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The Effect of Bank Recapitalization Policy on Credit Allocation and Corporate Investment: Evidence from a Banking Crisis in Japan*

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Abstract

This paper examines the effect of government capital injections into financially distressed banks on credit allocations and firm investment during the Japanese banking crisis. A standard investment theory suggests capital injection increases bank loans to high-productivity firms for promoting investments. In contrast, a theory of credit misallocation by Peek and Rosengren (2005) argues that banks have a perversive incentive to increase their loan supply to severely impaired firms. To assess the relative importance of these two theories, we combine the balance sheet data of Japanese manufacturing firms with that of banks and examine whether the effect of capital injections differs across different types of firms in terms of their total factor productivity (TFP) and zombie statuses. The regression analysis shows that the capital injections increased the supply of credit to two very different types of firms: high-productivity non-zombie firms and low-productivity zombie firms. On the other hand, we find that the supply of credit induced by capital injection only promotes investment by high TFP firms, but not by zombie firms. The result indicates that both mechanisms—one promoting efficient credit allocation via capital injection while the other leads to credit misallocation toward zombie firms—are quantitatively important for explaining the allocation of credits induced by Japanese government capital injections. Our analysis shows that

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capital injection increased the average investment rates of high-productivity firms with the 90th percentile TFP or above by 1.9 percentage points but finds no evidence that capital injection promoted investment by low-productivity zombie firms.

Journal of Economic Literature Classification Numbers: E22; G21; G28
Keywords: Capital injection; Bank regulation; Banking crisis; Total Factor Productivity, Zombie

1 Introduction

During the crisis, under the risk-based capital requirements imposed on banks, Japan experienced a sharp decline in bank loans to firms. As a result, Japanese corporate investments decreased during 1998 and 1999. According to the Short-Term Economic Survey of Enterprises in Japan (TANKAN) conducted by the Bank of Japan, there was a sharp deterioration in "banks' willingness to lend" during the first quarter of 1998 (Figure 1). To cope with this banking crisis, the Japanese government injected JPY 1.8 trillion in March 1998 and JPY 7.5 trillion in March 1999 into the top city, trust, and long-term credit banks and other regional banks. These capital injections helped many banks improve their capital ratios and attain capital requirements. As Figure 2 shows, the distribution of the regulatory capital adequacy ratio, which we call the Basel I capital ratio (BCR), weighted by the loan supply across banks, shifted upward significantly between 1997 and 1999.

One of the primary goals of the capital injection policy in Japan was to increase bank lending to productive firms and promote firm investment by improving bank capital ratios (Montgomery and Shimizutani 2009). Did the capital injection increase the credit supply to productive firms with investment projects without inducing credit misallocation toward "zombie" firms with large outstanding debts? Did the capital injection encourage investments in Japan? If so, did the impact of the capital injection on investment vary between high- and low-productive firms?

Given that over JPY 10 trillion of Japanese taxpayer money (roughly 2% of Japan's nominal gross domestic product) was spent on capital injections into troubled banks, these are important policy questions. A large body of research investigates whether the credit crunch in Japan constrained firm investment (Caballero et al. 2008; Hayashi and Prescott 2002; Hori et al. 2006; Hosono 2006; Ito and Sasaki 2002; Motonishi and Yoshikawa 1999; Peek and Rosengren 2000; Woo 2003) while pointing out the possibility of credit misallocations to "zombie" firms (Peek and Rosengren 2005; Caballero et al. 2008). However, few empirical studies (e.g., Giannetti and Simonov (2013), hereafter GS) quantitatively examine the extent to which the Japanese government capital injections induced a proper credit allocation from low-productivity firms to high-productivity firms and successfully promoted firm investment.

This paper examines the effect of government capital injections into financially troubled banks on credit allocations and firm investment during the Japanese banking crisis of 1997. The key empirical question we study is which types of firms had received bank loans induced by capital injection and, consequently, had increased their investments. A standard theory of capital investment suggests that capital injection increases bank loans to high-productivity firms for financing their positive net present value projects and promotes investments. In contrast, the existing literature emphasizes a theory of credit misallocation (e.g., Peek and Rosengren 2005; Caballero et al. 2008) which argues that banks have perversive incentive to increase their supply of loans to "zombie" firms with financial difficulties and low productivity; in this case, capital injection induces mis-allocation of capital toward firms with financial difficulties, and fails to promote investment.

Empirically assessing the relative importance of two theories is critical for properly evaluating the impact of capital injection on Japanese economies. We examine whether the observed patterns of bank loans and investments across different types of firms are consistent with these two theories by testing the following four hypotheses:

> **Hypothesis 1.** Among non-zombie firms in good financial condition, capital injections into banks increased lending to high-productivity firms more than to low-productivity firms.

> **Hypothesis 2.** Among zombie firms with financial problems, the capital injection to banks increased lending to low-productivity firms more than high-productivity firms.

> **Hypothesis 3.** The capital injection to banks increased investment of high-productivity non-zombie firms.

> **Hypothesis 4.** The capital injection did not lead to increased investment of low-productivity zombie firms even though they received more bank loans through capital injection.

Hypotheses 1 and 3 are consistent with a standard theory that bank loans are used to fund productive investment projects while Hypotheses 2 and 4 are consistent with a theory of credit misallocation by Peek and Rosengren (2005). Testing these hypotheses helps us to assess the extent to which capital injection increased bank loans to high-productivity firms and promoted investments rather than induced the misallocation of credits toward less productive zombie firms who were financially in trouble.

We construct a unique data set to examine these hypotheses, combining Japanese firm-level financial statement data with bank balance sheet data. Using the matched firm–bank data, we first investigate whether capital injections affected the supply of credit from banks to firms and whether this effect depends on a firm's total factor productivity (TFP) and zombie indicator to test Hypotheses 1 and 2. Here, the zombie indicator is constructed based on credit assistance (c.f., Caballero et al. 2008) and captures firm's financial health. To examine Hypotheses 3 and 4, we investigate the effect of the injections on corporate investment by regressing corporate investment on the weighted average of banks' BCR and capital injection while considering their interactions with TFP and zombie variables.

Regression analyses of loan growth on the ratio of the capital injection to equity and on the bank's BCR show that the coefficients of the capital injection and bank BCR are both positive and significant, indicating government capital injections and a higher BCR help banks to increase their supply of loans to firms. Furthermore, by dividing the sample by firm-level TFP and zombie status, we find that capital injection increased the credit supply to two very different firms: the high-productivity non-zombie firms and the low-productivity zombie firms. This finding supports Hypotheses 1 and 2. The latter suggests a possibility of a credit misallocation toward low-productivity zombie firms who use bank loans to finance their outstanding debts for their survival rather than to finance investment projects.

In fact, consistent with a theory of credit misallocation, our estimated investment regression model provides no evidence that capital injection had promoted the investment of zombie firms. Therefore, while receiving more bank loans after capital injections to their banks, low-productivity zombie firms did not increase their investment, presumably because they used loans to repay their outstanding debts or cover their losses. In contrast, the interaction of firm-level TFP with their banks' BCR or capital injection in the estimated investment regressions is positive and significant, showing that capital injections promoted investment of high-productivity firms. These results are largely consistent with Hypotheses 3 and 4.

Overall, our regression results suggest that there were two different credit allocation mechanisms in the Japanese financial crisis. One is the standard theory of the supply of loans to productive firms, and the other is the theory of credit misallocation to zombie firms. Capital injections increased the financing of investment projects by highly productive firms. On the other hand, capital injection partially caused credit misallocation without promoting investment by financially distressed zombie firms.

Evaluating how the average impact of capital injections on bank loans and investment differs across different categories of firms, we find that both mechanisms are quantitatively important and similar in magnitude in explaining the allocation of credits induced by capital injection. Our analysis shows that, if there had been no capital injection in 1999, the average loan growth rates of non-zombie firms with the 75th percentile TFP or above would have been smaller by 4.7 percentage points. The corresponding number for zombie firms with the 25th percentile TFP or below is 5.5 percentage points. We also find that capital injection increased the average investment rates of high-productivity firms with the 90th percentile TFP or above by as much as 1.9 percentage points but the estimated effect of capital injection on the average investment rates of low-productivity firms is negative.

The research most closely related to ours is that of GS, which also examines the effects of bank recapitalization policies on credit supply and firm performance using Japanese matched firm–bank data. They find that bank recapitalization through sufficiently large capital injection increases their credit supply and the firm's investment. This study extends the work of GS as follows.

First, we quantitatively assess the impact of capital injection on credit allocations across firms with different productivities and financial statuses. For this purpose, we examine whether firms' loan and investment responses to their banks' recapitalization depend on both their TFP and zombie status while GS did not examine the role of a firm's productivity. We find the capital injection improved the allocation of credits toward high-productivity firms but, at the same time, it induced credit misallocation toward zombie firms. Second, we use the BCR to assess the effect of capital injections. Despite the well-known problem of banks overstating their net wealth when reporting their capital ratios, it is crucial to examine how the *reported* BCR relates to firm investment decisions in this context because the banking regulations apply directly to the *reported* BCR.

Our study is related to a large body of literature on the negative effect of the sovereign crisis in Europe on bank loans and on firms' activity, based on matched bank–firm data. For example, using loan information data from DealScan, Acharya et al. (2018) find that the loan supply contraction of banks affected by the European sovereign debt crisis negatively affected the investments, employment, and sales of firms with significant business relationships with these banks. Other related studies using matched bank–firm data include those of Pierluigi Balduzzia (2018), De Marco (2019), Hubbard et al. (2002), and Schwert (2018).

Our study also contributes to the empirical literature on the effect of financial constraints on firm investment (e.g., Fazzari et al. (1988); Hoshi et al. (1991); Kaplan and Zingales (1997)). Empirical works on the effects of financial constraints use various observed measures for such constraints, including cash flow, firm size, and years of establishment, to examine their effect on investment. It is often difficult, however, to interpret these empirical results, because such measures of financial constraints can be viewed as endogenous variables and, thus, correlated with the firm's efficiency measure, which also explains investment. For example, a positive estimate of the cash flow coefficient could just reflect its positive correlation with firm efficiency. We examine how the BCR of a firm's bank influences the firm's investment decisions. To the extent that the BCR measure is more exogenous than other measures of financial constraints, our results shed further light on the impact of financial constraints on investment.

The remainder of this paper is organized as follows. Section 2 briefly describes the banking regulations and bank recapitalization policies during the Japanese banking crisis of the late 1990s. Section 3 describes our data sources and reports the descriptive statistics.

Section 4 presents our empirical analysis on the effects of capital injection policies on banks' regulatory capital ratios, the supply of credit, and corporate investment. Section 5 concludes the paper.

2 Banking Regulation and Recapitalization Policies in Japan

In December 1996, recognizing that a large amount of nonperforming loans had accumulated in the financial sector after the collapse of asset prices, the Ministry of Finance published the basic framework of the Prompt Corrective Action.[1] The Prompt Corrective Action was set to take effect in April 1998 and would allow the government to order undercapitalized banks to take remedial actions. As a response, many banks tried to improve their regulatory capital ratios by decreasing risky assets such as corporate loans. Concerned with a credit crunch, the government decided to allow some flexibility for banks in the scheme's implementation.[2] With such changes in place, the government officially introduced the Prompt Corrective Action in April 1998.

The Prompt Corrective Action requires banks to maintain the minimum capital requirement. For banks with international operations, the regulation applies the risk-based capital adequacy ratio specified by the Basel I capital requirements (BCR) as

$$BCR = \frac{\text{Tier I} + \text{Tier II} + \text{Tier III} - \text{Goodwill}}{\text{Risk Weighted Asset}}.$$

Tier I capital consists of equity capital and capital reserves. Tier II capital consists of 45% of unrealized capital gains on equity, 45% of the difference between any revalued land assets and their book value, general loan loss provisions (up to 1.25% of the risk-weighted asset), nonperpetual subordinated debt, and preferred stocks with more than five years to maturity. Tier III capital consists of (short-term) subordinated debt with more than two

[1]See Montgomery and Shimizutani (2009) and Hoshi and Kashyap (2010) for details. Following Basel I, the Japanese government gradually introduced capital requirements for banks. However, there was no explicit penalty for violating these capital requirements until the Prompt Corrective Action took effect in April 1998.

[2]For example, banks were allowed to choose between market and book values for their stocks and real estate holdings. Consequently, they did not have to report unrealized losses on securities in their trading account; they could also include unrealized capital gains in their real estate assets in their capital.

years to maturity. The sum of Tier II and Tier III capital cannot exceed the value of Tier I capital. Risk-weighted assets are the weighted sum of bank assets, with weights determined by the credit risk of each asset class, plus a market risk component.

For banks only with domestic operations, the following risk-based capital ratio is applied:

$$BCR_{domestic} = \frac{\text{Tier I} + \text{Tier II} - \text{Goodwill}}{\text{Risk Weighted Asset}},$$

where the definitions of the capital components and risk-weighted assets are the same as above, except that Tier II capital does not include unrealized capital gains from securities, which can now be subtracted from risk-weighted assets. Furthermore, general loan loss reserves can be counted only up to 0.625% of risk-weighted assets, and risk-weighted assets do not include the market risk component.

Banks with international operations must keep their BCR above 8%, while the minimum capital requirement for domestic banks is 4%. If banks cannot meet these capital requirements, the Prompt Corrective Action enables the government to order these banks to restructure or terminate business.

Before implementing the Prompt Corrective Action, some large banks and brokerage firms (Sanyo Securities, Yamaichi Securities, Hokkaido Takushoku Bank, and Tokuyo City Bank) failed in November 1997. In response to these failures, the Diet passed the Financial Function Stabilization Act, which allowed the government to use JPY 30 trillion of public funds. In March 1998, the Japanese government injected JPY 1.8 trillion into all major (city) banks and several regional banks, where almost all major banks received JPY 100 billion through subordinated debt. In the fall of 1998, the Financial Supervisory Agency conducted an intensive examination of the assets of 19 major banks, concluding that the previous assessment was too optimistic, and the Diet passed the Prompt Recapitalization Act to double the funds to JPY 60 trillion. The Long-Term Credit Bank of Japan (LTCB) and Nippon Credit Bank (NCB) were failed and nationalized in October and December of 1998. To stabilize the banking sector, the government conducted the second capital injection of JPY 7.5 trillion in March 1999, where the amount of capital each bank received varied substantially across banks (c.f., Hoshi and Kashyap 2010, Table 5).

3 Data Source and Variable Definition

We examine the effect of government capital injections on the credit supply and investment, focusing on how the impact of capital injections differs across different types of firms and banks. For this purpose, following Nagahata and Sekine (2005), we combine corporate investment data with bank balance sheet data. The former is taken from the data set compiled by the Development Bank of Japan (DBJ). The data on bank balance sheet information is from Nikkei NEEDS Financial Quest (Nikkei NEEDS) and the "Analysis of Financial Statements of All Banks" by the Japanese Bankers Association (JBA).

The DBJ data set contains detailed information about the financial statements for publicly traded firms in Japanese stock markets. Importantly, it provides data on outstanding loans by financial institutions, which we combine with the Nikkei NEEDS and JBA data.[3] Nikkei NEEDS and the JBA provide data on bank BCRs and nonperforming loans, as well as standard bank balance sheet information. In some years, the BCR data are missing from the Nikkei NEEDS data, and we use BCR data from the JBA in these years.

Our sample focuses on manufacturing firms because machine investment is more active in the manufacturing sector than in other nonfinancial industries. Our main sample period for regressions runs from 1998 to 2000, although we use data from 1995 to 1997 to compute the pre-sample period's loan shares and estimate the production function for the firm's TFP using the DBJ data from 1980 to 2008. Our sample differs from GS's sample because GS includes firms in nonfinancial sectors other than the manufacturing sector, and their sample period runs from 1998 to 2005. Because many bank mergers occurred after 2001, we decided to exclude the sample after 2001. GS's sample includes 71 bank mergers affecting 58 banks.

In a given year, each firm borrows from multiple banks. Panel A of Table 1 and Figure 3 present, respectively, the statistics and a histogram of the number of banks each firm

[3]Fiscal year-end months differ across firms, while all banks end their fiscal year in March in our data set. To reflect the timing of capital injections in March of 1998 and 1999, we match firm balance sheet information in year $t+1$ with bank balance sheet information in year t if the closing month of the firms is January or February, and match firm observations in year t with bank observations in year t otherwise.

borrowed from in 1998, where we exclude government financial institutions and insurance companies from the observations. The number of banks each firm borrows from varies significantly by firms and tends to increase with the firm size. The average loan share of the top bank—the bank from which a firm borrows the most—in the total loans is 33% while that of the top five banks is 75%.

The average number of bank relationships is high at 8.35 because our data set contains only publicly traded large firms.[4] The top five firms that borrow from more than 40 banks are Mitsubishi Electronic, Mazda, Fujitsu, NEC, and Toshiba, all of which are large and produce either electronics products or automobiles, having many plants across different regions. One explanation for this large number of bank relationships is that plants located across distinct areas borrow from different regional banks. Consistent with this explanation, in Panel B of Table 1, the share of regional banks in the number of bank relationships and the share of loans by regional banks increase with the number of bank relationships. Panel C of Table 1 suggests that a significant fraction of regional bank loans to firms with a large number of bank relationships are short-term loans that are rolled over from the past.

Table 2 reports the summary statistics for the variables for the period 1997–2000 used in our regression analysis. Appendix A.1 explains how we construct these variables from the original data. For bank k in year t, we define the variable BCR_{kt} as the difference between the bank's BCR and the required ratio under the banking regulations in Japan (8% for international banks and 4% for domestic banks). A firm-level variable $\overline{\mathrm{BCR}}_{it}$ is defined by the average of BCR_{kt} over the banks from which firm i borrows using the banks' outstanding loans for firm i in the pre-sample period of 1995–1997 as weights. Appendix A.2 describes our benchmark sample for estimating our firm investment model.

Peek and Rosengren (2005) argue that bank health is much better reflected by stock returns than by reported risk-based capital ratios because Japanese banks hid losses on

[4] Ogawa et al. (2007) find that the average number of bank relationships for Japanese small and medium-sized firms is around three. In a survey data set for 1079 large European firms across 20 European countries, Ongena and Smith (2000, Table 1) find that the median numbers of bank relationships in Italy, Portugal, France, Belgium, and Spain are 12, 10, 9, 7, and 7, respectively, while their maximum numbers are 70, 50, 40, 30, and 60, respectively. Hence, conditioning on being large firms, the number of bank relationships in our data set is comparable with those in some selected European countries.

their balance sheets during the 1990s.[5] We use the BCR because we are interested in a specific mechanism: the effect of the BCR reported in banks' financial statements on credit allocation and firms' investments, given the financial constraints imposed by Japanese banking regulations, rather than the effect of bank health in general. In this context, using the *reported* Basel I capital adequacy ratio is justified, to the extent that the banking regulations apply directly to the BCR in banks' financial statements. Furthermore, using the BCR is essential to quantifying the policy effect of the capital injection because we can construct the counterfactual value of the BCR without the capital injection from the detailed bank-level capital injection data in 1998–1999. In contrast, estimating counterfactual stock returns would be difficult.

Figure 4 compares counterfactual distributions of BCR_{kt} without the capital injection in 1998 and 1999 with the actual distributions, weighted by the loan supply, where the counterfactual value of BCR_{kt} is constructed by subtracting the amount of the capital injection from the numerator of the definition of the Basel I capital adequacy ratio, keeping the denominator (i.e, risk-weighted assets) constant. The figure indicates that many banks would have had trouble meeting the capital requirements if there had been no capital injections in 1998 and 1999.

The TFP measure is constructed from the estimated production function using revenue as output variable for the period from 1980 to 2008, following a procedure proposed by Gandhi et al. (2020). As a robustness check, we also use the alternative firm-level TFP measures estimated from using system GMM and the Solow residual. We classify firms as zombie firms if their observed interest payment is smaller than a hypothetical lower bound, using the benchmark crisp measure of Caballero et al. (2008). The appendix explains our construction of the TFP measure and the Zombie variable in detail. Figure 5 presents a histogram of the log of the TFP of zombie and non-zombie firms, where the Kolmogorov–

[5] The LTCB and NCB largely underreported their nonperforming loans and the losses arising from write-offs of such loans for the 1997 fiscal year before they failed in late 1998. For this reason, we exclude firms borrowing mainly from the LTCB or NCB from the benchmark sample. We include a dummy variable that takes the value of one if outstanding loans from the LTCB and NCB (in the pre-sample period) exceeded 10% of the total loans in the investment regressions. To mitigate the well-known reporting bias of the BCR, we perform a robustness check by adopting conservative measures of the BCR that take into account deferred tax assets and defaulted loans.

Smirnov test indicates that the TFP distributions differ between zombie and non-zombie firms; regressing the log of TFP on the Zombie dummy, we find that the average TFP of zombie firms is 4.7 % lower than that of non-zombie firms.

The TFP variable represents the residual from a firm's revenue after controlling for the firm's inputs. Figure 6 shows that firm-level TFP measures averaged over 1989-1990 are highly correlated with those over 1999-2000 across firms with the correlation coefficient of 0.793, suggesting that high TFP firms are firms that are highly productive over ten years. Therefore, a cross-sectional variation of TFP measures reflects persistent shocks, which is likely to represent persistent productivity shocks rather than temporary demand shocks.

The Zombie variable is constructed from a firm's recorded interest payment as discussed in Appendix B to capture the presence of credit assistance and, therefore, is more likely to reflect the firm's financial health status. We examine how the impact of the capital injection and the bank capital ratios on bank loans and firm investment varies across different types of firms regarding productivity and financial health status, respectively, measured by the TFP and Zombie variables.

Table 3 presents the summary statistics for the sub-sample of firms classified by zombie status and quartile ranges of TFP levels, where columns (5) and (8) report t statics for testing the difference between low and high TFP firms and the difference between the zombie and non-zombie firms, respectively. Columns (2)-(5) indicate that high TFP firms are larger in sales and capital stocks, invest more, are less likely to be zombie firms, have more cash, and borrow from a larger number of banks than the low TFP firms. On the other hand, the average characteristics of banks from which firms borrow are statistically similar between low and high TFP firms, suggesting no clear matching patterns between firms and banks. In columns (6)-(8), zombie firms are smaller in size, invest less, less productive, and borrow from a smaller number of banks than non-zombie firms; bank's characteristics are similar between zombie and non-zombie firms, except for the injection amount relative to bank equity in 1998.

4 Empirical Analysis

4.1 Parallel Trend Assumption and Determinants of Capital Injection

Before presenting our regression analysis, we check if treated and untreated banks did not differ in their lending patterns before the capital injections. Because all major banks received almost the same amount in March 1998, we define treatment (control) group by firm-bank pairs in which banks received (did not receive) capital injection in March 1999. Figure 7 plots the average loan growth rates over time for the treatment and control groups. We find that the average loan growth rate moves in parallel between 1995 and 1998, while it moves in opposite directions in 1999 with an increase for the treatment group only. Therefore, the lending patterns before intervention are similar between banks that received the capital injection in March 1999 and those that did not.

We also examine whether the capital injection was related to an increase in firm-side demand. If banks that received more equity are also the same ones whose firms experienced a larger increase in demand, then our regression results may only be capturing a shift in firm-level demand rather than the effect through the supply of bank loans. To examine this issue, we regress the amount of the capital injection on variables that capture firm-side demand factors while controlling for other bank characteristics as:

$$\frac{\text{Injection}_{kt}}{e_{k,t-1}} = \alpha_0 + \overline{\text{TFP}}_{kt-1}\alpha_1 + \overline{\text{Zombie}}_{kt-1}\alpha_2 + \frac{\Delta \ell_{kt-1}}{\ell_{k,t-2}}\alpha_3 + \frac{\Delta_2 \ell_{kt-1}}{\ell_{k,t-3}}\alpha_4 + (Z_{kt}^b)'\gamma + \epsilon_{kt}, \quad (1)$$

where $\text{Injection}_{kt}/e_{kt-1}$ is the sum of Tier 1 and Tier 2 capital injections into bank k in year t, relative to its previous year's equity; $\overline{\text{TFP}}_{kt-1}$ and $\overline{\text{Zombie}}_{kt-1}$ are bank-level variables, defined as the weighted average of firms' log TFP and of the Zombie dummy, respecitively, using the lagged loan shares as weights; $\frac{\Delta \ell_{kt-1}}{\ell_{k,t-2}}$ and $\frac{\Delta_2 \ell_{kt-1}}{\ell_{k,t-3}}$ are the previous year's and the previous two year's loan growth rates for bank k, respectively; and $Z_{kt}^b = (\text{BCR}'_{kt-1}, \text{Domestic}'_{kt-1}, \text{Deposit}_{kt-1}/A'_{kt-1})'$, where BCR_{kt-1} is the difference between the Basel I capital adequacy ratio and the required ratio under the banking regulations at the end of the previous year, Domestic_{kt-1} is a dummy variable taking the value one if bank k operates only in the domestic market in year $t-1$, and $\text{Deposit}_{kt-1}/A_{kt-1}$ is the deposit-to-asset ratio in year $t-1$.[6] We also For the data in 1999, we use an indicator variable for the capital injection, $\mathbb{I}\{\text{Injection}_{kt} > 0\}$, as an outcome variable in place of $\text{Injection}_{kt}/e_{kt-1}$.

Table 4 presents the results. Columns (1), (4), and (7) of Table 4 show that neither $\overline{\text{TFP}}_{kt-1}$ nor $\overline{\text{Zombie}}_{kt-1}$ is significantly correlated with the capital injection in both March of 1998 and March of 1999, suggesting that the demand factors were not relevant to the capital injection. Instead, the results indicate that the banks with lower capital ratios and lower deposit-to-asset ratios received a larger share of the capital injection. This result is consistent with the statement from the Financial Reconstruction Commission (Financial Reconstruction Commission 1999) that the injection amounts in March of 1999 were determined such that the applying banks were able to write off bad loans and unrealized losses from securities. In Columns (2)–(3), (5)–(6), and (7)–(8) of Table 4, the estimated coefficient of the previous year's loan growth rate is negative and nonsignificant. To the extent that a positive trend in lending before the injections captures the trend in the demand factors, the results provide no evidence that a capital injection is related to firm-side demand.

4.2 Bank Loan and Capital Injection

We test Hypotheses 1 and 2 by examining how the capital injection into banks affected the supply of bank loans to different types of firms using a bank-firm matched panel data set for 1995 to 2000.

We first examine how the size of the capital injection to bank k relative to the bank's capital in the previous year is related to the growth rate of the loans firm i receives from

[6] We also consider a specification with an additional variable of the ratio of bad loans to bank equity, where we use the loan to borrowers who had gone bankrupt as our measure of bad loans. The results are not sensitive to the inclusion of this variable.

bank k. To do so, we estimate the following regression, for $t = 1998$, 1999, and 2000:[7]

$$\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}} = \beta_0 + \beta_1 \left(\frac{\text{Injection}_{kt}}{e_{k,t-1}} \times \omega_{ik} \right) + \beta_2 \left(\text{BCR}_{kt-1} \times \omega_{ik} \right) + \beta_3 \omega_{ik} + \left(Z^b_{kt} \times \omega_{ik} \right)' \beta_b + \left(Z^f_{it} \times \omega_{ik} \right)' \beta_f + D^b_k + D^f_i \times D^{\text{year}}_t + D^{\text{year}}_t \times D^{\text{closing month}}_i + u_{ikt}, \tag{2}$$

where $\Delta \ell_{ikt}/\ell_{ik,t-1}$ is the growth rate of loans from bank k to firm i in year t. The main explanatory variables of interest are the ratio of capital injection to equity, $\text{Injection}_{kt}/e_{kt-1}$, and the difference between the Basel I capital adequacy ratio and the required ratio under the banking regulations in year $t-1$, denoted by BCR_{kt-1}. In Equation (2), we include the average share of bank k's loans of the total loans to firm i in the pre-sample years (1995–1997), denoted as ω_{ik}. Here, we use the pre-sample period's weights in our baseline specification to mitigate concerns about the endogenous determination of the bank share of loans. Following GS, we interact ω_{ik} with other explanatory variables.

We include the bank fixed effect and the firm-year fixed effect, denoted by D^b_k and $D^{\text{year}}_t \times D^f_i$, respectively, where the inclusion of firm-year fixed effects controls for the firm-level demand for bank loans, as discussed in Khwaja and Mian (2008). Because the definition of accounting years differs across firms, owing to different closing months, we also include the interaction term between a year dummy, D^{year}_t, and a firm-level dummy for the fiscal year closing month, $D^{\text{closing month}}_i$. In our alternative specification, we include the interaction term between the firm and bank dummies $D^f_i \times D^b_k$ to control for bank-firm-level unobserved heterogeneity arising from endogenous matching.

Our specification also includes bank-level variables $Z^b_{kt} = (\text{Domestic}_{kt-1}, \text{Deposit}_{kt-1}/A_{kt-1})'$ and firm-level variables $Z^f_{it} = (\text{TFP}_{it-1}, \text{Zombie}_{it-1}, \ln \text{K}_{it-1}, \text{Cash}_{it-1}/K_{it-1}, b_{it-1}/\text{Collat.}_{it-1})'$. The variable TFP_{it-1} is the log of the TFP of firm i in year $t-1$, $\ln \text{K}_{it-1}$ is the log of capital stock at the end of year $t-1$, $\text{Cash}_{it-1}/K_{it-1}$ is the ratio of cash holdings to capital stock in year $t-1$, and $b_{it-1}/\text{Collat}_{it-1}$ is the ratio of total debt to the collateral value of land

[7] We run this regression for $t = 1998$, 1999, and 2000, which corresponds to the banks' fiscal years of 1997, 1998, and 1999, because strict enforcement of the capital requirement was anticipated by banks and firms in the fiscal year 1997, and formally started after the introduction of the Prompt Corrective Action in March 1998. Furthermore, we exclude firm-bank pairs with the LTCB or NCB and those with missing values for the variables used in the regressions.

and capital stocks with $\text{Collat}_{it-1} = 0.1573\tilde{\text{K}}_{it-1} + 0.6777\text{Land}_{it-1}$, with $\tilde{\text{K}}_{it-1}$ representing the sum of machinery, instruments and tools, and transportation equipment, Land_{it-1} is land stock, and the weights (0.1573 and 0.6777) are taken from Ogawa and Suzuki (2000).

Table 5 presents the estimation results. We use the sum of Tier 1 and Tier 2 capital injections to compute $\text{Injection}_{kt}/e_{kt-1}$ in columns (1) to (4), but use only Tier 1 capital injections in columns (5) to (8). In columns (4) and (8), we include both the bank fixed effect and the firm-year fixed effect.

Across different specifications in Table 5, the estimated coefficient of $(\text{Injection}_{kt}/e_{kt-1}) \times \omega_{ik}$ is positive and significant, indicating that the banks that received government capital injections increased their supply of loans to firms. Given that the sample average of $(\text{Injection}_{kt}/e_{kt-1}) \times \omega_{ik}$ for $t = 1999$ is 0.047, the estimate of 0.5818 in column (4) implies that, on average, the capital injection increased bank loans by $(0.5818 \times 0.047 =)$ 2.7 percentage points. Furthermore, the coefficient of $\text{BCR}_{kt-1} \times \omega_{ik}$ is positive and significant. Therefore, banks with a high BCR increased their supply of loans to firms by more than banks with a low BCR during the financial crisis of 1998–2000. The coefficient of $\text{Domestic}_{kt-1} \times \omega_{ik}$ is negative and significant, indicating that international banks provide more loans than domestic banks do.

We now examine the heterogeneous effects of the capital injection on bank loans by firm-level TFP and zombie status to test Hypotheses 1 and 2. To do so, we split the sample into non-zombie firms and zombie firms, using our zombie indicator of whether the firm incurs low-interest payments. We further split each sample into high- and low- TFP firms, using the 25/50/75th percentile values of the average TFP over the 1995–1997 period. Table 6 reports the results of estimating (2) for each subsample, where columns (1)–(5) report the result for the non-zombie subsamples, and columns (6)–(10) report the results for zombie subsamples.

Columns (1) and (6) report the results for non-zombie firms and zombie firms, respectively, without splitting the sample by TFP. The estimated coefficients of $\text{Injection}_{kt}/e_{kt-1} \times \omega_{ik}$ are positive in both columns (1) and (6) but smaller in column (6), suggesting a larger impact of the capital injection on bank loans for non-zombie firms than for zombie firms.

Columns (2)–(5) of Table 6 report the results for the subsample of non-zombie firms whose average TFP over 1995–1997 period is above the 75th percentile, above the 50th percentile, below the 50th percentile, and below the 25th percentile, respectively. The estimated coefficient of $\text{Injection}_{kt}/e_{kt-1} \times \omega_{ik}$ is positive and significant for high-TFP firms in columns (2)–(4), but is nonsignificant for low TFP firms in column (5). The coefficients of $BCR_{kt-1} \times \omega_{ik}$ for high-TFP firms in columns (2)–(3) are larger than those for low-TFP firms in columns (4)–(5). Thus, well-capitalized banks tend to give more bank loans to high-TFP non-zombie firms than low-TFP firms. These findings support Hypothesis 1, suggesting that capital injection encourages banks to increase loans to high-productivity firms without any financial difficulties.

Strikingly, the opposite pattern is found for zombie firms, as shown in columns (7)–(10) of Table 6, where the estimated coefficient of $\text{Injection}_{kt}/e_{kt-1} \times \omega_{ik}$ is nonsignificant for high-TFP firms in columns (7)–(8), but is positive and significant for low-TFP firms in columns (9)–(10). The estimated coefficients of $BCR_{kt-1} \times \omega_{ik}$ for high-TFP firms in columns (7)–(8) are also smaller than those for low-TFP firms in columns (9)–(10). In this context, the combination of low TFP and our zombie indicator may have identified a “true” zombie firm, which cannot survive without credit assistance from banks. The results in columns (7)–(10) show that the capital injection partially induced a credit misallocation toward low-TFP firms that were financially troubled, which is consistent with our Hypothesis 2.

Overall, Table 6 supports Hypotheses 1 and 2. The result suggests that capital injection increased the credit supply to two very different firms: the high-productivity non-zombie firms with investment projects and the low-productivity zombie firms with outstanding debts.

We also examine whether the effect of the capital injection depends on bank BCR by including an interaction term between $\text{Injection}_{kt}/e_{kt-1}$ and BCR_{kt-1} as an additional covariate in (2). Table 7 reports the results across different subsamples. In columns (1) and (6), the estimated effect is larger for low-BCR banks than for high-BCR banks, especially for zombie firms; after the capital injection, undercapitalized banks increased their loans to zombie firms more than well-capitalized banks did. These results are largely consistent with that of Giannetti and Simonov (2013, Panel D of Table 3).

Table 8 examines the robustness of the results by constructing alternative measures of capital ratios. In columns (1)–(5), we modify the regulatory bank capital ratio by subtracting deferred tax assets and defaulted loans from bank capital (c.f., Hoshi and Kashyap 2010; Nagahata and Sekine 2005), where columns (1)–(5) of Table 8 correspond to column (1) of Table 5, and columns (2), (4), (7), and (10) of Table 6, respectively. Because data on deferred tax assets and defaulted loans are not available for some banks, columns (6)–(10) uses an alternative bank capital ratio that are computed from publicly available balance sheet information only. Table 8 shows that the estimated coefficients of $(\text{Injection}_{kt}/e_{kt-1}) \times \omega_{ik}$ and $\text{BCR}_{kt-1} \times \omega_{ik}$ are similar to the corresponding estimates in Tables 5–6.

Table 9 provides a falsification test by examining the effect of a "future" injection on bank lending by replacing the capital injection variable at t with the capital injection variable at $t+1$ in the regression. As shown in Table 9, the estimated coefficient of the future capital injection is negative, rather than positive, and is often nonsignificant, indicating that the increase in lending only happens after the injection.

Kasuya and Takeda (2000) examine the main shareholders of 46 regional banks and find that, on average, 2.84 % of regional banks' stocks were held by large city banks between 1974 and 1995. We checked the robustness by excluding the 29 regional banks from our sample whose stock shares were stably held by the same city banks as identified in Table 1 of Kasuya and Takeda (2000). Re-estimating the regression specifications in Tables 5, 6, and 9, we find that the results are robust for excluding those 29 regional banks.

4.3 Machine Investment and Capital Injection

We examine the impact of capital injection on machine investments across different types of firms. Given the minimum capital requirements, financially troubled banks may restrict the supply of loans to increase their regulatory BCR and reduces corporate investment.

Taking into account this dependence of investment on the bank capital ratio, we estimate the following linear investment model using firm-level panel data from 1997 to 1999:

$$\begin{aligned}\frac{I_{m,it}}{K_{m,it-1}} &= \alpha_0 + \alpha_1\overline{\mathrm{BCR}}_{it-1} + \alpha_2\mathrm{TFP}_{it-1}\times\overline{\mathrm{BCR}}_{it-1} + \alpha_3\mathrm{Zombie}_{it-1}\times\overline{\mathrm{BCR}}_{it-1} \\ &\quad + Z'_{it}\alpha_f + D_i^f + D_t^{\mathrm{year}}\times D_i^{\mathrm{closing\ month}} + \epsilon_{it},\end{aligned} \tag{3}$$

where the dependent variable $I_{m,it}/K_{m,it}$ is the ratio of machine investment in year t to machine capital stock in year $t-1$. The variable $\overline{\mathrm{BCR}}_{it-1}$ is the weighted average of the BCR less the required capital ratio in year $t-1$ across the banks from which firm i borrows, where the weights are constructed from the pre-sample loan shares in 1995–1997, computed as $\overline{\mathrm{BCR}}_{it-1} := \sum_k \omega_{ik}\mathrm{BCR}_{kt-1}$.

We include the interactions of $\overline{\mathrm{BCR}}_{it-1}$ with TFP_{it-1} and Zombie_{it-1} and examine how the effect of a bank's BCR depends on a firm's productivity and zombie status, where TFP_{it-1} represents either the log of TFP for firm i in year $t-1$, or a dummy TFP variable that takes the value one if the log of TFP for firm i is larger than the 25th percentile across all firms in year $t-1$. The identifying variation for the interaction term coefficients, α_2 and α_3, comes from both long-run and short-run variations of the lagged TFP and zombie variables, even after controlling for firm fixed effects.

The vector Z_{it} contains $\omega_i^{bankrupt}\times D_{99,00}^{year}$, TFP_{it-1}, Zombie_{it-1}, $\ln \mathrm{K}_{m,it-1}$, $\mathrm{Cash}_{it-1}/K_{it-1}$, $b_{it-1}/\mathrm{Collat.}_{it-1}$, $\overline{\mathrm{Domestic}}_{it-1}$, and $\overline{\mathrm{Deposit}/A}_{it-1}$. Here, $\omega_i^{bankrupt}$ is the pre-sample share of the LTCB and NCB among firm i's total loans, $D_{99,00}^{year}$ is the dummy variable for the period 1999–2000; and $\overline{\mathrm{Domestic}}_{it-1}$ and $\overline{\mathrm{Deposit}/A}_{it-1}$ are the weighted averages of domestic bank's dummy variables and deposit-to-asset ratios in year $t-1$, computed as $\overline{\mathrm{Domestic}}_{it-1} := \sum_k \omega_{ik}\mathrm{Domestic}_{kt-1}$ and $\overline{\mathrm{Deposit}/A}_{it-1} := \sum_k \omega_{ik}\mathrm{Deposit}_{kt-1}/A_{kt-1}$, respectively. We also include firm fixed effects and an interaction term between a year dummy and a firm-level dummy for the fiscal year closing months.

Columns (1)–(2) and (5)-(6) of Table 10 present the estimates of equation (3) using the log of TFP and dummy TFP variables. Across all specifications, the positive and significant interaction term between $\overline{\mathrm{BCR}}_{it-1}$ and TFP implies that improvements in the bank capital ratios induced larger investments in firms with higher productivity. Conditioning on capital stock levels, we find that an increase in productivity is associated with higher demand for capital investment but that firms can invest only if banks are healthy and willing to supply loans. In contrast, in columns (2) and (4), the interaction term between $\overline{\text{BCR}}_{it-1}$ and Zombie is not significant, suggesting that improvements in bank capital ratios do not affect investment decisions differently between zombie firms and non-zombie firms. To the extent that the impact of capital injection on investment is realized through its effect on bank's BCR, these results are largely consistent with Hypotheses 3 and 4.

We also examine the effect of capital injections on investments by estimating:

$$\frac{I_{m,it}}{K_{m,it-1}} = \alpha_0 + \alpha_1 \overline{\left(\frac{\text{Injection}}{e}\right)}_{it-1} + \alpha_2 \text{TFP}_{it-1} \times \overline{\left(\frac{\text{Injection}}{e}\right)}_{it-1} + \alpha_3 \text{Zombie}_{it-1} \times \overline{\left(\frac{\text{Injection}}{e}\right)}_{it-1} + Z'_{it}\alpha_f + D_i^f + D_t^{\text{year}} \times D_i^{\text{closing month}} + \epsilon_{it}, \tag{4}$$

where $\overline{(\text{Injection}/e)}_{it} := \sum_k \omega_{ik}(\text{Injection}_{kt}/e_{it-1})$ is the weighted average of the ratio of the sum of Tier 1 and Tier 2 capital injections in year t to bank k's equity in year $t-1$, across all banks from which firm i borrows, using weights constructed from pre-sample year loan shares. As shown in columns (3)-(4) of Table 10, the interaction of $\overline{(\text{Injection}/e)}_{it}$ with TFP is positive and significant, indicating that the effect of capital injections into associated banks on firm investment is larger for firms with higher productivity. This suggests that banks that received capital injections improved their capital ratios and became more willing to lend, which led to an increase in investments by firms with high-productivity growth and improved credit allocation. On the other hand, in column (3), the interaction term between $\overline{(\text{Injection}/e)}_{it}$ and Zombie is negative and insignificant, providing no evidence that the capital injection have positive impacts on investment among zombie firms.

Columns (5)–(8) of Table 10 report the results when we use a dummy variable for TFP as our TFP measure. The results are similar to those in columns (1)–(4). The coefficients of $\text{TFP}_{it-1} \times \overline{(\text{Injection}/e)}_{it-1}$ in columns (7)–(8) are estimated at 0.045. Given that the average value of $\overline{(\text{Injection}/e)}_{it}$ for $t = 1999$ is 0.488, this estimate implies that, on average, the capital injection in March 1999 increased investment rates in 2000 by $(0.045 \times 0.488 =)$ 2.2 percentage points among high-TFP firms, relative to low-TFP firms, which is substantial.

The effect of a capital injection on investment may depend on whether the banks receiving the money are under-capitalized. To examine this issue, we construct separate capital injection variables for high and low bank capital ratios as

$$\begin{aligned}\overline{(\text{Injection}/e)}_{it-1}^{\text{High-BCR}} &:= \sum_k \omega_{ik}(\text{Injection}_{kt}/e_{it-1})\mathbb{I}\{BCR_{k,t-1} \geq 1\} \quad \text{and} \\ \overline{(\text{Injection}/e)}_{it-1}^{\text{Low-BCR}} &:= \sum_k \omega_{ik}(\text{Injection}_{kt}/e_{it-1})\mathbb{I}\{BCR_{k,t-1} < 1\}\end{aligned} \tag{5}$$

so that bank capital ratios are classified as high when the difference between the BCR and the required ratio is larger than 1 %.

Table 11 presents the results of estimating the investment regression (4), using $\overline{(\text{Injection}/e)}_{it-1}^{\text{High-BCR}}$ and $\overline{(\text{Injection}/e)}_{it-1}^{\text{Low-BCR}}$ in place of $\overline{(\text{Injection}/e)}_{it}$ for the whole sample as well as the subsample of zombie or non-zombie firms. In columns (1)-(6) of Table 11, the estimated coefficient of an interaction of TFP variables with $\overline{(\text{Injection}/e)}_{it-1}^{\text{Low-BCR}}$ is positive and larger than that with $\overline{(\text{Injection}/e)}_{it-1}^{\text{High-BCR}}$ (albeit less precisely estimated), providing evidence that the effect of capital injection to under-capitalized banks on investment of high-TFP firms is larger than that to well-capitalized banks.

On the other hand, in columns (1) and (4) of Table 11, we continue to find that the effect of a capital injection on investment does not depend on a firm's zombie status, regardless of the bank capital ratios.[8] In columns (3) and (6), the estimated coefficients of $\overline{(\text{Injection}/e)}_{it-1}^{\text{Low-BCR}}$ and $\overline{(\text{Injection}/e)}_{it-1}^{\text{High-BCR}}$ are either insignificant or negatively significant, suggesting that capital injection did not promote investment by zombie firms.

Table 12 shows that the results are robust with alternative bank capital ratios and firm-level TFP measures. In columns (1) and (2), we examine the effects of the alternative

[8] Giannetti and Simonov (2013, Panel C of Table 5) finds that the effect of undercapitalized bank's injection exposure on investment in zombie firms is larger than that in non-zombie firms, on which we do not find any supportive evidence in Table 11. This difference may be due to the difference in sample selection. Because of our concern on bank mergers and our focus on investment, our data set only contains the sample of manufacturing firms before 2000 while the sample of Giannetti and Simonov contains other non-financial sectors from 1998 to 2005. The zombie finance may be more important in non-manufacturing sectors than the manufacturing sector. Also, a shorter length, as well as a smaller sample size, of our panel data with firm fixed effects makes it difficult to detect the differential impact of zombie status.

bank capital ratios, adjusted for deferred tax assets and defaulted loans, as in Table 8. Although the coefficient of $\text{TFP}_{it-1} \times \overline{\text{BCR}}_{it-1}$ becomes slightly smaller and statistically nonsignificant in column (1), the effect of the interaction term is larger and statistically significant in column (2). Columns (3)–(6) indicate that the empirical patterns found in Table 10 are robust with alternative firm-level TFP measures, constructed using system GMM and Solow residual. We also checked the robustness using the marginal product of capital (MPK) and find that the capital injection improved the credit allocation by inducing more investment in high-MPK firms than in low-MPK firms, of which result is available upon request.

These results are consistent with both Hypotheses 3 and 4 and provide evidence that the credit supply induced by capital injection promoted investment by high TFP firms but not by zombie firms.

4.4 Quantitative Evaluation of the Effect of Capital Injection on Credit Allocation and Investment

Finally, we quantitatively evaluate how the average impact of capital injections on bank loans and investment differs across different categories of firms in their TFP levels and zombie statuses.

Table 13 reports how much the average loan growth rates would have been reduced if there had been no capital injection in 1998 and 1999 across different categories of firms in terms of their TFP levels and zombie status using the estimates reported in the corresponding columns of Table 6. Here, the effect of capital injections on each firm-bank pair's loan growth is computed as: $\widehat{\left(\frac{\Delta \ell_{ikt}}{\ell_{ikt-1}}\right)}^{CF} - \widehat{\left(\frac{\Delta \ell_{ikt}}{\ell_{ikt-1}}\right)} = -\hat{\beta}_1 \left(\frac{\text{Injection}_{kt}}{e_{k,t-1}} \times \omega_{ik}\right)$, where $\widehat{\left(\frac{\Delta \ell_{ikt}}{\ell_{ikt-1}}\right)}^{CF}$ and $\widehat{\left(\frac{\Delta \ell_{ikt}}{\ell_{ikt-1}}\right)}$ are the predicted loan growth on counterfactual and actual data, respectively. In columns (2) and (10), the mean impacts of 1999 capital injection on loan growth rates are substantial for two types of firms: high TFP non-zombie firms and low TFP zombie firms. Specifically, had there been no capital injection in 1999, the average loan growth rates of high productive non-zombie firms with TFP>P75 would have been smaller by 4.7

percentage points. The corresponding number would have been 5.5 percentage points for low productive zombie firms with TFP<P25. The former is consistent with Hypothesis 1, while the latter supports Hypothesis 2.

The first panel of Table 14 reports the average impact of capital injection on the investment rates for the subsamples classified by percentiles of the log of TFP in year $t-1$, where we evaluate the counterfactual investment rates without capital injection by evaluating the estimated investment model in column (2) of Table 10 at the counterfactual BCR values without capital injection as reported in Figure 4(a). For high-productivity firms with the 90th percentile TFP or above, the investment rates would have been 0.4% lower in 1998 and 1.9% lower in 1999 without capital injections. For low-productivity firms with the 50th percentile TFP or below, the investment rates would have been *higher* without capital injection. The result indicates that capital injection substantially increased the high TFP firm's investment while lowering the low TFP firm's investment. The results are quantitatively similar when we consider alternative measures of the bank capital ratios in the panels labeled in and *Adjusted BCR 2* in Table 14, use the regression-based counterfactual BCR in Table A2, and use the alternative estimate of column (3) of Table (10) in Table A3.

Combined with our finding in Table 13, these results imply the co-existence of two different credit allocation mechanisms, a standard theory of supplying loans to productive firms and a theory of credit misallocation to zombie firms, in the Japanese capital injection policy. On the one hand, capital injection led to investment-promoting credit allocation toward high-productivity firms. On the other hand, capital injection partially resulted in credit misallocation toward low productive zombie firms to finance their outstanding debts without investment. Our analysis indicates that both mechanisms are quantitatively important and similar in magnitude in explaining the allocation of credits induced by capital injection.

5 Conclusion

In this study, we examine the effect of government capital injections into financially troubled banks on credit allocations and the level of corporate investment during the Japanese banking crisis of the late 1990s. Using the matched firm–bank data, we estimate the effects of the capital injections and bank regulatory capital ratios on the loan growth and investment.

By splitting the sample by firm-level TFP and zombie status, our regression analysis finds that the positive effect of capital injections on the credit supply is considerable for the high-productivity non-zombie firms and the low-productivity zombie firm. Those recapitalization policies promoted the investment of high-productivity firms by as much as 1.9 percentage points, but they did not increase the investment by low productive zombie firms despite the evidence that zombie firms received more bank loans. Therefore, the capital injection encouraged a credit allocation to high TFP firms to finance their investment but simultaneously led to a credit misallocation by increasing the loan supply to the zombie firms who use bank loans to survive rather than finance investment projects. We find that both mechanisms are quantitatively important.

Note that the objective of this study is limited, and does not examine the effect of capital injections in general. This is an important limitation, because capital injections are likely to have had important impacts on the Japanese economy through other mechanisms, such as writing off of nonperforming loans and stabilizing the financial system.

Appendix A: Development Bank of Japan Data

The data set compiled by the Development Bank of Japan (DBJ) contains detailed corporate balance sheet/ income statement data for firms listed on the stock markets in Japan. In our analysis, we deflate all nominal variables by the monthly Corporate Goods Price Index (CGPI) for all goods. If firms change their closing dates, the data after the change may refer to fewer than 12 months. When this occurs, we multiply the data x_{it} by $12/m$, where

m represents the number of months to which the data refer. The rest of this section explains how we construct variables from the original data.

A.1 Variable Construction

Capital Stock (other than Land)

The DBJ data set provides a breakdown of capital stock data between six capital goods: (1) nonresidential buildings; (2) structures; (3) machinery; (4) transportation equipments; (5) instruments and tools; (6) land. This section explains a perpetual inventory method to construct real stock data for each capital good, except for land.[9] First, we construct a series of nominal investments in each capital good. Let $(pI)_{it}$ denote firm i's nominal investment in period t. Let K_{it}^{book} denote the book value of the stock of a given capital good at the *end* of period t. Let δK_{it}^{book} denote a depreciated value. Then, we compute $(pI)_{it}$ by the following formula: $(pI)_{it} = K_{it}^{book} - K_{it-1}^{book} + \delta K_{it-1}^{book}$.

Second, we deflate the nominal investment data by the CGPI corresponding to each capital good. Denote the real investment by I_{it}. Third, we construct data on real capital stock by the perpetual inventory method. Let K_{it} denote firm i's real capital stock in period t. Then we compute $\{K_{it}\}_t$ by $K_{it+} = (1-\delta)K_{it} + I_{it}$, where the depreciation rate, δ, is taken from Hayashi and Inoue (1991). The initial base year is 1969. For firms entering the sample after 1969, we set the base year to their first year in the sample. We assume that the book value is equal to the market value for the base year and deflate the book value by the corresponding CGPI. If the stock value becomes negative in the perpetual inventory method, we reset the stock value to the book value for the year. We multiply real capital stock by the corresponding CGPI series to obtain data on capital stock in current yen. In our analysis, we define machine capital by the sum of machinery and transportation equipment.

Land

Setting the land depreciation rate to zero and using the last in, first out method to

[9] See Hayashi and Inoue (1991) for more details.

evaluate inventory, we construct nominal investment as follows:

$$(pI)_{it} = \begin{cases} K_{it}^{book} - K_{it-1}^{book} & \text{if} \quad K_{it}^{book} \geq K_{it-1}^{book} \\ (K_{it}^{book} - K_{it-1}^{book})(p_t^{land}/p_s^{land}) & \text{if} \quad K_{it}^{book} < K_{it-1}^{book}, \end{cases}$$

where p_s^{land} is the price of land at which land was last bought (Hoshi and Kashyap (1990); Hayashi and Inoue (1991)).

With the nominal investment series and the depreciation rate, which is set to zero, we construct data on the nominal stock of land through the perpetual inventory method, $(pK)_{it} = (p_t/p_{t-1})(pK)_{it-1} + (pI)_{it}$, where $(pK)_{it}$ represents the value of firm i's land stock in current yen in period t, $(pI)_{it}$ is the value of land investment in current yen, and p_t is the price of land in period t. For the base year, we use a book-to-market ratio to convert the book value of land stocks into their market value. For the book-to-market ratio, following Hayashi and Inoue (1991), we use an estimate of the market value of land owned by non-financial corporations from the National Income Accounts and the book value from Corporate Statistics Annual.

Net Debt

For debt, we use the sum of short- and long-term borrowing and corporate bonds. Net debt is then computed by subtracting the amount of deposits from the debt.

Output

The nominal output for period t is total sales plus changes in the inventories of finished goods. We deflate nominal output by detailed CGPI corresponding to each industry.

A.2 Sample Selection for Investment Model

Table A1 describes our benchmark sample for estimating our firm investment model. We first exclude those observations that have missing investment rates or Basel I capital adequacy ratios. We then exclude observations with the ratio of machine investment to machine capital stock greater than 2 or less than -2 as well as observations of firms that owe more than 20% of their total outstanding long-term loans to banks that are missing BCR data from Nikkei NEEDS during 1997–2000. We furtherexclude observations of firms that borrowed mainly from the LTCB, NCB, insurance companies, and government financial institutions, because the LTCB and NCB were nationalized in 1998, and insurance companies and government financial institutions are not governed by bank regulations. Finally, we exclude observations with missing values for the explanatory variables. The final sample contains 2552 observations.

Appendix B Construction of Zombie Variable

Caballero, Hoshi, and Kashyap (2008), henceforth CHK, classify firms as zombies in the following three steps: 1. Calculate a hypothetical lower bound for interest payments, R^*, that would apply for the highest quality borrowers only; 2. Compare the observed interest payments, R, with the hypothetical lower bound. Specifially, calculate the distance x by $x = (R - R^*)/B$ where B represents the firm's total borrowing at the beginning of the period; 3. Infer whether credit assistance is present from the distance x. If a firm is considered to be receiving credit assistance, then classify the firm as a zombie.

CHK define the hypothetical lower bound for firm i's interest payments in period t, R^*_{it}, by

$$R^*_{it} = rs_{t-1}BS_{it-1} + \Big(\frac{1}{5}\sum_{j=1}^{5} rl_{t-j}\Big)BL_{it-1} + rcb_{\text{min over last 5 years},t}Bonds_{it-1},$$

where BS_{it-1}, BL_{it-1}, and $Bonds_{it-1}$ represent short-term bank loans for firm i in the end of period $t-1$, long-term bank loans for firm i in the end of period $t-1$, and bonds and CBs outstanding for firm i in the end of period $t-1$; and rs_{t-1}, rl_{t-1}, and $rcb_{\text{min over last 5 years},t}$ represent the average short-term prime rate in $t-1$, the average long-run prime rate in $t-1$, and the minimum observed coupon rate on any convertible corporate bond issued in the last five years before t.

CHK normalize the difference between R_{it} and R^*_{it} by the amount of total borrowings at the end of period $t-1$, denoted by B_{it-1}, which is defined by

$$B_{it-1} = BS_{it-1} + BL_{it-1} + Bonds_{it-1} + CP_{it-1},$$

where CP_{it-1} represents the amount of commercial paper outstanding for firm i at the end of period $t-1$. The normalized distance, denoted x_{it}, is defined by

$$x_{it} = \frac{R_{it} - R^*_{it-1}}{B_{it-1}}.$$

To classify firms, CHK use the following indicator function: with $d_1 \leq 0 \leq d_2$,

$$z(x, d_1, d_2) = \begin{cases} 1 & \text{if } x < d_1 \\ \frac{d_2 - x}{d_2 - d_1} & \text{if } d_1 \leq x \leq d_2 \\ 0 & \text{if } x > d_2 \end{cases}$$

Following CHK, we classify a firm in each year as a zombie if $z(x, d_1, d_2) = 1$ (or $x < 0$).

To construct our zombie variables, we closely follow the instruction given by CHK in "DataConstruction.pdf" under https://www.aeaweb.org/aer/data/dec08/20060307_data.zip, including the detailed data sources for various interest rates.

Appendix C: Estimation of Production Function

C.1 Gandhi et al. (2020, GNR)

This section briefly explains the estimation procedure proposed by GNR . Please see Gandhi et al. (2020) for details. Consider

$$Y_{it} \quad = \quad \exp(\epsilon_{it} + \omega_{it}) F_t(L_{it}, K_{it}, M_{it}) \quad \text{with} \quad \omega_{it} = \rho_{0t} + \rho_1 \omega_{it-1} + \eta_{it}, \tag{6}$$

where Y_{it} is realized revenue, L_{it} is labor input, K_{it} is capital stock, M_{it} is intermediate input, ϵ_{it} is an unexpected idiosyncratic shock that is unknown when the input choice M_{it} is made in period t, and η_{it} is an innovation to ω_{it} that is unknown in period $t-1$ but known when the input choice M_{it} is made in period t. The shocks ϵ_{it} and η_{it} are independent and identically distributed, with mean zero and standard deviations σ_ϵ and σ_η, respectively. In what follows, we denote the logarithmic values of $(Y_{it}, L_{it}, K_{it}, M_{it}, F_t)$ by $(y_{it}, \ell_{it}, k_{it}, m_{it}, f_t)$.

We assume that M_{it} is a flexible input. As GNR discuss, the identification problem arises because m_{it} is a deterministic function of $(\omega_{it}, k_{it}, \ell_{it})$ and there is no cross-sectional variation that will allow us to identify the coefficient of m_{it} once $(\omega_{it}, k_{it}, \ell_{it})$ is conditioned on. To deal with the identification problem, we use the estimator proposed by GNR that exploits the first-order condition for profit maximization problem with respect to M_{it}: $\max_M E_\epsilon[\exp(\omega_{it} + \epsilon))]F_t(L_{it}, K_{it}, M) - P_{Mt}M$. The first-order condition is given by

$$\ln\left(\frac{P_{Mt}M_{it}}{Y_{it}}\right) = \ln\left(\frac{F_{M,t}(L_{it}, K_{it}, M_{it})M_{it}}{F_t(L_{it}, K_{it}, M_{it})}E_\epsilon[e^\epsilon]\right) - \epsilon_{it} = \ln\left(\frac{\partial f(\ell_{it}, k_{it}, m_{it})}{\partial m_{it}}E_\epsilon[e^\epsilon]\right) - \epsilon_{it}. \tag{7}$$

Following GNR, we specify $f(\ell_{it}, k_{it}, m_{it})$ using the polynomial function

$$f(\ell_{it}, k_{it}, m_{it}) = \sum_{r_l+r_k+r_m\le 2} \frac{\gamma_{r_l,r_k,r_m}}{r_m+1}\ell_{it}^{r_l}k_{it}^{r_k}m_{it}^{r_m+1} \tag{8}$$

so that

$$\frac{\partial f(\ell_{it}, k_{it}, m_{it})}{\partial m_{it}} = \sum_{r_l+r_k+r_m\le 2} \gamma_{r_l,r_k,r_m}\ell_{it}^{r_l}k_{it}^{r_k}m_{it}^{r_m}. \tag{9}$$

We first estimate $\{\gamma_{r_l,r_k,r_m}\}_{r_l+r_k+r_m\le 2}$ using the restriction from the first order condition (7) by minimizing the sum of implied squared residuals, $\sum_{i,t}\epsilon_{it}^2$, as:

$$\min_{r_l+r_k+r_m\le 2,\mathcal{E}} \sum_{i,t}\left(\ln\left(\frac{P_{Mt}M_{it}}{Y_{it}}\right) - \ln\left(\sum_{r_l+r_k+r_m\le 2}\gamma_{r_l,r_k,r_m}\ell_{it}^{r_l}k_{it}^{r_k}m_{it}^{r_m}\right) + \mathcal{E}\right)^2,$$

where $\mathcal{E} := \ln(E_\epsilon[e^\epsilon])$. Let $\{\hat\gamma_{r_l,r_k,r_m}\}_{r_l+r_k+r_m\le 2}$ and $\hat{\mathcal{E}}$ be this nonlinear least squares estimator and let

$$\frac{\partial f(\widehat{\ell_{it}, k_{it}}, m_{it})}{\partial m_{it}} := \sum_{r_l+r_k+r_m\le 2}\hat\gamma_{r_l,r_k,r_m}\ell_{it}^{r_l}k_{it}^{r_k}m_{it}^{r_m},\ \ \hat\epsilon_{it} := \ln\left(\frac{P_{Mt}M_{it}}{Y_{it}}\right) - \ln\left(\frac{\partial f(\widehat{\ell_{it}, k_{it}}, m_{it})}{\partial m_{it}}\right) - \hat{\mathcal{E}}.$$

Because $f(\ell, k, m) = \int_{\bar m}^{m_{it}} \frac{\partial f(\ell_{it}, k_{it}, m)}{\partial m}dm + f(\ell_{it}, k_{it}, \bar m)$ for any $\bar m$, the logarithm version of production function (6) implies that

$$\omega_{it} = y_{it} - \int_{\bar m}^{m_{it}} \frac{\partial f(\ell_{it}, k_{it}, m)}{\partial m}dm - f(\ell_{it}, k_{it}, \bar m) - \epsilon_{it}. \tag{10}$$

Then, substituting (8)-(9) to (10) and evaluating at the estimated value of $\frac{\partial f(\ell_{it}, k_{it}, m_{it})}{\partial m_{it}}$ and ϵ_{it}, we define $\omega_{it}(\alpha)$ by

$$\omega_{it}(\alpha) = \left(y_{it} - \sum_{r_l+r_k+r_m\le 2}\frac{\hat\gamma_{r_l,r_k,r_m}}{r_m+1}\ell_{it}^{r_l}k_{it}^{r_k}m_{it}^{r_m+1} - \hat\epsilon_{it}\right) - (\alpha_\ell\ell_{it} + \alpha_k k_{it} + \alpha_{\ell\ell}\ell_{it}^2 + \alpha_{kk}k_{it}^2 + \alpha_{\ell k}\ell_{it}k_{it}),$$

where $\alpha = (\alpha_\ell, \alpha_k, \alpha_{\ell\ell}, \alpha_{kk}, \alpha_{\ell k})$. To estimate α, we use the following moment conditions:

$$E[\mathbf{z}_{it}\eta_{it}] = \mathbf{0}, \quad \text{where } \hat{\eta}_{it}(\alpha) = \omega_{it}(\alpha) - \rho_{0t} - \rho_1\omega_{it-1}(\alpha)$$

with $\mathbf{z}_{it} = (\ell_{it}, k_{it}, \ell_{it}^2, k_{it}^2, \ell_{it}k_{it})$.

C.2 System GMM à la Blundell and Bond (1998, 2000)

We consider the following production function:

$$y_{it} = \alpha_0 + \alpha_\ell \ell_{it} + \alpha_k k_{it} + \alpha_m m_{it} + \mu_i + \eta_t + \omega_{it} + \epsilon_{it} \tag{11}$$

$$\omega_{it} = \rho\omega_{i,t-1} + \eta_{it} \tag{12}$$

where y_{it} is the logarithm of the total gross output, ℓ_{it} is the logarithm of labor input, k_{it} is the logarithm of capital input, and m_it is the logarithm of intermediate input. The variable ω_{it} represents the persistent component of TFP and follows the AR(1) process, where η_{it} is independent of $\omega_{i,t-1}$. The variable ϵ_{it} is a measurement error.

One of the main econometric issues in estimating the production function (11)–(12) is the simultaneity of a productivity shock ω_{it} and input decisions. All the input variables, ℓ_{it}, k_{it}, and m_{it}, are likely to be correlated with productivity shock ω_{it} and the ordinary least squares estimate will be biased.

To estimate the production function consistently, we first take a "quasi-difference," $y_{it} - \rho y_{i,t-1}$, to eliminate ω_{it} and $\omega_{i,t-1}$ as

$$\begin{aligned} y_{it} &= \rho y_{i,t-1} + \alpha_\ell \ell_{it} - \rho\alpha_\ell \ell_{i,t-1} + \alpha_k k_{it} - \rho\alpha_k k_{i,t-1} + \alpha_m m_{it} - \rho\alpha_m m_{i,t-1} + \mu_i + \eta_{it} \\ &= \pi_1 y_{i,t-1} + \pi_2 \ell_{it} + \pi_3 \ell_{i,t-1} + \pi_4 k_{it} + \pi_5 k_{i,t-1} + \pi_6 m_{it} + \pi_7 m_{i,t-1} + \mu_i + \eta_{it}. \end{aligned}$$

Then, we apply the system GMM estimator of Blundell and Bond (1998) to estimate the parameter vector $\pi = (\pi_1, \pi_2, \pi_3, \pi_4, \pi_5, \pi_6, \pi_7)$ without imposing cross-parameter constraints. We also include the year dummies. Here, k_{it} is a predetermined variable so that $E[\Delta\omega_{it}k_{i,t-s}] = 0$ holds for $s = 1, 2, ...$, while ℓ_{it} and m_{it} are endogenous variables, where $E[\Delta\omega_{it}\ell_{i,t-s}] = 0$ and $E[\Delta\omega_{it}m_{i,t-s}] = 0$ hold for $s = 2, 3, ...$ We also use additional moment conditions implied by initial conditions under stationarity. After estimating π by the

GMM estimation procedure, we impose cross-parameter restrictions, such as $\pi_5 = -\rho\alpha_k$, by using minimum distance to obtain consistent estimates of $(\alpha_\ell, \alpha_k, \alpha_m, \rho)$.

Figures and Tables

Figure 1: Bank Attitudes toward Lending (TANKAN, Bank of Japan)

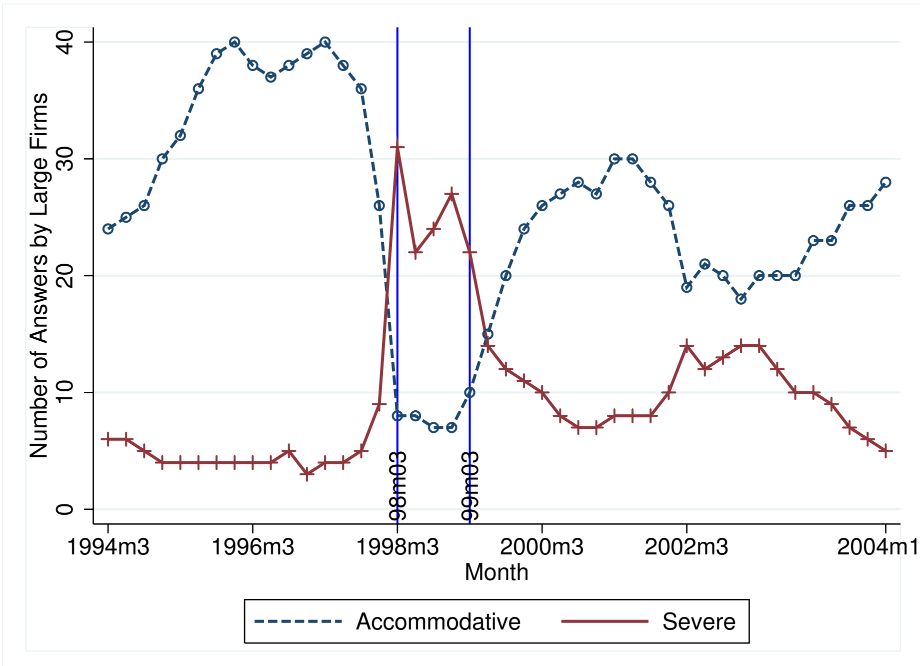
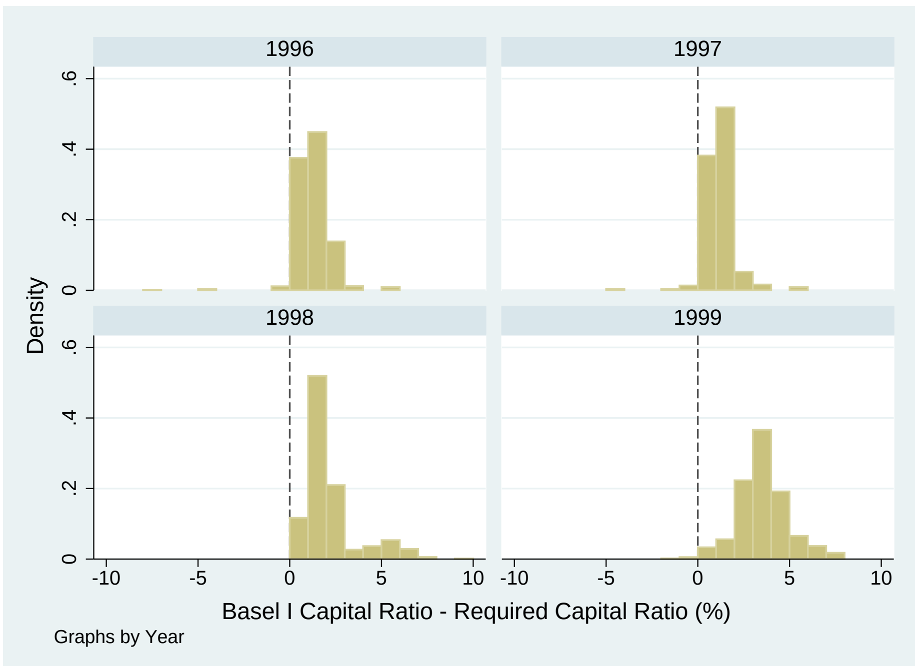


Figure 2: Distribution of Basel I Capital Adequacy Ratios, 1996-1999



Notes: Weighted by the loan supply.

Figure 3: Distribution of the Number of Banks Each Firm Borrows from in 1998

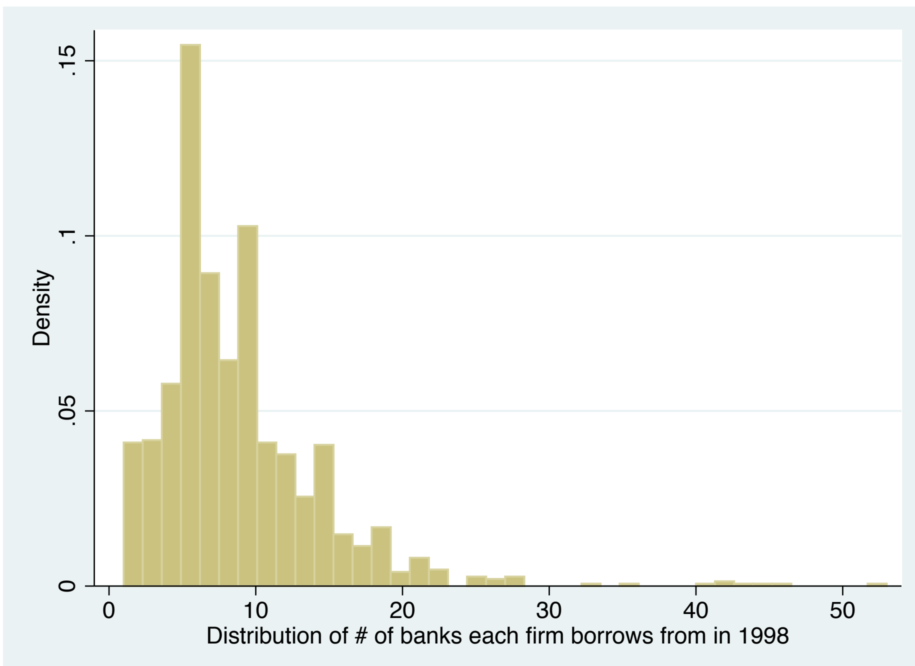
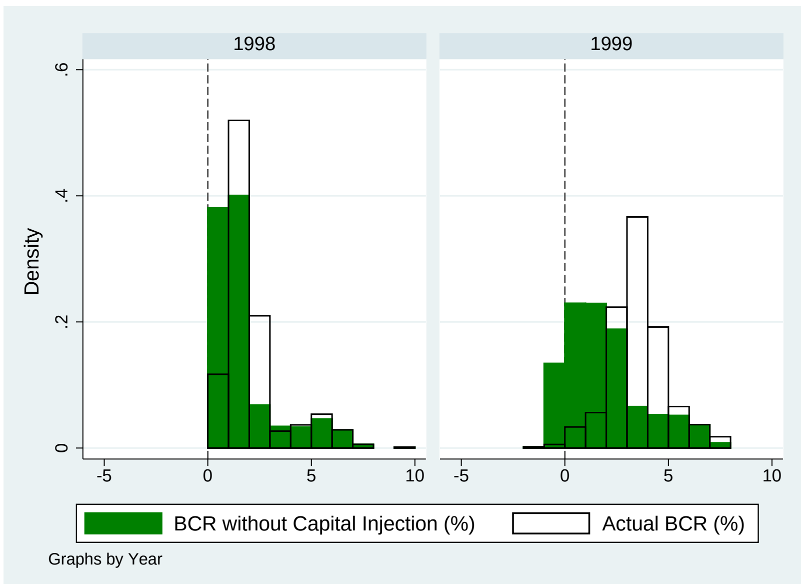
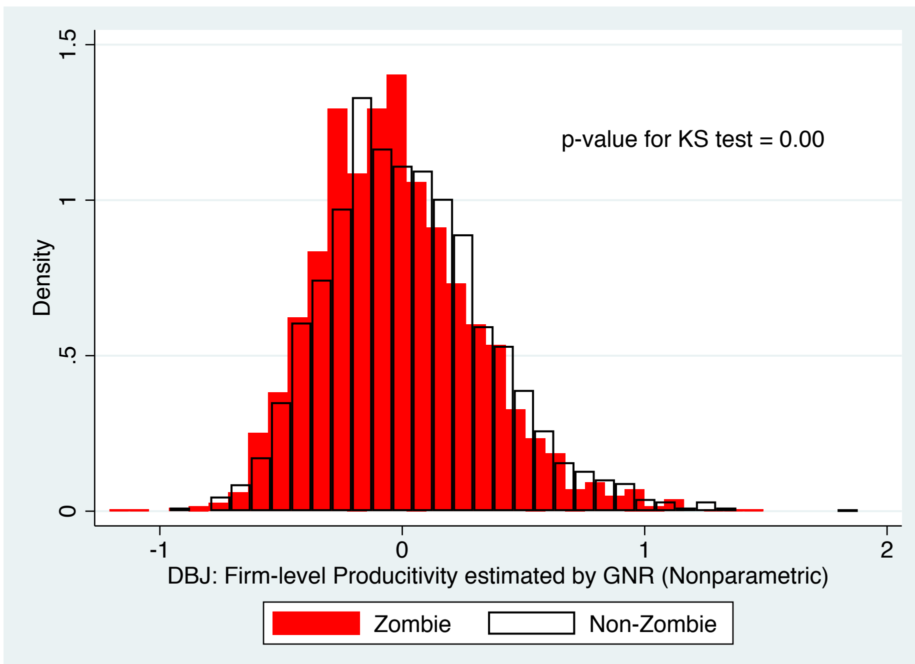


Figure 4: Basel I Capital Adequacy Ratios (BCRs) without Capital Injections, 1998 and 1999



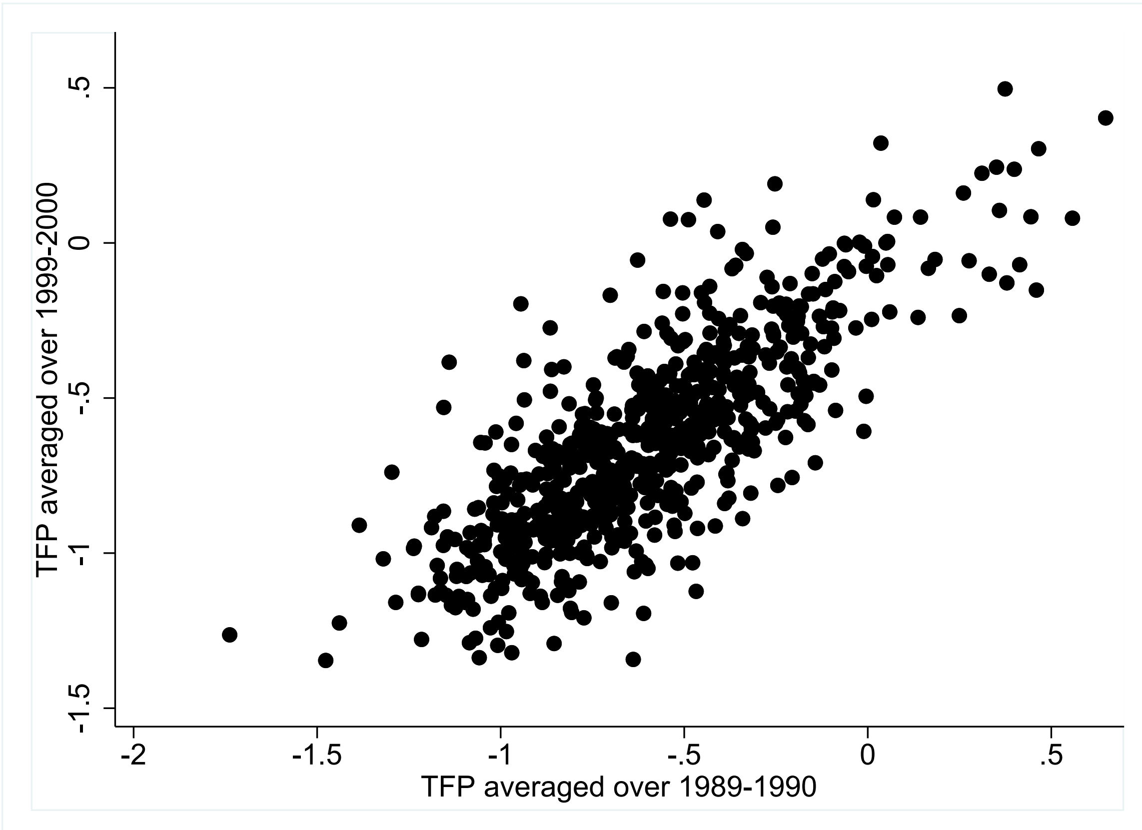
Notes: Weighted by the loan supply. The x-axis is the Basel I capital adequacy ratio less the required capital ratio.

Figure 5: Distribution of TFP for Zombie vs. Non-Zombie Firms



Notes: The x-axis is the log of TFP.

Figure 6: The Persistence of TFP Measure



Notes: The figure plots each firm's average of TFP measures over 1989-1990 against the average of TFP measures over 1999-2000.

Figure 7: Average loan growth rate

Notes: The treatment group is defined as firm-bank pairs of which bank received the 1999 injection.

Firm-bank-level data are used.

Table 1: Number of Banks Each Firm Borrows from and Top Bank Loan Shares in 1998

Panel A: Summary Statistics						
		Obs	Mean	Std. Dev.	Min	Max
# of banks each firm borrows from	All firms	1144	8.35	5.33	1	51
	Small	113	6.41	6.13	1	41
	Medium	768	7.61	3.64	1	25
	Large	263	11.36	7.52	1	51
Loan share of the top bank		1144	0.33	0.17	0.06	1.00
Loan share of top 5 banks		1144	0.75	0.19	0.07	1.00

Panel B: The average share of regional banks					
# of bank relationships	1-5	6-10	11-20	21-30	30-
Frac. of regional banks in # of bank relationships	0.205	0.235	0.353	0.542	0.665
Frac. of regional banks in total loans	0.199	0.187	0.207	0.242	0.302
# of Obs	345	514	255	21	9

Panel C: The average share of short-term loans and zero-growth loans					
# of bank relationships	1-5	6-10	11-20	21-30	30-
Frac. of short-term loans	0.582	0.664	0.694	0.753	0.779
Frac. of short-term loans by regional banks	0.605	0.766	0.841	0.921	0.933
Frac. of loans with zero growth	0.268	0.285	0.354	0.471	0.550
Frac. of loans with zero growth by regional banks	0.232	0.334	0.454	0.635	0.642

Notes: Small, medium, and large firms are those with fewer than 200 employees, between 200 and 2000 employees, and more than 2000 employees, respectively. The regional banks are defined as the banks that belong to either the Regional Banks Association of Japan or the Second Association of Regional Banks. "Frac. of loans with zero growth" is the average fraction of banks of which loan growth rate in 1998 is less than 0.01 percent in all banks with non-zero loans. Similarly, "Frac. of loans with zero growth by regional banks" is the average fraction of regional banks of which loan growth rate is less than 0.01 percent in all regional banks.

Table 2: Summary Statistics ($t = 1998, 1999, 2000$)

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Firm–bank-level variable						
$\Delta\ell_{ikt}/\ell_{ik,t-1}$	24685	0.166	0.000	1.342	-0.999	60.127
ω_{ik}	24685	0.102	0.057	0.124	0	1
$\text{Injection}_{kt}/e_{k,t-1} \times \omega_{ik}$ (Tier 1 + Tier 2)	24685	0.020	0.000	0.051	0.000	0.785
$\text{Injection}_{kt}/e_{k,t-1} \times \omega_{ik}$ (Tier 1 only)	24685	0.015	0.000	0.045	0.000	0.785
$BCR_{kt-1} \times \omega_{ik}$	24685	0.223	0.106	0.348	-0.678	4.719
Bank-level variable						
$\text{Injection}_{kt}/e_{k,t-1}$ (Tier 1 + Tier 2)	338	0.051	0.000	0.18	0	1.257
$\text{Injection}_{kt}/e_{k,t-1}$ (Tier 1 Only)	338	0.039	0.000	0.161	0	1.257
BCR_{kt-1}	338	2.595	2.100	1.954	-1.15	9.48
Domestic_{kt-1}	338	0.536	1.000	0.499	0	1
$\text{Deposit}_{kt-1}/\text{A}_{kt-1}$	338	0.816	0.876	0.155	0.135	0.940
Firm-level variable						
$I_{m,it}/K_{m,it-1}$	2552	0.092	0.072	0.113	-0.58	1.647
$\overline{\text{BCR}}_{it-1}$	2552	2.219	1.792	1.179	-0.535	7.592
$\overline{(\text{Injection}/e)}_{it-1}$ (Tier 1 + Tier 2)	2552	0.170	0.076	0.216	0	0.84
$\overline{(\text{Injection}/e)}_{i,1998}$ (Tier 1 + Tier 2)	875	0.084	0.081	0.034	0	0.22
$\overline{(\text{Injection}/e)}_{i,1999}$ (Tier 1 + Tier 2)	791	0.488	0.457	0.162	0	0.84
$\overline{(\text{Injection}/e)}_{it-1}$ (Tier 1 Only)	2552	0.121	0.000	0.193	0	0.84
TFP_{it-1}	2552	0.006	-0.031	0.331	-1.056	1.879
Zombie_{it-1}	2552	0.402	0	0.490	0	1
$\ln K_{m,t-1}$	2552	15.370	15.335	1.543	10.354	20.128
$b_{it-1}/\text{Collat.}_{it-1}$	2552	1.772	1.326	1.75	0.013	22.305
$\text{Cash}_{it-1}/K_{it-1}$	2552	0.313	0.197	0.379	0.001	3.561
$\overline{\text{Domestic}}_{it-1}$	2552	0.065	0.000	0.130	0	1

Notes: The summary statistics for *Firm–bank-level variable* and *Bank-level variable* are computed from the firm–bank observations and bank observations used in estimating column (3) of Table 5. The summary statistics for the other firm-level variables are computed from the firm-level observations used in estimating Table 10 that satisfy the sample selection criteria reported in Table A1. The variable $\Delta\ell_{ikt}/\ell_{ik,t-1}$ denotes the growth of loans of bank k to firm i between years $t-1$ and t; ω_{ik} is the average share of bank k's loans among total loans to firm i in the pre-sample years (1995–1997); $\text{Injection}_{kt}/e_{k,t-1}$ (Tier 1 + Tier 2) is the amount of capital injection into bank k' Tier 1 and Tier 2 capital in year t relative to its previous year's equity; $\text{Injection}_{kt}/e_{k,t-1}$ (Tier 1 only) is the ratio of the capital injection amount into Tier 1 capital to the bank's previous year's equity; BCR_{kt-1} is the difference between the bank's BCR and the required ratio under Japanese banking regulations; Domestic_{kt-1} is a dummy variable that takes the value of one if bank k operates only in the domestic market in year $t-1$; $I_{m,it}/K_{m,it-1}$ is the ratio of firm i's investment to its previous year's assets; $\overline{\text{BCR}}_{it-1}$ is the weighted average of BCR_{kt} over the banks from which firm i borrows; $\overline{(\text{Injection}/e)}_{it-1}$ (Tier 1 + Tier 2) is the ratio of the weighted average of Tier 1 and Tier 2 injections to equity; $\overline{(\text{Injection}/e)}_{it-1}$ (Tier 1 only) is the ratio of the weighted average of Tier 1 injection to equity; TFP_{it-1} is the logarithm of firm i's TFP in year $t-1$; Zombie_{it-1} is a dummy variable that takes the value of one if the actual interest payments of firm i in year $t-1$ is less than the minimum required interest payment defined in Caballero et al. (2008); $b_{it-1}/\text{Collat.}_{it-1}$ is the ratio of total debt to the collateral value of land and capital stocks of firm i in year $t-1$; $\text{Cash}_{it-1}/K_{it-1}$ is the ratio of firm i's cash holdings to capital stock in year $t-1$; and $\overline{\text{Domestic}}_{it-1}$ is the weighted average of Domestic_{kt-1} over the banks from which firm i borrows.

Table 3: Summary Statistics by TFP and Zombie Status

	All	TFP≤P25	P25< TFP≤P75	P75<TFP	t-stat for (4)-(2)	Zombie	Non-Zombie	t-stat for (7)-(6)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln Y_{it-1}$	17.380	16.911	17.420	17.845	14.815	17.050	17.599	12.389
$\ln L_{it-1}$	6.704	6.679	6.733	6.709	0.531	6.402	6.906	12.962
$\ln K_{it-1}$	16.418	16.297	16.490	16.454	2.295	16.112	16.621	10.781
$I_{m,it}/K_{m,it-1}$	0.092	0.083	0.093	0.098	2.441	0.086	0.096	2.118
$\overline{BCR}_{it-1}$	2.219	2.277	2.195	2.177	-1.482	2.172	2.250	1.639
$\overline{(Injection/e)}_{it}$	0.170	0.172	0.167	0.170	-0.140	0.162	0.176	1.640
$\overline{(Injection/e)}_{I,1998}$	0.085	0.085	0.083	0.089	1.207	0.089	0.081	-3.288
$\overline{(Injection/e)}_{I,1999}$	0.458	0.466	0.450	0.468	0.133	0.462	0.456	-0.549
$\overline{(Injection/e)}_{it}$ (Tier 1)	0.121	0.124	0.118	0.119	-0.380	0.115	0.125	1.218
TFP_{it-1}	0.006	-0.348	-0.021	0.436	71.843	-0.025	0.027	3.979
$Zombie_{it-1}$	0.402	0.455	0.405	0.341	-4.149	1.000	0.000	n.a.
$\ln K_{m,it-1}$	15.370	15.232	15.504	15.329	1.144	15.049	15.587	9.003
$b_{it-1}/collat_{it-1}$	1.772	1.857	1.659	1.899	0.384	1.735	1.797	0.861
$Cash_{it-1}/K_{it-1}$	0.313	0.226	0.311	0.405	8.154	0.311	0.314	0.208
$\overline{Domestic}_{it}$	0.065	0.069	0.065	0.059	-1.421	0.064	0.065	0.156
Number of banks	8.728	8.356	8.758	9.197	2.678	8.241	9.055	4.241

Notes: See Table 2 for variable definitions. Column (5) reports t-statistics for the difference between high TFP firms above the 75th percentile value and low TFP firms below the 25th percentile value. Column (8) reports t-statistics for the difference between zombie and non-zombie firms.

Table 4: Determinants of Government Capital Injections

Dependent Variable	$\text{Injection}_{kt}/e_{k,t-1}$			$\text{Injection}_{kt}/e_{k,t-1}$			$\mathbb{I}\{\text{Injection}_{kt} > 0\}$		
Timing of Injection	March 1998			March 1999			March 1999		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\frac{\Delta \ell_{kt-1}}{\ell_{k,t-2}}$		-0.0044			-0.0480			-0.0494	
		[0.004]			[0.038]			[0.053]	
$\frac{\Delta_2 \ell_{kt-1}}{\ell_{k,t-3}}$			-0.0005			-0.0167			-0.0168
			[0.003]			[0.019]			[0.027]
$\overline{\text{TFP}}_{kt-1}$	-0.0192	-0.0216	-0.0210	0.0641	0.0811	0.0671	0.0960	0.1114	0.0970
	[0.028]	[0.030]	[0.031]	[0.056]	[0.059]	[0.055]	[0.079]	[0.086]	[0.080]
$\overline{\text{Zombie}}_{kt-1}$	0.0198	0.0204	0.0214		0.0079	0.0195	-0.0023	-0.0021	0.0095
	[0.013]	[0.013]	[0.014]		[0.040]	[0.043]	[0.052]	[0.055]	[0.059]
BCR_{kt-1}	-0.0069	-0.0069	-0.0071	-0.0197**	-0.0179*	-0.0193*	-0.0341**	-0.0324**	-0.0338**
	[0.006]	[0.006]	[0.006]	[0.010]	[0.010]	[0.010]	[0.015]	[0.015]	[0.015]
Domestic_{kt-1}	-0.0124	-0.0114	-0.0131	-0.0404	-0.0454	-0.0410	-0.0593	-0.0639	-0.0594
	[0.011]	[0.011]	[0.011]	[0.032]	[0.034]	[0.032]	[0.046]	[0.048]	[0.046]
$\text{Deposit}_{kt-1}/A_{kt-1}$	-0.3449***	-0.3455***	-0.3454***	-0.9877***	-0.9665***	-0.9812***	-1.4426***	-1.4215***	-1.4368***
	[0.102]	[0.103]	[0.103]	[0.226]	[0.226]	[0.227]	[0.293]	[0.295]	[0.295]
Observations	109	109	107	107	107	107	107	107	107

Notes: Robust standard errors are in brackets. *** 1%, ** 5%, * 10%.

Table 5: Effect of Capital Injections on Bank Loans (Dependent Variable $\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}}$)

Definition of Injection	Tier 1 + Tier 2				Tier 1 Only			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{Injection}_{kt}/e_{k,t-1} \times \omega_{ik}$	0.6688***	0.8349***	1.0368***	0.5818***	0.7728***	0.9820***	1.0885**	0.8296***
	[0.220]	[0.243]	[0.361]	[0.203]	[0.273]	[0.301]	[0.449]	[0.224]
$\text{BCR}_{kt-1} \times \omega_{ik}$	0.2052***	0.2169***	0.2958***	0.2479***	0.1983***	0.2092***	0.2719***	0.2505***
	[0.037]	[0.035]	[0.051]	[0.048]	[0.038]	[0.036]	[0.049]	[0.048]
ω_{ik}	-1.5558***	-1.3614		-1.5834***	-1.4670***	-1.2828		-1.5542***
	[0.245]	[1.969]		[0.280]	[0.237]	[1.956]		[0.273]
$\text{Domestic}_{kt-1} \times \omega_{ik}$	-0.7259**	-0.6924**	-0.9234***	-0.6448**	-0.7091**	-0.6706**	-0.8484***	-0.6470**
	[0.295]	[0.302]	[0.325]	[0.272]	[0.290]	[0.295]	[0.316]	[0.268]
$\text{Deposit}_{kt-1}/\text{A}_{kt-1} \times \omega_{ik}$	0.7775*	0.7119*	1.9437	0.6327	0.6799*	0.5877	1.7007	0.5618
	[0.393]	[0.397]	[5.985]	[0.410]	[0.382]	[0.383]	[5.957]	[0.406]
$\text{TFP}_{it-1} \times \omega_{ik}$		-0.3002	-1.7506			-0.2936	-1.7067	
		[0.187]	[2.101]			[0.189]	[2.088]	
$\text{Zombie}_{it-1} \times \omega_{ik}$		-0.0763	-0.4333			-0.0694	-0.4260	
		[0.160]	[0.410]			[0.160]	[0.407]	
$\ln K_{it-1} \times \omega_{ik}$		-0.0134	-0.2909*			-0.0115	-0.2774*	
		[0.110]	[0.156]			[0.109]	[0.158]	
$b_{it-1}/\text{Collat.}_{it-1} \times \omega_{ik}$		-0.1059***	-0.7038*			-0.1054***	-0.7020*	
		[0.035]	[0.372]			[0.035]	[0.372]	
$\text{Cash}_{it-1}/K_{it-1} \times \omega_{ik}$		0.0940	0.1999			0.0923	0.2044	
		[0.248]	[0.652]			[0.249]	[0.658]	
Bank Fixed Effects	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Firm Fixed Effects	Yes	Yes	No	No	Yes	Yes	No	No
Bank × Firm Fixed Effects	No	No	Yes	No	No	No	Yes	No
Firm × Year Fixed Effects	No	No	No	Yes	No	No	No	Yes
Year × Closing Month	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Observations	24,685	22,436	22,436	24,685	24,685	22,436	22,436	24,685
Number of Firms	1122	1074	1074	1122	1122	1074	1074	1122

Notes: The matched firm–bank observations for $t = 1998$, 1999, and 2000 are used for estimation, where the numbers of observations are unbalanced across different specifications because of missing values for some regressors. The dependent variable is the growth rate of loans from bank k to firm i. The variable ω_{ik} is the average share of bank k's loans among firm i's total loans in the pre-sample years from 1995 to 1997. The variable $\text{Injection}_{kt}/e_{k,t-1}$ is the ratio of the sum of Tier 1 and Tier 2 capital injections in year t to bank k's equity in year $t-1$ in columns (1) to (4), while we use Tier 1 capital injections in place of the sum of Tier 1 and Tier 2 capital injections in columns (5) to (8). The variable $\text{BCR}_{k,t-1}$ is defined as the BCR less the required capital ratio (8% for internationally operated banks and 4% for domestic banks) in year $t-1$; Domestic_{kt-1} is a dummy variable that takes the unit value if bank k is a domestically operating bank in year $t-1$; TFP_{it-1} is the logarithm of firm i's TFP in year $t-1$; $\ln K_{it-1}$ is the logarithm of capital stock for firm i in year $t-1$; $b_{it-1}/\text{Collat.}_{it-1}$ is the ratio of total debt to the collateral values of land and capital stocks for firm i in year $t-1$; and $\text{Cash}_{it-1}/K_{it-1}$ is the ratio of cash holdings to capital stocks for firm i in year $t-1$. Standard errors adjusted for clustering at the bank level are in brackets. *** 1%, ** 5%, * 10%.

Table 6: Effect of Capital Injections on Bank Loans: Zombie vs. Non-Zombie (Dependent Variable $\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}}$)

	Non-Zombie					Zombie				
Sample	All	TFP>P75	TFP>P50	TFP<P50	TFP<P25	All	TFP>P75	TFP>P50	TFP<P50	TFP<P25
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\text{Injection}_{kt}/e_{k,t-1} \times \omega_{ik}$	0.8209***	1.1755***	1.0132**	0.6593**	0.4066	0.3021	0.0196	-0.2022	0.7314**	0.9903**
	[0.270]	[0.416]	[0.448]	[0.276]	[0.408]	[0.254]	[0.505]	[0.319]	[0.299]	[0.431]
$\text{BCR}_{kt-1} \times \omega_{ik}$	0.3111***	0.4184***	0.4384***	0.2142***	0.1559*	0.1856***	0.1815*	0.0407	0.3228***	0.3152***
	[0.078]	[0.156]	[0.139]	[0.076]	[0.088]	[0.060]	[0.092]	[0.064]	[0.086]	[0.096]
ω_{ik}	-1.7810***	-3.0404***	-2.6870***	-0.9443**	-0.7705	-1.1520***	-0.8361	-0.6740*	-1.5922***	-1.7567***
	[0.483]	[0.968]	[0.830]	[0.426]	[0.467]	[0.312]	[0.796]	[0.402]	[0.421]	[0.536]
$\text{Domestic}_{kt-1} \times \omega_{ik}$	-0.7440*	-1.1769	-1.0327	-0.5535	-0.1669	-0.4913	0.6371	-0.3849	-0.8813**	-1.0875*
	[0.393]	[0.965]	[0.720]	[0.421]	[0.402]	[0.332]	[0.644]	[0.532]	[0.416]	[0.633]
$\text{Deposit}_{kt-1}/\text{A}_{kt-1} \times \omega_{ik}$	0.5813	2.1377*	1.4138	-0.2547	-0.1892	0.2706	-0.6189	0.0326	0.4344	0.4611
	[0.640]	[1.144]	[1.116]	[0.753]	[0.591]	[0.403]	[1.481]	[0.707]	[0.455]	[0.603]
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,883	4,114	7,584	7,299	3,555	8,527	1,716	3,942	4,585	2,382
Number of Firms	772	200	387	385	184	550	116	255	295	154

Notes: The matched firm–bank observations for t = 1998, 1999, and 2000 are used for estimation, where the numbers of observations are unbalanced across different specifications because of missing values for some regressors. The dependent variable is the growth rate of loans from bank k to firm i. The sum of Tier 1 and Tier 2 capital injections is used to compute $\text{Injection}_{kt}/e_{k,t-1}$. Columns (1) and (6) reports the results for the sample of non-zombie firms and zombie firms, respectively. Columns (2), (3), (4), and (5) report the results for non-zombie firms whose average TFP over the 1995-1997 period is above the 75th percentile, above the 50th percentile, below the 50th percentile, below the 25th percentile, respectively. Columns (7), (8), (9), and (10) report the results for zombie firms whose average TFP over the 1995-1997 period is above the 75th percentile, above the 50th percentile, below the 50th percentile, below the 25th percentile, respectively. Standard errors adjusted for clustering at the bank level are in brackets. *** 1%, ** 5%, * 10%.

Table 7: Effect of Capital Injections on Bank Loans: Zombie vs. Non-Zombie (Dependent Variable $\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}}$)

	Non-zombie					Zombie				
Sample	All	TFP>P75	TFP>P50	TFP<P50	TFP<P25	All	TFP>P75	TFP>P50	TFP<P50	TFP<P25
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\text{Injection}_{kt}/e_{k,t-1} \times \omega_{ik}$	1.1919**	1.7728*	1.5691*	0.8595	0.1681	0.8163**	-0.2096	0.5207	0.7814*	1.9476**
	[0.528]	[0.918]	[0.866]	[0.711]	[0.736]	[0.398]	[1.434]	[0.573]	[0.468]	[0.844]
$\text{BCR}_{kt-1} \times \omega_{ik}$	0.3244***	0.4405***	0.4563***	0.2222**	0.1442	0.2039***	0.1744*	0.0702	0.3242***	0.3441***
	[0.083]	[0.165]	[0.148]	[0.087]	[0.098]	[0.062]	[0.103]	[0.063]	[0.086]	[0.110]
$\text{Injection}_{kt}/e_{k,t-1} \times \text{BCR}_{kt-1} \times \omega_{ik}$	-0.2236	-0.3465	-0.3277	-0.1227	0.1512	-0.3081*	0.1282	-0.4322*	-0.0300	-0.5790
	[0.261]	[0.490]	[0.366]	[0.360]	[0.452]	[0.179]	[0.565]	[0.246]	[0.245]	[0.463]
ω_{ik}	-1.7797***	-3.0479***	-2.6872***	-0.9432**	-0.7742*	-1.1556***	-0.8336	-0.6860*	-1.5920***	-1.7734***
	[0.485]	[0.969]	[0.831]	[0.427]	[0.463]	[0.311]	[0.793]	[0.398]	[0.421]	[0.548]
$\text{Domestic}_{kt-1} \times \omega_{ik}$	-0.7731*	-1.2521	-1.0693	-0.5731	-0.1298	-0.5291	0.6471	-0.4905	-0.8820**	-1.1088*
	[0.393]	[0.976]	[0.726]	[0.425]	[0.426]	[0.346]	[0.638]	[0.524]	[0.417]	[0.666]
$\text{Deposit}_{kt-1}/\text{A}_{kt-1} \times \omega_{ik}$	0.5280	2.0673*	1.3439	-0.2873	-0.1406	0.2017	-0.5895	-0.0649	0.4280	0.3603
	[0.658]	[1.151]	[1.143]	[0.788]	[0.606]	[0.396]	[1.537]	[0.718]	[0.462]	[0.622]
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,883	4,114	7,584	7,299	3,555	8,527	1,716	3,942	4,585	2,382
Number of Firms	772	200	387	385	184	550	116	255	295	154

Notes: The matched firm–bank observations for t = 1998, 1999, and 2000 are used for estimation, where the numbers of observations are unbalanced across different specifications because of missing values for some regressors. The dependent variable is the growth rate of loans from bank k to firm i. The sum of Tier 1 and Tier 2 capital injections is used to compute $\text{Injection}_{kt}/e_{k,t-1}$. Columns (1) and (6) reports the results for the sample of non-zombie firms and zombie firms, respectively. Columns (2), (3), (4), and (5) report the results for non-zombie firms whose average TFP over the 1995-1997 period is above the 75th percentile, above the 50th percentile, below the 50th percentile, below the 25th percentile, respectively. Columns (7), (8), (9), and (10) report the results for zombie firms whose average TFP over the 1995-1997 period is above the 75th percentile, above the 50th percentile, below the 50th percentile, below the 25th percentile, respectively. Standard errors adjusted for clustering at the bank level are in brackets. *** 1%, ** 5%, * 10%.

Table 8: Effect of Capital Injections on Bank Loans: Robustness Check (Dependent Variable $\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}}$)

Definition of BCR	Deferred Tax Assets, Risk Loan					Balance Sheet Based				
		Non-zombie		Zombie			Non-zombie		Zombie	
Sample	All	TFP>P75	TFP<P25	TFP>P75	TFP<P25	All	TFP>P75	TFP<P25	TFP>P75	TFP<P25
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\text{Injection}_{kt}/e_{k,t-1} \times \omega_{ik}$	0.4968**	1.1152***	0.1604	-0.0363	0.8264	0.4739**	0.8451**	0.4190	0.1429	0.7080*
	[0.231]	[0.414]	[0.417]	[0.625]	[0.503]	[0.194]	[0.329]	[0.352]	[0.587]	[0.383]
ω_{ik}	-1.2789***	-2.5057***	-0.5379	-0.3513	-1.3548***	-2.2827***	-3.4858***	-1.8001***	-1.8715**	-2.5987***
	[0.242]	[0.715]	[0.413]	[0.912]	[0.481]	[0.297]	[0.758]	[0.479]	[0.867]	[0.829]
$\text{BCR}_{kt-1} \times \omega_{ik}$	0.2259***	0.3530***	0.1603*	0.0731	0.2759***	0.2872***	0.3740***	0.2778***	0.3153*	0.3157***
	[0.059]	[0.133]	[0.095]	[0.104]	[0.099]	[0.057]	[0.119]	[0.083]	[0.180]	[0.112]
$\text{BCR}_{kt-1} \times \text{Domestic}_{kt-1} \times \omega_{ik}$						-0.3114**	-1.7221***	-0.0049	0.2175	-0.1992
						[0.126]	[0.583]	[0.128]	[0.458]	[0.124]
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	22,090	3,663	3,127	1,590	2,173	24,681	4,112	3,556	1,718	2,378
Number of Firms	1120	199	184	116	154	1122	200	184	116	154

Notes: The matched firm–bank observations for t = 1998, 19999, and 2000 are used for estimation, where the numbers of observations are unbalanced across different specifications because of sample selections as well as missing values for some regressors. The dependent variable is the growth rate of loans from bank k to firm i. The sum of Tier 1 and Tier 2 capital injections is used to compute $\text{Injection}_{kt}/e_{k,t-1}$. Columns (1)-(5) report the results for a modified BCR of bank k, with deferred tax assets and defaulted loans subtracted from the bank capital while columns (6)-(10) use the capital ratio based on the balance sheet data in which deferred tax assets and defaulted loans are subtracted from the bank capital. Column (1) uses all observations. Columns (2) and (3) report the results for firms whose average TFP over the 1995-1997 period is above the 75th percentile and below the 25th percentile, respectively, for the sample of firms that are not classified as zombie firms. Columns (4) and (5) report the results for firms whose average TFP over the 1995-1997 period is above the 75th percentile and below the 25th percentile, respectively, for the sample of firms that are classified as zombie firms. The sample selection for columns (6)-(10) is similar to that for columns (1)-(5). Other covariates in Table 5 are also included in specifications. Standard errors adjusted for clustering at the bank level are in brackets. *** 1%, ** 5%, * 10%.

Table 9: Effect of Future Capital Injections on Bank Loans: Placebo Test (Dependent Variable $\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}}$)

Definition of Injection	Tier 1 + Tier 2				Tier 1 Only			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{Injection}_{k,t+1}/e_{k,t} \times \omega_{ik}$	-0.3945	-0.4345	-0.5135**	-0.3473	-0.4708*	-0.5301*	-0.5694**	-0.5136
	[0.246]	[0.284]	[0.240]	[0.318]	[0.270]	[0.309]	[0.270]	[0.357]
ω_{ik}	-1.0038**	-0.8026		-1.2016***	-1.0486**	-0.8380		-1.2226***
	[0.441]	[1.668]		[0.449]	[0.410]	[1.645]		[0.416]
$\text{BCR}_{kt-1} \times \omega_{ik}$	0.1231	0.1686	0.3125	0.1140	0.1273	0.1730	0.3293	0.1142
	[0.122]	[0.130]	[0.257]	[0.094]	[0.119]	[0.126]	[0.255]	[0.091]
Bank Fixed Effects	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Firm Fixed Effects	Yes	Yes	No	No	Yes	Yes	No	No
Bank × Firm Fixed Effects	No	No	Yes	No	No	No	Yes	No
Firm × Year Fixed Effects	No	No	No	Yes	No	No	No	Yes
Year × Closing Month	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Observations	23,455	21,116	21,116	23,455	23,455	21,116	21,116	23,455
Number of Firms	1114	1066	1066	1114	1114	1066	1066	1114

Notes: The matched firm–bank observations for $t = 1997$, 1998, and 1999 are used for estimation, where the numbers of observations are unbalanced across different specifications because of missing values for some regressors. The dependent variable is the growth rate of loans from bank k to firm i. The variable ω_{ik} is the average share of bank k's loans among firm i's total loans in the pre-sample years from 1994 to 1996. The variable $\text{Injection}_{k,t+1}/e_{k,t}$ is the ratio of the sum of Tier 1 and Tier 2 capital injections in year $t+1$ to bank k's equity in year t in columns (1) to (5), while we use Tier 1 capital injections in place of the sum of Tier 1 and Tier 2 capital injections in columns (6) to (10). Other covariates in Table 5 are also included in specifications. Standard errors adjusted for clustering at the bank level are in brackets. *** 1%, ** 5%, * 10%.

Table 10: Firm Machine Investment Rates, Capital Adequacy Ratios, and Capital Injections (Dependent Variable $\frac{I_{m,it}}{K_{m,it-1}}$)

TFP measure	ln TFP				TFP Dummy			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\overline{\text{BCR}}_{it-1}$	-0.0026	-0.0011			-0.0089	-0.0073		
	[0.006]	[0.006]			[0.007]	[0.007]		
$\text{TFP}_{it-1} \times \overline{\text{BCR}}_{it-1}$	0.0153**	0.0149**			0.0091**	0.0089**		
	[0.007]	[0.007]			[0.004]	[0.004]		
$\text{Zombie}_{it-1} \times \overline{\text{BCR}}_{it-1}$		-0.0033				-0.0033		
		[0.005]				[0.005]		
$\overline{(\text{Injection}/e)}_{it-1}$			-0.0168	-0.0074			-0.0502	-0.0407
			[0.035]	[0.036]			[0.038]	[0.040]
$\text{TFP}_{it-1} \times \overline{(\text{Injection}/e)}_{it-1}$			0.0615*	0.0607*			0.0452**	0.0446**
			[0.033]	[0.033]			[0.023]	[0.023]
$\text{Zombie}_{it-1} \times \overline{(\text{Injection}/e)}_{it-1}$				-0.0226				-0.0217
				[0.025]				[0.025]
$\omega_i^{bankrupt} \times D_{99,00}^{\text{year}}$	-0.0425	-0.0405	-0.0418	-0.0405	-0.0433	-0.0412	-0.0418	-0.0405
	[0.067]	[0.068]	[0.067]	[0.067]	[0.067]	[0.067]	[0.066]	[0.067]
TFP_{it-1}	0.0344	0.0370	0.0611	0.0631	-0.0131	-0.0122	-0.0007	-0.0001
	[0.056]	[0.055]	[0.055]	[0.055]	[0.019]	[0.018]	[0.016]	[0.015]
Zombie_{it-1}		0.0099	0.0025	0.0065		0.0096	0.0021	0.0059
		[0.014]	[0.010]	[0.011]		[0.014]	[0.010]	[0.011]
$\ln K_{m,it-1}$	-0.6549***	-0.6569***	-0.6532***	-0.6565***	-0.6538***	-0.6558***	-0.6541***	-0.6572***
	[0.080]	[0.081]	[0.080]	[0.081]	[0.080]	[0.081]	[0.080]	[0.081]
$b_{it-1}/\text{Collat}_{it-1}$	-0.0043	-0.0043	-0.0043	-0.0045	-0.0053	-0.0053	-0.0053	-0.0055
	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]	[0.008]
$\text{Cash}_{it-1}/K_{it-1}$	0.0050	0.0056	0.0050	0.0056	0.0105	0.0112	0.0106	0.0112
	[0.031]	[0.032]	[0.031]	[0.031]	[0.031]	[0.031]	[0.031]	[0.031]
$\overline{\text{Domestic}}_{it-1}$	-0.0374	-0.0376	-0.0535	-0.0530	-0.0422	-0.0425	-0.0568*	-0.0563*
	[0.034]	[0.034]	[0.035]	[0.034]	[0.035]	[0.035]	[0.034]	[0.034]
$\overline{\text{Deposit/A}}_{it-1}$	0.0247	0.0271	0.0170	0.0209	0.0200	0.0224	0.0127	0.0164
	[0.097]	[0.097]	[0.096]	[0.095]	[0.099]	[0.099]	[0.096]	[0.095]
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year×Closing Month	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,552	2,552	2,552	2,552	2,552	2,552	2,552	2,552
Number of Firms	975	975	975	975	975	975	975	975

Notes: The matched firm–bank observations for 1998–2000 are used for estimation. The dependent variable is the ratio of machine investment in year t to the beginning-of-period machine capital stock in year t. The variable $\overline{\text{BCR}}_{it-1}$ is the weighted average of the BCR less the required capital ratio in year $t-1$ across the banks firm i borrows from, where the weight is constructed by the loan share in 1995–1997. The variable $\overline{(\text{Injection}/e)}_{it}$ is the weighted average of the ratio of the sum of Tier 1 and Tier 2 capital injections in year t to bank k's equity in year $t-1$ across the banks firm i borrows from, using weights constructed from pre-sample year loan shares. The variable TFP_{it-1} in columns (1)-(4) is the logarithm of firm i's TFP in year $t-1$ while, in columns (5)-(8), TFP_{it-1} is a dummy variable that takes 1 if the logarithm of firm i's TFP in year $t-1$ is above the 25th percentile and 0 otherwise; $\ln K_{m,it}$ is the logarithm of machine capital stock for firm i in year $t-1$; $b_{it-1}/\text{Collat.}_{it-1}$ is the ratio of debt to the collateral value of land and capital stocks for firm i in year $t-1$; $\text{Cash}_{it-1}/K_{it-1}$ is the ratio of cash holdings to capital stocks for firm i in year $t-1$; $\overline{\text{Domestic}}_{it-1}$ and $\overline{\text{Deposit/A}}_{it-1}$ are the weighted averages of a domestically operating bank's dummy variable and the bank's deposit-asset ratio, respectively, using the loan share of firm i as weights. Standard errors adjusted for clustering at the firm level are in brackets. *** 1%, ** 5%, * 10%.

Table 11: Effect of Capital Injections on Firm Machine Investment Rates: Low vs. High Capital Adequacy Ratios (Dependent Variable $\frac{I_{m,it}}{K_{m,it-1}}$)

TFP measure	ln TFP			TFP Dummy		
Sample	All (1)	Non-Zombie (2)	Zombie (3)	All (4)	Non-Zombie (5)	Zombie (6)
$\overline{(\text{Injection}/e)}^{\text{High-BCR}}_{it-1}$	-0.0084	0.0389	-0.0839	-0.0482	-0.0129	-0.1533**
	[0.034]	[0.038]	[0.063]	[0.037]	[0.041]	[0.071]
$\overline{(\text{Injection}/e)}^{\text{Low-BCR}}_{it-1}$	-0.0284	0.0240	0.0613	-0.4295*	-0.2238	-0.6241
	[0.153]	[0.210]	[0.320]	[0.247]	[0.312]	[0.408]
$\text{TFP}_{it-1} \times \overline{(\text{Injection}/e)}^{\text{High-BCR}}_{it-1}$	0.0713**	0.0726	0.1418*	0.0546**	0.0760**	0.0799*
	[0.034]	[0.046]	[0.078]	[0.023]	[0.036]	[0.044]
$\text{TFP}_{it-1} \times \overline{(\text{Injection}/e)}^{\text{Low-BCR}}_{it-1}$	0.5822	0.7311	0.6999	0.5362**	0.3379	0.8215*
	[0.408]	[0.540]	[0.977]	[0.228]	[0.303]	[0.427]
$\text{Zombie}_{it-1} \times \overline{(\text{Injection}/e)}^{\text{High-BCR}}_{it-1}$	-0.0170			-0.0168		
	[0.023]			[0.023]		
$\text{Zombie}_{it-1} \times \overline{(\text{Injection}/e)}^{\text{Low-BCR}}_{it-1}$	0.0048			-0.0123		
	[0.192]			[0.189]		
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year×Closing Month	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,552	1,525	1,027	2,552	1,525	1,027
Number of Firms	975	691	513	975	691	513

Notes: The matched firm–bank observations for 1998–2000 are used for estimation. The dependent variable is the ratio of machine investment in year t to the beginning-of-period machine capital stock in year t. The variables $\overline{(\text{Injection}/e)}^{\text{High-BCR}}_{it-1}$ and $\overline{(\text{Injection}/e)}^{\text{Low-BCR}}_{it-1}$ are defined in (5). The variable TFP_{it-1} in columns (1)-(3) is the logarithm of firm i's TFP in year $t-1$ while, in columns (4)-(6), TFP_{it-1} is a dummy variable that takes 1 if the logarithm of firm i's TFP in year $t-1$ is above the 25th percentile and 0 otherwise. Other covariates in Table 10 are also included in specifications. Columns (1) and (4) use the sample of all firms. Columns (2) and (5) use the sample of non-zombie firms while columns (3) and (6) use the sample of zombie firms. Standard errors adjusted for clustering at the firm level are in brackets. *** 1%, ** 5%, * 10%.

Table 12: Firm Machine Investment Rates, Basel I Capital Adequacy Ratios, and Capital Injections: Robustness Check (Dependent Variable $\frac{I_{m,it}}{K_{m,it-1}}$)

	Adjusted BCR 1	Adjusted BCR 2	System GMM		Solow Residual	
	(1)	(2)	(3)	(4)	(5)	(6)
$\overline{\text{BCR}}_{it-1}$	-0.0032	0.0008	-0.0009		-0.0009	
	[0.008]	[0.010]	[0.006]		[0.006]	
$\text{TFP}_{it-1} \times \overline{\text{BCR}}_{it-1}$	0.0109	0.0176*	0.0142**		0.0141**	
	[0.007]	[0.011]	[0.006]		[0.006]	
$\overline{\text{BCR} \times \text{Domestic}}_{it-1}$		0.0182				
		[0.023]				
$\text{TFP}_{it-1} \times \overline{\text{BCR} \times \text{Domestic}}_{it-1}$		0.0136				
		[0.020]				
$\text{Zombie}_{it-1} \times \overline{\text{BCR}}_{it-1}$	-0.0010	-0.0009	-0.0014		-0.0030	
	[0.005]	[0.006]	[0.005]		[0.005]	
$\text{Zombie}_{it-1} \times \overline{\text{BCR} \times \text{Domestic}}_{it-1}$		-0.0093				
		[0.015]				
$\overline{(\text{Injection}/e)}_{it-1}$				-0.0092		-0.0079
				[0.037]		[0.037]
$\text{TFP}_{it-1} \times \overline{(\text{Injection}/e)}_{it-1}$				0.0608*		0.0565*
				[0.032]		[0.034]
$\text{Zombie}_{it-1} \times \overline{(\text{Injection}/e)}_{it-1}$				-0.0140		-0.0207
				[0.026]		[0.025]
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year×Closing Month	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,418	2,543	2,552	2,552	2,552	2,552
Number of Firms	963	974	975	975	975	975

Notes: See the main text for explanations of columns (1)-(8). Other covariates in Table 10 are also included in specifications. Standard errors adjusted for clustering at the firm level are in brackets. *** 1%, ** 5%, * 10%.

Table 13: Effects of Capital Injection on Average Loan Growth Rates

Sample	Non-Zombie					Zombie				
	All	TFP>P75	TFP>P50	TFP<P50	TFP<P25	All	TFP>P75	TFP>P50	TFP<P50	TFP<P25
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
No 1998 injection	-0.0064	-0.0087	-0.0077	-0.0053	-0.0033	-0.0029	-0.0002	0.0020	-0.0067	-0.0095
No 1999 injection	-0.0360	-0.0468	-0.0418	-0.0307	-0.0193	-0.0159	-0.0012	0.0107	-0.0381	-0.0553
Number of Firms	772	200	387	385	184	550	116	255	295	154

Notes: Columns (1)-(10) report mean changes in the growth rate of bank loans by zombie status and the percentiles of average TFP over the 1995-1997 period if there had been no capital injection in 1998 and 1999 based on the estimated loan regression models reported in the corresponding columns of Table 6. The rows designated No 1998 Injection reports the counterfactual mean changes in the loan growth rates if there was no capital injection in March 1998, while the rows designated No 1999 Injection report the counterfactual mean changes in the loan growth rates without the March 1999 capital injection.

Table 14: Effects of Capital Injections on Average Investment Rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
TFP_{it-1}	All	$\leq 10\%$	(10% 25%]	(25% 50%]	(50% 75%]	(75% 90%]	$> 90\%$
$\overline{\text{BCR}}_{it-1}$							
No 1998 Injection	0.0003	0.0029	0.0020	0.0011	0.0000	-0.0013	-0.0035
No 1999 Injection	0.0033	0.0175	0.0117	0.0060	-0.0002	-0.0075	-0.0186
Adjusted BCR 1							
No 1998 Injection	0.0003	0.0010	0.0007	0.0006	0.0004	0.0000	-0.0008
No 1999 Injection	0.0064	0.0158	0.0117	0.0081	0.0044	-0.0003	-0.0076
Adjusted BCR 2							
No 1998 Injection	-0.0002	0.0010	0.0006	0.0002	-0.0003	-0.0009	-0.0019
No 1999 Injection	-0.0009	0.0098	0.0053	0.0012	-0.0034	-0.0095	-0.0173

Notes: Columns (1)-(7) report mean changes in the investment rates by percentile of TFP_{it-1}. We construct the counterfactual BCR without capital injections by simply subtracting the amount of capital injections from banks' Tier I and Tier II capital. The sample for 1998–2000 is used to compute the percentiles of TFP_{it-1}. The rows designated No 1998 Injection report the counterfactual mean changes in the investment rates if there was no capital injection in March 1998, while the rows designated No 1999 Injection report the counterfactual mean changes in the investment rates without the March 1999 capital injection.

Table A1: Benchmark Sample Selection for Firm Investments Model

	Observations deleted	Remaining observations
Initial data for 1997-2000 (manufacturing)		3300
Missing data (I_m/K_m, BCR)	188	3112
$I_m/K_m > 2$ or $I_m/K_m < -2$	1	3111
Large long-term loan with missing Basel I capital ratio	7	3104
More loans from other banks	274	2830
Missing $\ln TFP$	144	2686
Missing regressors other than $\ln TFP$	134	2552
Benchmark sample		**2552**

Notes: The term I_m/K_m represents the ratio of machine investment to machine capital stock. The large long-term loans missing the BCR omits firms that owe more than 20% of total outstanding long-term loans to banks whose BCR data are missing from the Nikkei NEEDS data. The so-called other banks include the LTCB, NCB, insurance companies, and government financial institutions such as the DBJ. (Sources: DBJ and Nikkei NEEDS)

Table A2: Effects of Capital Injections on Average Investment Rates (Regression-Based)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
TFP_{it-1}	All	$\leq 10\%$	(10% 25%]	(25% 50%]	(50% 75%]	(75% 90%]	$> 90\%$
No 1998 Injection	0.0002	0.0018	0.0013	0.0007	0.0000	-0.0008	-0.0021
No 1999 Injection	0.0020	0.0101	0.0068	0.0034	-0.0001	-0.0045	-0.0103
Adjusted BCR 1							
No 1998 Injection	0.0007	0.0020	0.0016	0.0011	0.0006	0.0000	-0.0011
No 1999 Injection	0.0050	0.0122	0.0091	0.0062	0.0033	-0.0003	-0.0056
Adjusted BCR 2							
No 1998 Injection	-0.0004	0.0019	0.0011	0.0003	-0.0007	-0.0017	-0.0038
No 1999 Injection	-0.0007	0.0111	0.0060	0.0015	-0.0035	-0.0099	-0.0183

Notes: Columns (1) to (7) report mean changes in the investment rates by the percentile of TFP_{it-1}. We construct the counterfactual BCR without capital injections based on the estimated regression of the BCR on the lagged capital ratio, the ratio of the injection amount to equity, year dummies, and bank fixed effects. The sample for 1998–2000 is used to compute the percentiles of TFP_{it-1}. The rows designated No 1998 Injection report the counterfactual mean changes in the investment rates if there was no capital injection in March 1998, while the rows designated No 1999 Injection report the counterfactual mean changes in the investment rates without the March 1999 capital injection.

Table A3: Effects of Capital Injections on Average Investment Rates (Column (2), Table 10)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
TFP_{it-1}	All	$\leq 10\%$	(10% 25%]	(25% 50%]	(50% 75%]	(75% 90%]	$> 90\%$
Based on Col.(4), Table 10							
No 1998 Injection	0.0005	0.0030	0.0022	0.0012	0.0002	-0.0009	-0.0031
No 1999 Injection	0.0044	0.0173	0.0119	0.0066	0.0011	-0.0054	-0.0151

Notes: Columns (1) to (7) report mean changes in the investment rates by the percentile of TFP_{it-1}. The sample for 1998–2000 is used to compute the percentiles of TFP_{it-1}. The rows designated No 1998 Injection report the counterfactual mean changes in the investment rates if there was no capital injection in March 1998, while the rows designated No 1999 Injection report the counterfactual mean changes in the investment rates without the March 1999 capital injection.

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