling estimation results of equation (1), using $FDIST_t^j$ as the indicator variable $FIRM_t^j$

The nonperforming loan ratios (NPL_{it}) have significantly positive estimates from the late 1990s to the early 2000s (from 1997 to 2001), while having significantly negative ones in the middle 2000s (2004 and 2005). As discussed in Subsection 2.2.5, the nonperforming loan ratios have much higher values from the late 1990 to the early 2000s, but lower ones on and after the early 2000s. Therefore the estimation results imply that, for the period from the late 1990s to the early 2000s,

the increase in the nonperforming loans would result in credit expansion toward non-distressed borrowers of $FDIST^{j}_{i,t-1}=0$, whereas in the middle 2000s, the decrease in them would cause credit expansion toward non-distressed ones.

The insufficiency ratios of bank capital buffers ($ICAP_{it}$) appear to have significantly negative estimates for the periods of the late 1990s (from 1997 to 1999) and the middle 2000s (from 2004 to 2007), indicating that large (small) capital buffers were associated with increases (decreases) in bank loans to non-distressed borrowers; that is, the balance sheet channel of bank lending toward non-distressed ones would be effective in those periods. For other sample periods, the insufficiency ratios appear not to have significant estimates. Taking into account that the insufficiency ratios have relatively smaller values in the late 1990s and the middle 2000s, the negative estimates imply that the increase in capital buffers would lead to credit expansion toward non-distressed borrowers.

Coefficients on the switching indicator ($SWITCH_{it}$) are estimated to be significantly positive in the late 1990s during which Japanese international banks intensively switched to domestic banks with the enforcement of Article 26 of the Banking Act in 1996, thus increasing their capital buffers by 4%. From the positive estimates, we can infer that banks improving capital positions by switching to domestic banks would extend credits toward their borrowing firms.

Summing up the above estimation results, in the late 1990, the development in bank financial distress due to the increase in the nonperforming loans would cause the increase in bank loans to non-distressed borrowers, while the mitigation in it due to the increase in the capital buffers would do that. In the middle 2000s, the mitigation in financial distress due to the decrease in the nonperforming loans and the increase in the capital buffers would induce credit expansion toward non-distressed borrowers.

3-2. Low-quality Borrowers

In this subsection, we report estimation results for the four indicators of low-

quality borrowers: (i) financial-distress firms ($FDIST_i^j$); (ii) operational-distress ones ($ODIST_i^j$); (iii) zombie firms with lower interest payments ($ZOMBIE_i^j$) and (iv) zombie firms with low profitability ($FN\text{-}ZOMBIE_i^j$). Figure 3 shows estimated coefficients on those indicators, each obtained by including each indicator into bank lending equation (1). The estimated coefficients reported in Figure 3 are preliminarily transformed as $100\times\lambda+\delta$ in order to extract pure indicator effects from indicator ones involving the crossed variables, which consists of the indicators of low-quality borrowers.

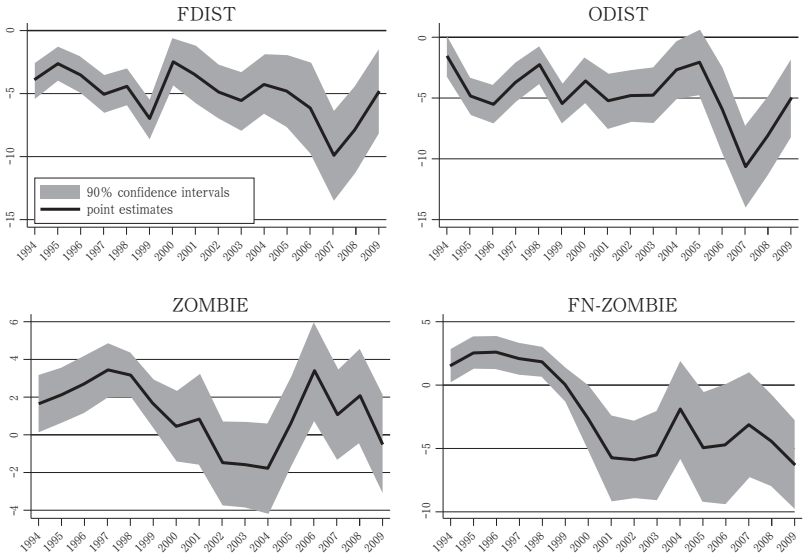

Figure 3: Linear combinations of estimated coefficients $\hat{\delta}+100\hat{\lambda}$ from rolling estimation results of equation (1)

Coefficients on the two indicators for financial- and operational-distress firms ($FDIST_i^j$ and $ODIST_i^j$) are estimated to have significantly negative values for the almost whole sample period from the early 1990s to the end 2000s. This estimation result indicates that financial- and operational-distress firms would face decreases in bank borrowings.

The indicator variable of lower-interest-rate paying zombies ($ZOMBIE_t^j$) appears to have significantly positive estimates from the early 1990s to the early 2000s. This result implies that firms making lower interest payments, identified by the method of Caballero et al. (2008), are more likely to borrow their lending banks, particularly, for the overall period of the 1990s. As for the lowly profitable zombie indicator ($FN\text{-}ZOMBIE_t^j$), its coefficient has significantly positive estimates in the 1990s, but significantly negative ones in the middle 2000s.

The above estimation results for the two zombie indicators are quite consistent with the findings of Fukuda and Nakamura (2011). The positive estimates of both zombie indicators in the 1990s imply that lowly profitable firms would have their interest payment reduced by their lending banks in the 1990s. In contrast, the qualitatively different estimates of the two zombie indicators in the 2000s imply that firms that made lower interest payments could not be lowly profitable ones in the 2000s.

3-3. Unviable Relationships

In this subsection, we report estimation results for the effects of unviable lender-borrower relationships, proxied by the two types of mixed variables ($NPL_{it}\cdot FIRM_t^j$ and $ICAP_{it}\cdot FIRM_t^j$), on bank lending. As discussed in Subsection 2.1, the transformed parameters, $\alpha+\theta$ and $\beta+\lambda$, allow us to measure how bank lending toward low-quality borrowers is affected by the increase (decrease) in the relationship deterioration due to the development (mitigation) in bank financial distress. Figure 4 shows estimated parameters related to the eight mixed variables ($\hat{\alpha}+\hat{\theta}$ and $\hat{\beta}+\hat{\lambda}$), each obtained by including each of the eight mixed variables into bank lending equation (1). Estimation results obtained in bank lending equation (2) did not qualitatively differ from those obtained in equation (1) reported below.

The unviable-relationship variables constructed by multiplying the nonperforming loans by each indicator of borrower's financial and operational distress ($NPL_{it}\cdot FDIST_t^j$ and $NPL_{it}\cdot ODIST_t^j$) have significantly positive parameters

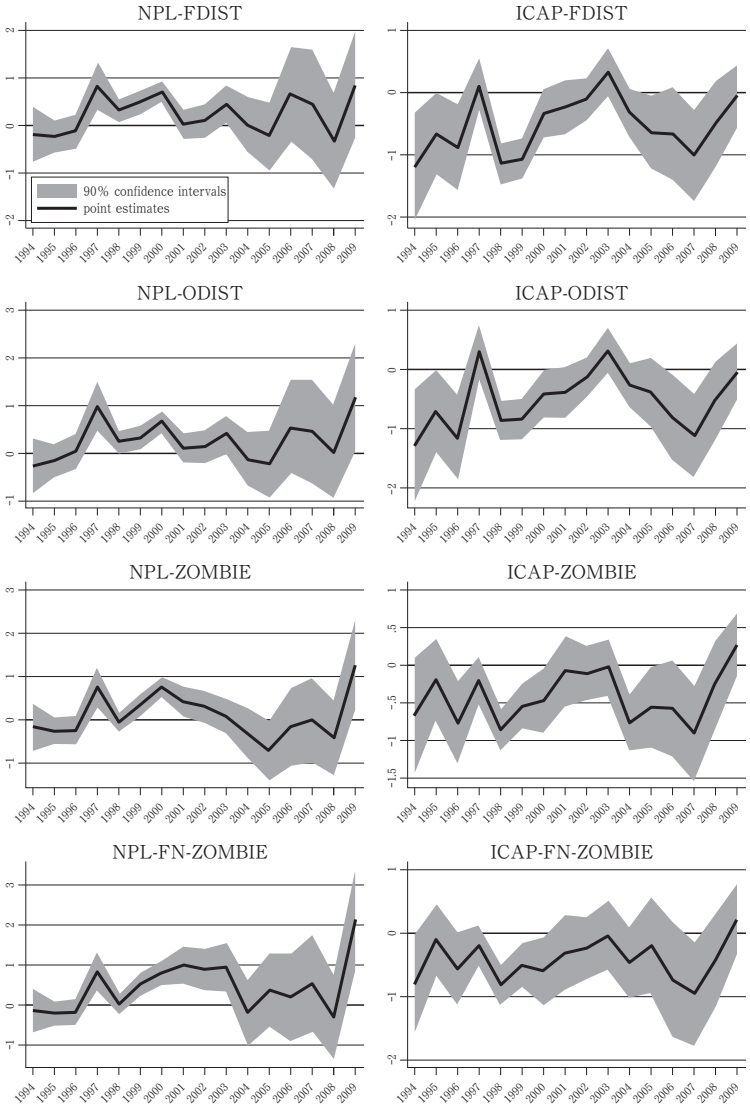

Figure 4: Linear combinations of estimated coefficients $\hat{\alpha}+\hat{\theta}$ (on left panels) and $\hat{\beta}+\hat{\lambda}$ (on right panels) from rolling estimation results of equation (1) for four cases of the indicator variables FIRM^{j}_{t-1}

($\hat{\alpha}+\hat{\theta}>0$) for the period from the late 1990s to the early 2000s (from 1997 to 2000). Given that, in the late 1990, both mixed variables have relatively larger values mainly due to the continuous increase in the nonperforming loans, the positive estimates indicate that banks facing the increase in nonperforming loans would expand credits toward distressed borrowers as well as non-distressed ones (see Subsection 3.1 for estimation results on non-distressed borrowers); in other words, forbearance lending, particularly by unhealthy banks increasing the nonperforming loans, toward distressed borrowers would exist in the late 1990s.

Estimated parameters for the mixed variable consisting of the insufficiency ratios of bank's capital buffers and the indicator of borrower's financial distress ($ICAP_{it}\cdot FDIST_t^j$) appear to have qualitatively the same tendency as those for the mixed one consisting of the insufficiency ratios and the operational distress indicator ($ICAP_{it}\cdot ODIST_t^j$). More concretely, both the mixed variables have significantly negative parameters ($\hat{\beta}+\hat{\lambda}<0$) in the overall 1990s and the middle 2000s.

To explore the implications of the negative estimates, we must recall the movement of the two mixed variables reported in Subsection 2.2.5: the variables still remains at high level before the late 1990s, while they continuously decrease on and after the late 1990s. Such a movement is mainly caused by the movement of bank's capital buffers. Taking into account of the finding, the negative estimates before the late 1990s (from 1993 to 1996) indicate that banks facing the inefficiency of capital buffers would decrease loans toward distressed borrowers as well as non-distressed ones (see Subsection 3.1); that is, the capital crunch would exist before the late 1990s. As for the negative estimates in the late 1990s (1998 and 1999) and the middle 2000s (2006 and 2007), they indicate that banks improving capital positions would expand credits toward distressed borrowers as well as non-distressed ones. From these estimation results, we can infer that forbearance lending by lowly capitalized banks did not exist. Our finding is the rebuttal against that of Peek and Rosengren (2005): they used a sample from 1994 to 1999 and thus claimed that lowly capitalized bank, whose capital buffers were less than 2%, extended credits

toward lowly profitable borrowers[12].

Both the mixed variables consisting of the nonperforming loan ratios and each of the two zombie indicators based on interest payments and based on borrower's profitability (NPL_{it}・$ZOMBIE_t^j$ and NPL_{it}・$FN\text{-}ZOMBIE_t^j$) have positive estimates ($\hat{\alpha}+\hat{\theta}>0$) from the late 1990s to the early 2000s (from 1997 to 2002). As discussed in Subsection 2.2.5, the two mixed variables continuously increases due to the increase in nonperforming loans during that period. Hence the positive estimates imply that, in the period from the late 1990s to the early 2000s, the development in the deterioration of relationships mainly due to the increase in nonperforming loans would induce lending toward zombie firms as well as toward non-zombie ones. Such deterioration effects on lending appear to last slightly longer for the lowly-profitable zombies than does for the lower-interest paying ones.

The mixed variable consisting of the insufficiency ratios of bank's capital buffers and the lower-interest-rate paying zombie indicator ($ICAP_{it}$・$ZOMBIE_t^j$) have significantly negative parameters ($\hat{\beta}+\hat{\lambda}<0$) for the two periods of the late 1990s and the middle 2000s, while the mixed variable constructed from the lowly-profitable zombie indicator ($ICAP_{it}$・$FN\text{-}ZOMBIE_t^j$) have negative parameters only in the late 1990s. Given that, since the late 1990s, both the mixed variables continue to decrease mainly due to the increase in capital buffers, the negative estimates imply that, in the late 1990s and the middle 2000s, the mitigation in the inferiority of relationships due to the improvement in bank's capital positions would lead to credit expansion toward zombie firms as well as non-zombie ones; in other words, whether borrowers are zombies or not, the balance sheet channel would be effective in the late 1990s and the middle 2000s, as in the way that the more active lending emerged.

We can summarize our empirical analysis conducted in this subsection as follows: for the period from the early to the middle 1990s, lowly capitalized banks were more likely to contract credits toward low-quality borrowers as well as non-

low-quality ones; that is, the capital crunch would exist in that period. As for the periods of the late 1990s and the middle 2000s, banks increasing capital buffers were more likely to expand credits toward both quality-types of borrowers. We should note that, in the late 1990s, Japanese banks were facing the continuous increase in the nonperforming loans, while increasing capital buffers. In that period, such Japanese banks would also increase loans not only toward non-low-quality borrowers, but also toward low-quality ones; that is, forbearance lending, particularly by banks facing the increase in the nonperforming loans, toward low-quality borrowers would exist in the late 1990s. The late 1990s would see the coexistence of more active lending toward low-quality borrowers due to the improvement in capital positions and forbearance lending toward them due to the increase in the nonperforming loans.

3-4. Consolidation Effects

We report consolidation effects captured by the three consolidation dummy variables included into $CONSO_{it}$: the merger dummy ($MERGE_{it}$), the business transfer dummy (BT_{it}) and the divestiture dummy variable ($DIVEST_{it}$). The merger dummy variable ($MERGE_{it}$) has significantly positive estimates for the period of the late 1990s, but insignificant estimates for other sample periods. The business transfer dummy (BT_{it}) are estimated to have significantly positive values for the periods of the late 1990s and the early 2000s. The divestiture dummy ($DIVEST_{it}$) have positive estimates for the period from the early to the middle 2000s. From the positive estimates, we can infer that the consolidation of Japanese banks developed from the late 1990s to the early 2000s would help to activate lending to listed borrowers. The estimation results reported here are robust to using lending equations (1) and (2) and to including the indicators of low-quality borrowers.

3-5. Unobservable Fixed Effects

To estimate bank lending equations (1) and (2), we employ the three-way fixed-effect estimation method of Abowd (1999) and Andrews et al. (2008). The advantage of the estimation method can provide consistent estimates of two types of unobservable fixed effects. This subsection reports estimated bank's and borrower's fixed effects: v_i and v^j in equation (1)[13]. Figure 5 plots sample means of estimated fixed effects, each effect obtained by conducting the rolling-window estimation, and the 90% confidence intervals of the sample means. The fixed effects are estimated by including the indicator of financial-distress borrowers (FDIST_t^j) into lending equation (1). Estimation results obtained by including the other indicators of low-quality borrowers are qualitatively the same as those reported in this subsection.

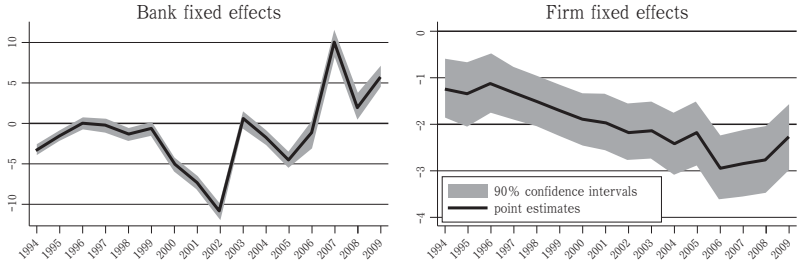

Figure 5: Estimates of bank fixed effects $\hat{v}_i$ and firm fixed effects $\hat{v}^j$ from rolling estimation results of equation (1), using FDIST_t^j as the indicator variable FIRM_t^j

Judging from the magnitude of estimated bank- and firm-fixed effects, both effects are substantive in determining bank lending. More concretely, bank's fixed effects (v_i) are estimated to have significantly negative values for the period from the early 1990s to the middle 2000s (1993 to 2006) except for 2000. As for the period from 2007, however, those effects have significantly positive values. From the estimation results, we can infer that lender-side unobservables, such as bank's managerial ability, would work as a factor in suppressing lending until the middle 2000s, but in increasing it on and after the late 2000s.

In contrast to bank fixed effects, firm fixed effects (v^f) are estimated to have significantly negative values during the whole sample period. Note that the qualitative tendency of borrower-side unobservables, such as firm's potential productivity, has a declining trend from the late 1990s. From the estimated firm fixed effects, borrower-side unobservables would continuously play in reducing bank loans from the late 1990s.

3-5. Bank Lending toward Low-quality Borrowers

In this subsection, we summarize our analysis of bank lending conducted in this section. As reported in Subsection 3.3, the choice of a measure that we focus on as a bank financial health variable decisively matters in the examination of whether and when lending toward low-quality borrowers existed. When focusing on bank capital buffers, we find that forbearance lending by lowly capitalized bank toward low-quality borrowers would not exist. On the contrary, our estimation results suggest that, for the period from the early to the middle 1990s (from 1993 to 1996), banks decreasing capital buffers would decrease loans toward low-quality borrowers as well as non-low-quality ones; that is to say, the capital crunch would exist in that period. Our finding of the capital crunch is consistent with Woo (2003) and Watanabe (2007), both of which demonstrated that the capital crunch would exist in 1997 (see also Bernanke and Lown (1991) and Peek and Rosengren (1995) for U.S researches on capital crunches).

As for the periods of the late 1990s (1998 and 1999) and the middle 2000s (2006 and 2007), banks increasing the capital buffers would expand credits toward low-quality borrowers as well as non-low-quality ones. At least in the overall 1990s and the middle 2000s, the balance sheet channel would be effective as in the way that the increase in the capital buffers would boost bank lending.

When focusing on the nonperforming loans, on the other hand, our results show that the forbearance lending by banks facing the increase in the nonperforming loans toward their low-quality borrowers would exist in the late 1990s and around

2000 (from 1997 to 2002). Note that, in that period, those banks would also expand credits toward non-low-quality borrowers. In the late 1990s (1998 and 1999), two types of lending toward low-quality borrowers would coexist: more active lending due to the improvement in bank capital buffers and forbearance lending due to the increase in the nonperforming loans.

4. Background Mechanisms

In this section, we figure out a background mechanism of estimation results reported in the previous section, and provide an insight on Japan's bank lending. To this end, we reveal the characteristics of covariates included to estimate the lending equations. More precisely, we focus on the numerator and denominator in the regulatory capital adequacy ratios in Subsection 4.1, and detect factors responsible for unviable relationships involving low-quality borrowers in Subsection 4-2. In Subsection 4.3, we provide an insight into Japan's bank lending on the basis of the analysis conducted in this section.

4-1. Capital Buffers and Bank Lending

In this subsection, we give an elaborate explanation of estimation results relating to bank capital buffers: estimated coefficients on $ICAP_{it}$ and $ICAP_{it} \cdot FIRM_i^j$. According to this objective, we pay attention to the regulatory capitals consisting of Tier 1 capitals plus Tier 2 ones (called RCAPs hereafter) and the risk-weighted assets (called RWAs hereafter). The former is the numerator in the regulatory capital adequacy ratio, and the latter is the denominator in it.

Figure 6 shows the historical paths of the capital buffers (the difference between bank's reported capital ratios and its regulatory target capital ratio), the RCAP ratios and the RWA ratios, each ratio defined by dividing the RCAPs and the RWAs by the total assets and expressed in percentage terms.

As shown in this figure, the RCAP ratios decrease drastically from the middle 1990s to the late 1990s, but increase for the period from the late 1990s to the early

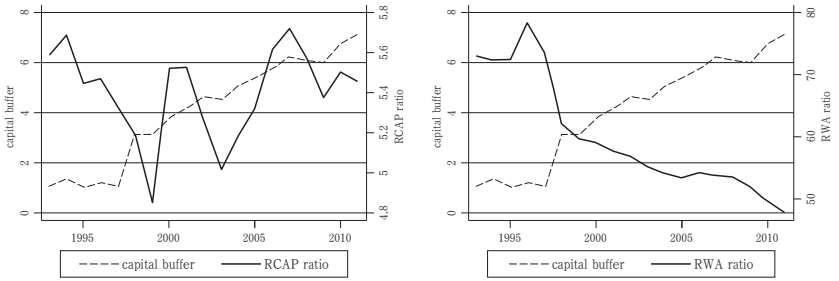

Figure 6: Historical paths of the capital buffer, the RCAP ratio, and the RWA ratio

2000s, in which two large public capital injections were conducted in 1998 and 1999. From 2001 to 2003, the RCAP ratios appear to decrease, but turn to increase after the enforcement of the Financial Revitalization Program in 20002 and the third public capital injection into Resona bank in 2003. After the global financial turmoil in 2007, the RCAP ratios decrease again, but the range of reduction appears to be smaller.

In contrast to the RCAP ratios, the RWA ratios show a continuously decreasing trend from 1996. This observation indicates that Japanese banks have a long-run inclination to increase capital buffers by reducing the RWAs since the late 1990s.

In the previous section, we found that, in the late 1990s and the middle 2000s, a larger amount of capital buffers would induce more lending toward low-quality borrowers as well as non-low-quality ones (see Subsections 3.1 and 3.3). Given that, in the late 1990s and the middle 2000s, the RCAPs and the RWAs were increasing and decreasing as the capital buffers were increasing, the active lending in the two periods would revolve around the increase in the capital buffers, in particular, driven by the concurrent increase and decrease in the numerator and denominator of the regulatory capital adequacy ratios.

As for the capital crunch found in the period from the early to the middle 1990s, its main drivers would be the drastic decrease in the RCAPs.

4-2. Detecting Factors Responsible for Unviable Relationships

In this subsection, we examine what factors determine unviable relationships between financial-distress banks and low-quality borrowers. To this end, we newly introduce the following equation for an unviable relationship[10]:

$$\begin{aligned}\mathrm{UNVIABLE}_{it}^{j} = {} & \mathrm{const} + \alpha(\mathrm{SHARE}_{it-1}) + \beta(\mathrm{MAJOR}_{i}) \\ & + \gamma(\mathrm{CB}_{t-1}^{j}) + \delta(\mathrm{NUMBER}_{t-1}^{j}) + \varphi(\mathrm{MAIN}_{t-1}^{j}) \\ & + \mu(\mathrm{INDUST}^{j}) + \eta(\mathrm{BORROWEXP}_{it-1}^{j}) \\ & + \lambda(\mathrm{LENDEXP}_{it-1}^{j}) + \theta(\mathrm{DURATION}_{it-1}^{j}) + \varepsilon_{it}^{j}, \qquad (3)\end{aligned}$$

where $\mathrm{UNVIABLE}_{it}^{j}$ is the dependent variable measuring the relationship deterioration: a mixed variable consisting of a measure for bank financial health and an indicator for low-quality borrowers, $\mathrm{ICAP}_{it} \cdot \mathrm{FIRM}_{t}^{j}$ or $\mathrm{NPL}_{it} \cdot \mathrm{FIRM}_{t}^{j}$, each defined in Subsection 2.2. Equation (3) specifies how bank financial health affects their inferior relationships with low-quality borrowers, if $\mathrm{UNVIABLE}_{it}^{j} > 0$.

SHARE_{it} denotes bank i's market share, defined as the ratio of bank i's total assets to the sum of all banks' total assets. MAJOR_{i} denotes the dummy indicating bank i's attribute: either the major or the regional bank. The major banks, $\mathrm{MAJOR}_{i}=1$, are defined as the city, the trust and the long-term credit bank, while the non-major banks, $\mathrm{MAJOR}_{i}=0$, as the regional and the second-tier regional bank. The major bank dummy also captures the effect of bank size because the size of the major banks is much larger than that of the non-major ones.

CB_{t}^{j}, NUMBER_{t}^{j} and MAIN_{t}^{j} denote borrower-side debt-funding factors. CB_{t}^{j} indicates the dummy indicating whether firm j issues corporate bonds or not. Corporate bonds include both straight and convertible bonds. NUMBER_{t}^{j} is the number of firm j's relationships with its lending banks. MAIN_{t}^{j} denotes firm j's dependence on borrowings outstanding from the main bank. The main bank is defined as a bank from which firm j borrows the most. INDUST^{j} indicates an industry to which firm j belongs. In our analysis of equation (3), we include four non-manufacturing industry dummies (construction, real estate, trade and services). Thus, the manu-

facturing industry is the excluded industry as a reference industry.

In addition to the lender- and borrower-side factors, we include three relationship factors: $BORROWEXP_{it}^{j}$, $LENDEXP_{it}^{j}$ and $DURATION_{it}^{j}$. $BORROWEXP_{it}^{j}$ denotes firm j's borrowing exposure from bank i, while $LENDEXP_{it}^{j}$ bank i's lending exposure to firm j. The former is calculated as firm j's loan from bank i as a percentage of its total loans from bank i, and the latter is calculated as bank i's loans to firm j as a percentage of its total loans to firm j. $DURATION_{it}^{j}$ is the duration of the relationship between bank i and its borrowing firm j.

In order to estimate equation (3), we employ Heckman two-step estimation method[15]. This is because, as discussed in Section 2, the mixed variable, $UNVIABLE_{it}^{j}$, has two different implications between $UNVIABLE_{it}^{j}>0$ and $UNVIABLE_{it}^{j}=0$; in the former case, higher (lower) values imply that the relationship deterioration increased (decreased), but in the latter, all borrowers are not of low-quality irrespective of bank's financial health. In the two-step estimation, we estimate a selection equation at first, and then estimate equation (3) including the Inverse Mills ratios calculated from the first-stage estimation. The dependent variable in our selection equation is defined as $SELECT_{it}^{j}=1$ if $UNVIABLE_{it}^{j}>0$, and $SELECT_{it}^{j}=0$ if $UNVIABLE_{it}^{j}=0$; thus, the selection equation specifies how inferior relationships with low-quality firms are formed. In Appendix II, we report estimation results for the selection equation.

Table 2 report estimation results obtained by the second-stage estimation of equation (3)[16]. The left panel in this table reports estimated coefficients obtained by including the crossed variable consisting of the nonperforming loans and the financial-distress borrowers ($NPL_{it}\cdot FDIST_{t}^{j}$) as the unviable relationship variable ($UNVIABLE_{it}^{j}$), while the right panel obtained by using the crossed one of the insufficient capital buffer ratios and the financial-distress borrowers ($ICAP_{it}\cdot FDIST_{t}^{j}$). We also estimated equation (3) by including the other indicators of low-quality borrowers (the operational-distress borrowing firms and the zombie borrowing ones), and found that estimation results did not qualitatively differ from

Table 2: Estimation Results for the Unviable Relationship Equation: The Second-Stage Estimation in Heckman two-step estimation method

	$NPL_{it} \cdot FDIST_t^j$			$ICAP_{it} \cdot FDIST_t^j$		
	1993－2011	1993－1999	2000－2011	1993－2011	1993－1999	2000－2011
$SHARE_{it-1}$	0.0921***	0.0317***	−0.0372	−0.175***	−0.187	−0.179***
	(0.00338)	(0.00421)	(0.0307)	(0.00421)	(0.0732)	(0.00737)
$MAJOR_i$	0.907***	1.532***	−0.0939	−0.503***	−0.455	−0.610***
	(0.0265)	(0.0145)	(0.0672)	(0.0332)	(0.0465)	(0.0797)
CB_{t-1}^j	−0.324***	−0.161*	−0.0249	−0.435***	−0.302*	−0.114**
	(0.0981)	(0.009)	(0.0383)	(0.120)	(0.176)	(0.0450)
$NUMBER_{t-1}^j$	−0.0149***	−0.00386**	−0.0312**	−0.0213***	−0.00389	−0.0443***
	(0.00371)	(0.00174)	(0.0133)	(0.00481)	(0.00311)	(0.0151)
$MAIN_{t-1}^j$	−0.00494***	−0.000451	−0.00884**	−0.00760***	−0.00262*	−0.0127***
	(0.00149)	(0.000849)	(0.00395)	(0.00189)	(0.00149)	(0.00451)
$CONSTRUCT^j$	0.826***	0.386**	0.488**	1.063***	0.445	0.604***
	(0.231)	(0.183)	(0.217)	(0.287)	(0.326)	(0.231)
$TRADE^j$	0.151***	0.00432	0.353**	0.143***	−0.00823	0.359**
	(0.0410)	(0.0106)	(0.146)	(0.0525)	(0.0187)	(0.164)
$ESTATE^j$	0.484***	0.109***	1.354**	0.626***	0.0463	1.779***
	(0.119)	(0.0196)	(0.594)	(0.162)	(0.0334)	(0.678)
$SERVICE^j$	0.543***	0.181*	0.817**	0.669***	−0.260	0.937**
	(0.154)	(0.0978)	(0.339)	(0.202)	(0.174)	(0.404)
$BORROWEXP_{it-1}^j$	0.00592***	0.00149**	0.00503**	0.00843***	0.000719***	0.00511**
	(0.00190)	(0.0060)	(0.00240)	(0.00229)	(0.000281)	(0.00260)
$LENDEXP_{it-1}^j$	0.0104**	0.0170**	0.0135***	0.00575	0.0417***	0.00904*
	(0.00489)	(0.00084)	(0.00598)	(0.00646)	(0.0100)	(0.00527)
$DURATION_{it}^j$	−0.0208***	−0.00501	−0.0265**	−0.0296***	0.0101	−0.0354***
	(0.00582)	(0.00414)	(0.0109)	(0.00760)	(0.00729)	(0.0131)
const.	3.630***	1.206**	6.219***	95.18***	94.48***	97.79***
	(0.901)	(0.484)	(2.334)	(1.165)	(0.861)	(2.682)
Mills	−2.448***	−0.626*	−4.063**	−3.192***	1.056*	−4.894**
	(0.716)	(0.361)	(1.757)	(0.922)	(0.640)	(2.017)
Obs.	281980	134214	147766	294234	133711	160523

1. Standard errors are in parentheses.
2. *, ** and *** indicate the 10%, 5% and 1% levels of significance, respectively.

those reported in Table 2. Hence we focus on the estimation results based on the financial-distress borrowers. The table also reports estimation results not only for the full sample period, but also for the two subsample periods of the 1990s (from 1993 to 1999) and the 2000s (from 2000 to 2011)[17]. The inverse Mills' ratio is calculated using the probit estimation method in the first-stage estimation.

4-3. Development in the Inferiority of Relationships

As discussed in the previous subsection, equation (3) specifies how the inferiority of bank's relationships with its low-quality borrowers develops (is mitigated) through the depreciation (improvement) in its financial health. Here we start by reporting estimation results on the unviable relationship variable of the nonperforming loans (NPL_{it}・$FDIST_t^j$), and next show results on that of the insufficient capital ratios ($ICAP_{it}$・$FDIST_t^j$).

As shown in the left panel of Table 2, bank's market share ($SHARE_{it}$) and the major bank dummy ($MAJOR_i$) have significantly positive estimates, particularly, in the 1990s, indicating the major banks with larger market shares were more likely to develop the relationship depreciation through increasing the nonperforming loans and aggravating bank financial distress through that period. On the other hand, from negative, but insignificant, estimates in the 2000s, we can infer that those larger banks would decrease the nonperforming loans, thus striving to alleviate the inferiority of relationships with distressed borrowers.

Estimates on the firm debt-funding variables (CB_t^j, $NUMBER_t^j$ and $MAIN_t^j$) indicate that banks that had relationships with distressed borrowers, in particular, that did not issue corporate bonds, had a smaller number of relationships, and more depended on their main bank were more likely to worsen the quality of relationships through the increase in the nonperforming loans. From this estimation results, it can be inferred that banks that had tendency to lock in low-quality borrowers with limited access to external debt-funding sources other than its particular lending banks were more likely to face the increase in the nonperforming loans; consequently, the quality of its inferior relationships with those low-quality borrowers would result in deteriorating more.

Estimated coefficients on the industry dummy variables ($INDUST^j$ $=CONSTRUCT^j$, $TRADE^j$, $ESTATE^j$ or $SERVICE^j$) indicate that, as compared with low-quality firms belonging to the manufacturing industry, low-quality ones belonging to the non-manufacturing industry (the construction, real estate,

trade and services industries) have more tendency to face the relationship depreciation through the increase in the nonperforming loans of their lending banks. These estimation results are consistent with Caballero et al. (2008), who empirically demonstrated that large Japanese banks engaged in lending to insolvent borrowers belonging to the non-manufacturing industry.

Estimates on the three relationship-level factors ($BORROWEXP_{it}^{j}$, $LENDEXP_{it}^{j}$ and $DURATION_{it}^{j}$) have the following implications: as low-quality firms depended more on a particular bank for financing, the inferiority of their relationships would develop more. This result is consistent with those for the borrower-side debt-funding variables. In addition, as a bank concentrated credits more to a distressed borrower, the depreciation of their relationships would be depreciated through the increase in the nonperforming loans. In contrast to these two relationship factors, the duration of relationships appears to have contributed to suppressing the inferiority of relationships. This may be because a distressed company with which a bank decided to sustain a longer relationship might often have revived later and consequently the bank might have succeeded in suppressing the inferiority of that relationship.

Next we report estimation results for the crossed variable of the insufficient capital ratios and the financial-distress borrowers ($ICAP_{it} \cdot FDIST_{t}^{j}$). As shown in Table 2, estimation results obtained using the crossed variable of the insufficient capital ratios are not so different from those obtained using the crossed one of the nonperforming loans ($NPL_{it} \cdot FDIST_{t}^{j}$), in particular, except results for the bank market share ($SHARE_{it}$) and the major bank dummy ($MAJOR_{i}$). In contrast to the results of the nonperforming loan ratios, those of the insufficient capital ratios has significantly negative estimates on the bank market share ($SHARE_{it}$) and the major bank dummy ($MAJOR_{i}$) for the sample period of the 2000s, but does not for the period of the 1990s. These estimation results would mainly reflect that large banks continuously increased the capital buffers from the late 1990s and consequently, the inferiority of relationships with their low-quality borrowers was

alleviated in the 2000s.

Note that estimated coefficients on the firm debt-funding variables (CB_t^j, $NUMBER_t^j$ and $MAIN_t^j$), the industry dummy variables ($INDUST^j$ $=CONSTRUCT^j$, $TRADE^j$, $ESTATE^j$ or $SERVICE^j$) and the relationship factors ($BORROWEXP_{it}^j$, $LENDEXP_{it}^j$ and $DURATION_{it}^j$) appear to have qualitatively the same tendency as those obtained in the case of the nonperforming loans.

4-4. Formation of Bad Relationships

In this subsection, we report estimation results obtained in the first-stage estimation of the selection equation of unviable relationship equation (3), introduced in Subsection 4.2. As discussed in that subsection, the selection equation, in which the dependent variable is defined as $SELECT_{it}^j=1$ if $UNVIABLE_{it}^j>0$, and $SELECT_{it}^j=0$ if $UNVIABLE_{it}^j=0$, specifies how banks selected to form inferior relationships with low-quality firms. When estimating the selection equation, we use the same covariates included into equation (3)[18]. Table 3 shows estimation results obtained by employing the probit model to estimate the selection equation.

As clearly shown in Tables 2 and 3, estimation results of the selection equation, or the equation for the formation of inferior relationships, appear to have the same qualitative tendency as those of the equation for relationship depreciation (3). This suggests that the formation of inferior relationships and the development in their depreciation would have the same drivers. In addition, the estimation for the mixed variable consisting of the bank nonperforming loans ($NPL_{it}\cdot FDIST_t^j$) and the insufficiency ratios ($ICAP_{it}\cdot FDIST_t^j$) do provide almost the same estimates because the dependent variable of each equation is the same but the number of observations involves a little difference.

Both the bank market share ($SHARE_i$) and the major bank dummy ($MAJOR_i$) appear to have positive estimates in the 1990s, but negative ones in the 2000s. Judging from those significant estimates, we can infer that major banks with larger market shares were more likely to form bad relationships with low-

Table 3: Estimation Results for the Unviable Relationship Equation: The First-Stage Estimation in Heckman two-step estimation method

	$NPL_{it} \cdot FDIST_t^j$			$ICAP_{it} \cdot FDIST_t^j$		
	1993－2011	1993－1999	2000－2011	1993－2011	1993－1999	2000－2011
$SHARE_{it-1}$	0.000534	0.00990***	-0.000922***	-0.000740***	0.00973***	-0.000746***
	(0.00130)	(0.00336)	(0.000249)	(0.000124)***	(0.00333)	(0.000142)
$MAJOR_t$	-0.0266***	0.0122	-0.0337***	-0.0242***	0.0214	-0.0351***
	(0.00877)	(0.0150)	(0.0121)	(0.00861)	(0.0149)	(0.0119)
CB_{t-1}^j	-0.179***	-0.369***	-0.0147*	-0.170***	-0.366***	-0.0157**
	(0.00562)	(0.00829)	(0.00768)	(0.00550)	(0.00831)	(0.00736)
$NUMBER_{t-1}^j$	-0.00673***	-0.00622***	-0.0101***	-0.00678***	-0.00627***	-0.0100***
	(0.000247)	(0.000325)	(0.000414)	(0.000246)	(0.000330)	(0.000402)
$MAIN_{t-1}^j$	-0.00255***	-0.00288***	-0.00286***	-0.00252***	-0.00284***	-0.00285***
	(0.000207)	(0.000344)	(0.000261)	(0.000202)	(0.000346)	(0.000251)
$CONSTRUCT^j$	0.418***	0.646***	0.157***	0.402***	0.651***	0.145***
	(0.00970)	(0.0143)	(0.0135)	(0.00950)	(0.0144)	(0.0130)
$TRADE^j$	0.0671***	0.0106	0.106***	0.0668***	0.0114	0.103***
	(0.00729)	(0.0110)	(0.00981)	(0.00711)	(0.0110)	(0.00939)
$ESTATE^j$	0.207***	0.0228	0.439***	0.220***	0.0133	0.436***
	(0.0143)	(0.0201)	(0.0209)	(0.0140)	(0.0202)	(0.0200)
$SERVICE^j$	0.272***	0.340***	0.245***	0.277***	0.341***	0.254***
	(0.0109)	(0.0200)	(0.0132)	(0.0106)	(0.0200)	(0.0126)
$BORROWEXP_{it-1}^j$	0.00332***	0.00568***	0.00157***	0.00309***	0.00565***	0.00146***
	(0.000213)	(0.000374)	(0.000261)	(0.000206)	(0.000374)	(0.000249)
$LENDEXP_{it-1}^j$	0.00792***	0.0159***	0.000964	0.00785***	0.0215***	0.00136
	(0.000931)	(0.00139)	(0.00131)	(0.00101)	(0.00175)	(0.00131)
$DURATION_{it}^j$	0.0107***	0.0149***	0.00818***	0.0108***	0.0148***	0.00860***
	(0.000314)	(0.000585)	(0.000374)	(0.000306)	(0.000587)	(0.000360)
const.	-0.652***	-0.754***	-0.750***	-0.659***	-0.765***	-0.751***
	(0.0176)	(0.0203)	(0.0198)	(0.0173)	(0.0205)	(0.0193)
Obs.	281980	134214	147766	294234	133711	160523

1. Standard errors are in parentheses.
2. *, ** and *** indicate the 10%, 5% and 1% levels of significance, respectively.

quality borrowers in the late 1990s, while less likely to do that in the 2000s.

Estimates of the firm-funding variables (CB_t^j, $NUMBER_t^j$ and $MAIN_t^j$) imply that firms, particularly that issued corporate bonds, had a larger number of relationships and depended less on the main bank, were less likely to involve relationships as low-quality borrowers. The industry dummies ($INDUST^j = CONSTRUCT^j$, $TRADE^j$, $ESTATE^j$ or $SERVICE^j$) appear to have positive estimates in all cases, indicating that, as compared with manufacturing firms, construction, real

estate, trade and services firms were more likely to establish bad relationships; hence, once they involved bad relationships, the deterioration of the bad relationships would develop due to the increase in bank financial distress, as discussed in Subsection 4.3.

Estimation results for the relationship factors ($BORROWEXP_{it}^{j}$ and $LENDEXP_{it}^{j}$) also appear to be qualitatively the same as those obtained by estimating the equation for relationship depreciation (2) except for estimation results for the duration of relationships ($DURATION_{it}^{j}$). More concretely, firms that depended more on a particular bank for borrowing were more likely to form bad relationships after becoming distressed firms. The results are consistent with those for the number of relationships ($NUMBER_{t}^{j}$). Banks that concentrated credits more on a particular borrower would have tendency to establish bad relationships with distressed firms. Banks and firms that had a longer duration were more likely to form bad relationships.

Summing up our estimation results, a major bank that focused more on a particular relationship in a long period was more likely to establish a bad relationship with a low-quality firm that were more dependent on a particular bank for debt-financing.

4-5. Insight on Japan's Credit Misallocation

In the previous subsections, we explored determinants responsible for bank-borrower unviable relationships. Thus we found that if a major bank committed to unviable relationships with low-quality non-manufacturing firms that depended greatly on that major bank, such unviable relationships would deteriorate more through the increase in its nonperforming loans, in particular, in the 1990s. That is, the further deterioration of unviable relationships in the 1990s would be attributed to close ties between a major bank facing the increase in the nonperforming loans and their low-quality non-manufacturing borrowers. Given that the forbearance lending by unhealthy banks increasing the nonperforming loans toward their low-quality borrowers would exist from the late 1990s to the early 2000s (see Subsec-

tion 3.5), the further cementing of the inferior, albeit close, bank-borrower relationships would induce the forbearance lending more.

As with the analysis of bank lending, it matters decisively in the analysis of unviable relationships which measure for bank financial health we focus on, the nonperforming loans or the insufficient capital buffers. When focusing on the insufficient capital buffers, we found as follows: if a major bank committed to relationships with low-quality non-manufacturing firms that had limited access to external debt-funding source, the quality of the inferior relationships would more depreciate due to the worsening of its capital positions in the 1990s; as for the 2000s, on the other hand, the quality would be alleviated due to the improving of them.

Given that the capital crunch would exist from the early to the middle 1990s (see Subsection 3.5), a promising driver of the capital crunch in that period would be unviable, albeit considerably close, relationships between a lowly-capitalized major bank and its low-quality borrowers. As for the lending by banks increasing the capital buffers toward low-quality borrowers in the late 1990s and the middle 2000s, the closeness of the inferior relationships between a major bank and its low-quality borrowers belonging to non-manufacturing industries would boost that lending through the improvement in the relationship inferiority due to major banks' sufficient capitalization. Note that such capitalization was caused by the concurrent increase and decrease in the numerator and denominator of the regulatory capital adequacy ratios (see Subsection 4.1).

5. Conclusions

In this paper, using a matched sample of Japanese banks and their listed borrowers for the period between 1993 and 2010, we have examined bank lending in terms of how and when a bank-borrower unviable relationship involving a low-quality borrower induced the increase in the supply of credits toward it. We provide four substantive conclusions about this question.

First, Japanese banks contracted credits toward low-quality borrowers as well as

non-low-quality ones from the early to the middle 1990s; that is, the capital crunch would exist in that period. A substantive driver of the stagnant bank lending toward low-quality borrowers would be the drastic decrease in the regulatory capitals, or the numerator, of major banks' capital ratios and the resulting depreciation of the unviable relationships with their low-quality borrowers.

Second, Japanese banks, continuously improving their regulatory capital buffers from the late 1990s, activated the supply of loans toward both type of borrowers in the late 1990s and the middle 2000s. In particular, the lending toward low-quality borrowers were driven by the inferiority alleviation in the unviable relationships between major banks and their low-quality borrowers; that mitigation was rooted in the concurrent increase and decrease in the numerator and denominator, or the regulatory capitals and risk-weighted assets, of their capital adequacy ratios.

Third, the forbearance lending toward low-quality borrowers existed from the late 1990s to the early 2000s, and it was driven by the further depreciation of the unviable relationships between major banks facing the increase in the nonperforming loans and their low-quality borrowers. Given that the second conclusion, the two types of lending toward low-quality borrowers would coexist in the late 1990s: the forbearance lending by major banks facing the increase in their nonperforming loans and the active lending by major ones improving their capital buffers.

Fourth, and most importantly, the quality of the unviable relationship would change according to the strength of the ties between banks and their low-quality borrowers with a limited access to external debt-funding sources. That closeness effect involves major banks more. As the tie between a major bank and its low quality borrower with a limited access to external debt-funding sources becomes stronger in that the major bank locks in the low-quality borrower and the borrower consequently depends more on the major bank, the relationship quality would fluctuated more through the changes in major bank's financial distress[19]. Therefore the further cementing of the inferior, albeit close, bank-borrower relationships would induce or prevent lending more toward low-quality borrowers.

Appendix. Construction of Loan-level Matched Sample

The Japanese banking sector experienced significant M & A, business transfer, and divestiture activity over the late 1990s and early 2000s. To construct our loan-level dataset, we checked whether succeeding banks took over the merged or eliminated bank's credit claims on its borrowing firms before and after the relevant M & A, business transfer, or divestiture. This Appendix explains how we define the termination of a bank-borrower relationship in the case of M & A, business transfer, and divestiture.

The Case of M & A

Here, we consider the case of an absorption-type merger. If a surviving bank took over a merged bank's loan lent to a borrowing firm after the absorption merger, we assume that the pre-M & A relationship between the merging bank and the borrowing firm continues in the post-M & A relationship between the surviving bank and the firm. That is, the pre-M & A relationship did not terminate at the time of the absorption merger. On the other hand, if no bank took over the loan of the merging bank, we assume that the pre-M & A relationship terminated at the time of the absorption merger.

The Case of Business Transfer

Next, we consider the case in which a bank transferred its business to other banks. In this case, we define a relationship termination as the case of M & A. If we find that the transferee bank took over the loans of the transferor bank, we suppose that the transferor bank also held over pre-transfer relationships between the transferor bank and its borrowing firms, and that the pre-transfer relationships did not terminate. As long as we find that the transferee banks did not take over loans of the transferor bank, we assume that the pre-transfer relationships between the transferor bank and its borrowing firms terminated. We adopt the above way of defining a relationship termination, whether the accepting banks had enjoyed

relationships with those borrowing firms before the business transfer or not.

The Case of Merger and Divestiture

We consider the case in which banks merged and then divested. In this case, we should identify which banks formed after the merger and divestiture, and whether they took over the loans of the merging banks. If a firm had enjoyed relationships with one of the merging banks before the merger and divestiture, and the firm had a relationship with at least one of the surviving banks after the merger and divestiture, we consider that the relationships between the merging banks and the firm were preserved. That is, the relationships did not terminate. If the firm did not have any relationships with the surviving banks after the merger and divestiture, we consider that the relationships between the merged banks and the firm terminated at that time.

Notes

(1) In terms of a theoretical framework, Bruche and Llobet (2014) provided a precondition for avoiding forbearance lending to low-quality firms. They suggested that regulators should construct a scheme that would induce banks to disclose the deterioration of capital condition.

(2) See e.g. Hoshi (2001) for Japan's bubble economy and its collapse in the early 1990s.

(3) In contrast to those previous researches, Berger et al. (2014) demonstrated that German capital-injected banks did not activate lending.

(4) Before Article 26 of the banking act was revised in 1996, a Japanese bank was allowed to select the international standard on capital adequacy of 8%, even though it did not have oversea branches. After the revision, a Japanese bank that does not have oversea branches is forced to adopt the domestic standard of 4%. Consequently, the number of banks with the international standard reduced from 82 to 26 during the period from 1996 to 2000. Using the 1996 revision of the banking act, Inoue et al. (2015a) examined the effect of the exogenous increase in bank capitals on its risk taking behavior.

(5) We also ran regression without using lagged variables for lender-side factors, but estimation results are not qualitatively different from those obtained using lagged ones. This would be because banks' lending exposure to borrowing firms are calculated to

about 0.7% on average for our sample period from 1993 to 2011; hence, the dependence of banks on borrowing firms is not so high that we should deal with the reverse causality from bank loans to lender-side factors. In the following analysis, we use the one-period lags of lender-side factors in consistent manner with borrower-side ones.

(6) Inoue et al. (2015b) discussed that estimation results of Peek and Rosengren (2005), which are based on the random effect probit model, would imply that, in the late 1990s (from 1994 to 1999), both capitalized and lowly capitalized Japanese banks would increase credits not only to good borrowers but also to bad ones.

(7) We also conducted rolling-window estimations with the widths of two, four and five years, but estimation results did not qualitatively differ from those reported in Section 3.

(8) The fiscal year-end for Japanese banks is March 31, but this is not necessarily the case for the borrowing firms. When combining the Nikkei database with the financial statement data, we match bank-side information to borrower-side information in the same fiscal year.

(9) 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, we adopt the strategy of dropping a firm's observation from our dataset in year t if the firm exited from the original data after year t. Thus, if a firm's last observation in the original dataset was in t, our adjusted sample includes the firm's observations until year $t-1$.

(10) The minimum interest payments for each year proposed by Caballero et al. (2008) are constructed from the average short-term prime rate as the lower bound of short-term bank-loan prices, the average long-term prime rate as that of long-term bank-loan prices and the minimum observed coupon rate on any convertible corporate bond as that of bond prices. To construct the minimum interest payments, we use the minimum coupon rate on convertible corporate bonds, as suggested by Caballero et al. (2008). The data about the average short-term and long-term prime rate for each year are provided by the Bank of Japan. The data up to 1999 about minimum observed coupon rate on any convertible corporate bond are obtained from the lists of convertible bond issues by listed companies published in Annual Report of Securities Bureau of Ministry of Finance. The data from 2000 are set to be zero, which had been the level since 1996.

(11) We preliminarily excluded three types of extreme values from our samples: the upper five percentile of the growth rates of loans; the upper one percentile of the nonperforming loan ratios and the upper and the lower one percentile of the insuffi-

ciency capital ratios. All the extreme values involve bank consolidations or bankruptcies.

(12) Inoue et al. (2015b) used the crossed variable proposed in Peek and Rosengren (2005), and thereby demonstrated that their estimation results based on the sample period from 1994 to 1999 would imply that both capitalized and lowly capitalized Japanese banks extended credits not only lowly profitable borrowers but also profitable ones.

(13) We also estimate bank and firm fixed effects, v_i and $v^j \cdot time$ in lending equation (2). Estimated bank fixed effects have qualitatively the same tendency as those obtained by estimating equation (1). Estimated firm effects, $v^j \cdot time$, have an increasing trend from the early to the 1990s, and a decreasing one on and after the late 1990s. These results are available upon request.

(14) When estimating equation (3), we also include time dummy variables to control for market-wide effects at each date.

(15) We also employed the two part model and Tobit model to estimate equation (3), but estimation results are not qualitatively different from those reported in this subsection.

(16) We also employed the three-way fixed-effects estimation method, which allows us to include bank and firm fixed effects into equation (3), to conduct the second-stage estimation of Heckman estimation method and the two-part estimation method. Estimation results obtained are not so different from those reported below.

(17) Equation (3) was estimated using various subsample periods for the 1990s and the 2000s. Estimation results in the subsample periods are not so different from those in the 1990s and the 2000s, each reported in Table 2.

(18) We used various subsets of the covariates in equation (3) to estimate the selection equation, but we found that each result obtained in the second-stage estimation did not qualitatively differ.

(19) Bernanke and Gertler (1989), Bernanke et al. (1999) and Brunnermeier and Sannikov (2014) proposed theoretical models in which financial frictions would amplify and propagate adverse shocks, even though the adverse shocks are small.

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