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Abstract

This paper examines the ramification of government capital injections into financially distressed banks during the 1997 Japanese banking crisis. By leveraging a unique dataset merging firm-level financial statements and bank balance sheets, the study aims to examine whether the capital injections primarily benefited high-productivity firms or were misallocated to struggling "zombie" firms. The empirical results suggest that banks, post-injection, increased lending to both high-productivity non-zombie firms and low-productivity zombie firms. While the former is in line with conventional theories that prioritize high-productivity firms for investment and productivity enhancement, the latter suggests credit misallocation towards struggling firms mainly for debt servicing. Intriguingly, the study finds no evidence that these injections promoted investments among firms, irrespective of their productivity or financial health status. In particular, we provide suggestive evidence that zombie firms even reduced investments, especially in infrastructure, while high-productivity non-zombie firms did not exhibit a significant investment boost despite receiving more loans. However, these high-productivity firms displayed positive growth in labor productivity and total factor productivity, potentially driven by sales growth and increased advertisement expenses rather than employment and wage adjustments.

JEL-Codes: E220, G210, G280.

Keywords: capital injection, bank regulation, banking crisis, total factor productivity, Zombie.

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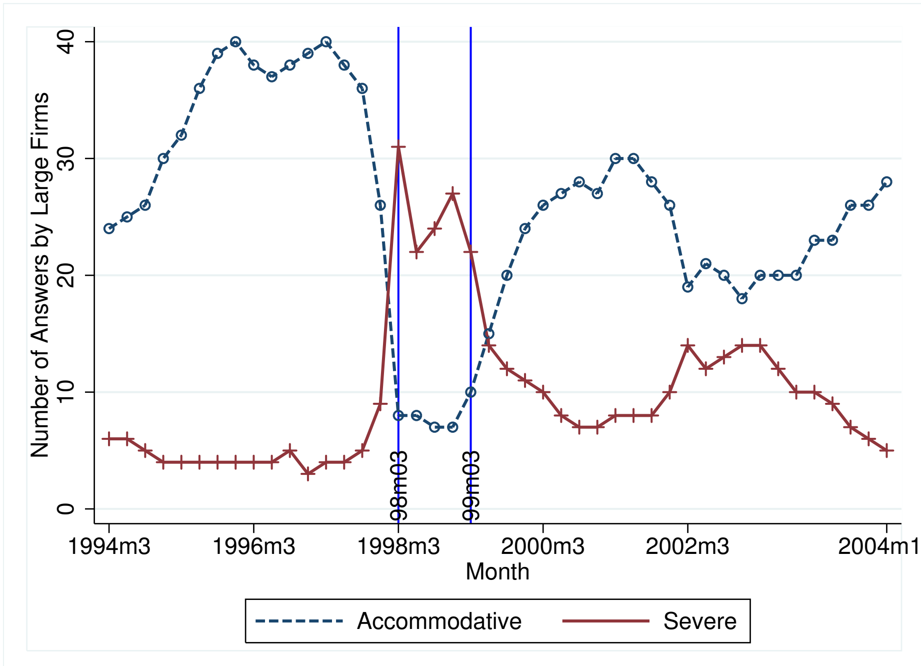
Figure 1: Bank Attitudes toward Lending (TANKAN, Bank of Japan)



1 Introduction

During the Japan's financial crisis in the late 1990s when its government imposed the risk-based capital requirements on banks, the country experienced a sharp decline in bank loans to firms. As a result, Japanese corporate investments decreased between 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, hereafter), weighted by the loan supply across banks, shifted upward significantly between 1997 and 1999.

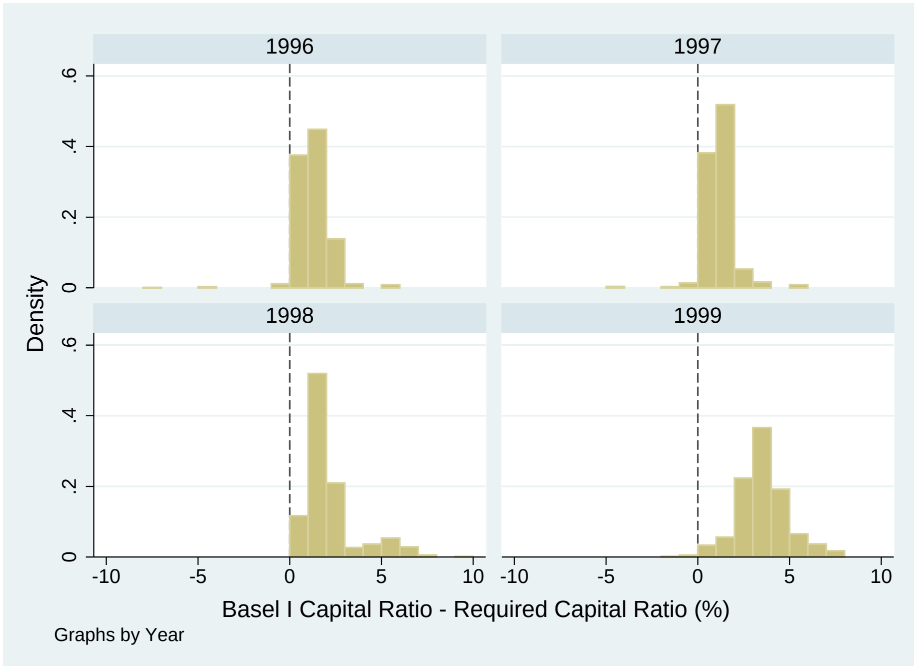
One of the primary goals of the capital injection policy in Japan was to increase bank lending to productive firms and promote firm investment by improving bank capital ratios (Montgomery and Shimizutani 2009). Given that over JPY 10 trillion of Japanese taxpayer money (roughly 2% of Japan's nominal gross domestic product) was spent on capital injections into troubled banks, it would be imperative to conduct rigorous impact evaluation of the intervention.

In this study, we empirically assess the ramifications of governmental capital injections into banks facing financial distress on credit distribution, corporate investment, and productivity amid the 1997 Japanese banking crisis. Our empirical analysis seeks to identify which types of firms had benefited from the bank loans triggered by these capital injections, and subsequently augmented their investment and productivity. While conventional theoretical frameworks posit that capital injections predominantly amplify bank lending to high-productivity firms, facilitating the financing of projects with positive net present value and enhancing productivity, recent literature offers a contrasting perspective on credit misallocation (see Peek and Rosengren 2005; Caballero et al. 2008). This literature suggests that banks might be incentivized, albeit perversely, to augment loan provisions to so-called "zombie" firms—those with financial challenges and diminished productivity. Under such conditions, capital injections could inadvertently channel capital toward these financially embattled firms, primarily serving debt settlement rather than catalyzing investment.

An empirical evaluation of the relative importance of the two theories is critical for properly evaluating the impact of capital injection on Japanese economies. Therefore, we analyze whether the observed patterns of bank loans and investments across different types of firms align with these theoretical frameworks. Specifically, we investigate how the effects of capital injection into banks on lending depend on their productivity and financial conditions. Moreover, we examine whether the capital injection to banks has influenced various investment categories and improved firm-level productivity.

For this purpose, we have constructed a unique dataset that pairs Japanese firm-level financial statements with corresponding bank balance sheet figures. Leveraging this matched firm-bank data, we explore the influence of capital injections on the credit supply from

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



Notes: Weighted by the loan supply.

banks to firms. Furthermore, we analyze whether this effect depends on a firm's total factor productivity (TFP) and its zombie status. To create the zombie indicator that captures a firm's financial health, we rely on the methodology of Caballero et al. (2008) based on credit assistance. We also assess how corporate investment and productivity were related to the injections by regressing investment and productivity on the weighted average of capital injection and banks' BCR across banks.

In our empirical analysis, we first conducted an event-study analysis using our matched firm-bank data to examine the arguably causal relationship between capital injections and bank lending. Our baseline analysis shows that capital injections into banks are associated with an increase in lending to firms. We interpret this evidence as as suggesting that capital injection policies ease bank constraints and facilitate lending to firms. While the endogenous nature of the injections implies that any casual interpretation needs to be done carefully, the paper employs several tests, including an assessment of the presence of pre-trends, which provide corroborating evidence in support of our interpretation.

Subsequently, we estimate the loan growth panel regression model with bank fixed effects and firm-year fixed effects, where the inclusion of firm-year fixed effects effectively controls for time-varying unobserved demand factors. Our regression analyses demonstrate that government capital injections and higher BCR levels are related to banks' increasing their loan supply to firms. Furthermore, we divide the sample by firm-level TFP and zombie status, revealing that capital injection is associated with the increased credit supply to two distinct categories of firms: the high-productivity non-zombie firms and the low-productivity zombie firms. The former aligns with the conventional theory, where banks extend their loans to high-productivity firms to finance their investments and productivity-enhancing activities. In contrast, the latter points to a credit misallocation towards low-productivity zombie firms, who seemingly utilize bank loans to service outstanding debts for survival.

Continuing our investigation, we employ a linear investment model using firm-level panel data covering 1997 to 1999 to examine the association of capital injection with firm investment rates across firm categories, considering their TFP levels and zombie status. Intriguingly, our analysis unveils no supportive evidence that capital injection promoted investments, regardless of their TFP levels and zombie status. What is even more remarkable is our finding that capital injection is associated with a *reduction* in investments for unproductive zombie firms, particularly concerning investments in buildings and structures. This finding provides suggestive evidence that, despite receiving more bank loans, these firms opted not to expand or even curtailed their investments, contrary to the expectation of leveraging increased credit for productive investments.

A potential reason behind the reduced investments among unproductive zombie firms could be their utilization of bank loans to cover losses or debts rather than for actual investment projects, where their main banks could have limited their expansions to curb future losses. On the other hand, it remains puzzling that high-TFP non-zombie firms showed no significant investment boost despite increased loans. Therefore, we further explore if bank loans aimed to improve productivity beyond traditional physical investments.

Analyzing capital injection's link to labor productivity and TFP growth, we find that capital injection is positively associated with the labor productivity and TFP growth of high-productivity non-zombie firms. Our result shows that labor productivity's growth is closely tied to sales growth rather than employment changes. Moreover, there is no indication of wage increases, suggesting heightened productivity is not driven by improved labor quality or increased hours per employee. However, we do observe a connection between capital injection and growth in advertisement expenses for high-TFP non-zombie firms. We view this as indicative evidence that capital injections may have propelled sales growth through heightened investment in advertising.

A substantial body of prior research has explored whether the credit crunch in Japan impeded 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 existing empirical studies 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 and productivity growth. The current research that is most closely related to ours is that of (Giannetti and Simonov 2013, , hereafter GS), which likewise examined the impact of bank recapitalization policies on credit provisioning and firm performance using matched firm-bank data in Japan.[1] Their work found that a substantial capital injection through bank recapitalization led to an expansion in credit availability and firm investment.

This study builds on the work of GS, but examines how firms' responses in terms of loans, investment, and productivity to their banks' recapitalization vary based on their TFP and zombie status. Unlike GS, who overlooked the influence of a firm's productivity, our research underscores that its reaction to capital injections is intimately tied to its productivity level.

[1] Kanazawa (2021) examines the long-run effect of bank capitalization on a firm's financing policies using the Japanese matched firm–bank data. He finds that firms borrowed from the recapitalized banks increased the debt-to-asset ratio and reduced the cash-to-asset ratios after the capital injection over more than 15 years.

This presents a new dimension, expanding upon GS's findings. Specifically, our analysis indicates that capital injections encouraged credit allocation to high-TFP firms without financial difficulties. At the same time, however, there was a noticeable credit misallocation towards low-TFP zombie firms experiencing financial strains. Contrary to the findings of GS, our empirical analysis reveals little evidence to suggest that capital injections spurred investment even for high-TFP firms, regardless of the bank's capitalization level, while we provide evidence of a reduction in investment by low-TFP zombie firms.[2] Furthermore, our study offers novel evidence hinting at the possibility that these bank loans were channeled to boost the productivity of high-TFP non-zombie firms driven by growth in advertising expenditures.

Our study is also 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 Balduzzia et al. (2018), De Marco (2019), Hubbard et al. (2002), and Schwert (2018).

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. In Section 3, we describe 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 and productivity. In Section 5, we present our concluding remarks.

[2]The difference in findings between GS and our study may be due to the difference in data coverage, since, as discussed in detail in Section 3, our sample differs from GS's sample in terms of both sectors and sample periods.

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.[3] 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 about a credit crunch, the government decided to allow some flexibility for banks in the scheme's implementation.[4] 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 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.

[3] 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.

[4] 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.

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.

Prior to the implementation of the Prompt Corrective Action, several major banks and securities firms collapsed in November 1997. In response, the Diet enacted the Financial Function Stabilization Act, authorizing the use of JPY 30 trillion in public funds. By March 1998, the government had injected JPY 1.8 trillion into all major (city) banks and several regional banks, most of which received JPY 100 billion in subordinated debt. Later in 1998, after an intensive review of 19 major banks' assets, the Financial Supervisory Agency felt prior evaluations were overly optimistic. As a result, the Diet doubled the available funds to JPY 60 trillion through the Prompt Recapitalization Act. The Long-Term Credit Bank of Japan (LTCB) and Nippon Credit Bank (NCB) went under and were nationalized later that year. In March 1999, to further strengthen the banking sector, a JPY 7.5 trillion capital injection was issued. The amount of the 1999 capital injection varied considerably across banks (see Hoshi and Kashyap 2010, Table 5), providing a source of variation for identifying the impact of the capital injection on bank lending, investment, and productivity.

3 Data Source and Variable Definition

Following Nagahata and Sekine (2005), we combine firm-level 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).

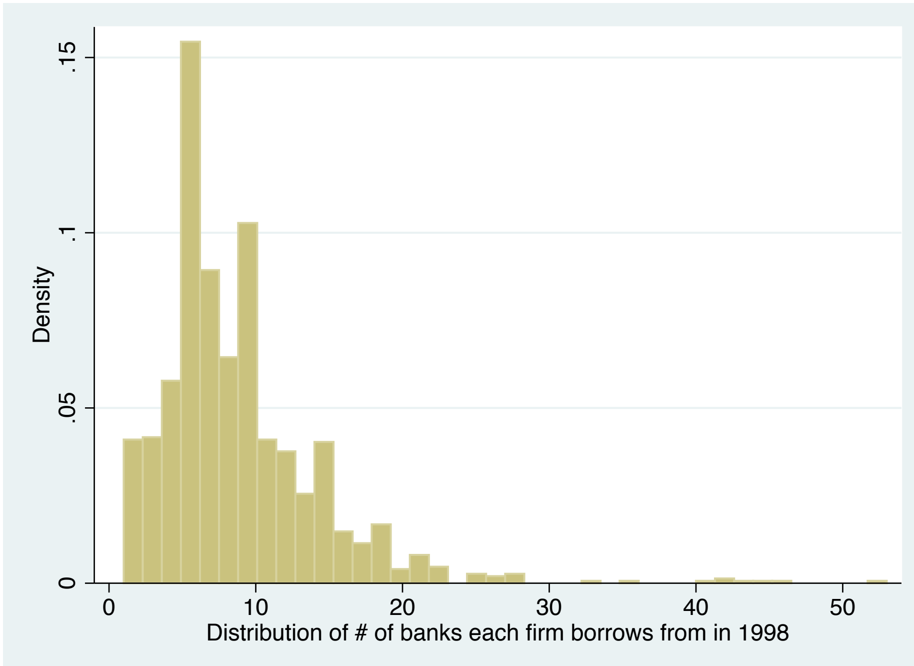
The DBJ data set contains detailed information about the financial statements for publicly traded firms in Japanese stock markets. We construct the firm-level variables used in our regression analysis from the DBJ data set. Importantly, it provides data on outstanding loans by financial institutions, which we combine with the Nikkei NEEDS and JBA data.[5] 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 investment in fixed assets is more active in the manufacturing sector than in other non-financial industries. Our main sample period for regressions runs from 1998 to 2000, although we use data from 1995 to 1997 to compute loan shares for the pre-sample period and to estimate the production function for the firm's TFP using the DBJ data from 1980 to 2008. Our sample differs from the GS sample in that GS includes firms in non-financial sectors other than the manufacturing sector, and its sample period is from 1998 to 2005. Because many bank mergers occurred after 2001, we decided to exclude the sample after 2001 to eliminate the additional impacts from the mergers. The GS sample includes 71 bank mergers affecting 58 banks.

Table 1 reports various statistics on bank-firm relationships based on the 1998 sample, which contains 9556 relationships between firms and banks, among 135 banks and 1144 firms. In a given year, each firm borrows from multiple banks. Panel A of Table 1 and Figure

[5] 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.

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



3 present, respectively, the statistics and a histogram of the number of banks each firm 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 median loan share of the top bank—the bank from which a firm borrows the most—in the total loans is 29% while that of the top five banks is 77%.

In our dataset, large publicly-traded firms have a median of 7 bank relationships, comparable to several European countries when controlling for firm size.[6] Notably, the top five firms (Mitsubishi Electronic, Mazda, Fujitsu, NEC, and Toshiba) have ties with over 40 banks. These industry giants, producing electronics or cars and operating in various regions, often engage with different regional banks. Panel B of Table 1 shows that as firms have more bank connections, they increasingly borrow from regional banks, where many of

[6]For comparison, smaller Japanese firms average three bank connections (Ogawa et al. 2007). Large European firms show varied bank relationships ranging from 7 to 12, depending on the nation (Ongena and Smith 2000).

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

Panel A: Summary Statistics		Obs	Mean	Median	Std. Dev.	Min	Max
# of banks each firm borrows from	All firms	1144	8.353	7	5.327	1	51
	Small	83	4.795	5	2.722	1	16
	Medium	781	7.607	7	3.648	1	25
	Large	280	11.489	10	7.853	1	51
Loan share of the top bank		1144	0.334	0.294	0.174	0.059	1.000
Loan share of top 5 banks		1144	0.750	0.774	0.194	0.074	1.000
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	0.564	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	

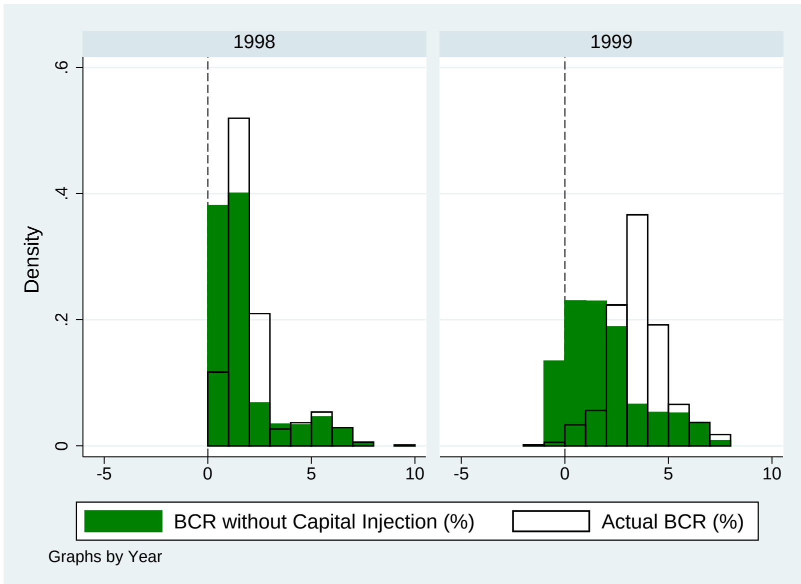
Notes: This table is based on the 1999 sample, which contains 9556 relationships between firms and banks, among 135 banks and 1144 firms. Small, medium, and large firms have fewer than 200 employees, between 200 and 2000 employees, and more than 2000 employees, respectively. The regional banks are the 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.

these loans are short-term, often renewing previous loans, as shown in Panel C of Table 1.

To gauge the bank's compliance with capital regulations, we construct the variable BCR_{kt} for each bank k during year t 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).[7] Figure 4 contrasts the counterfactual distribution of BCR_{kt}

[7] 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.

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



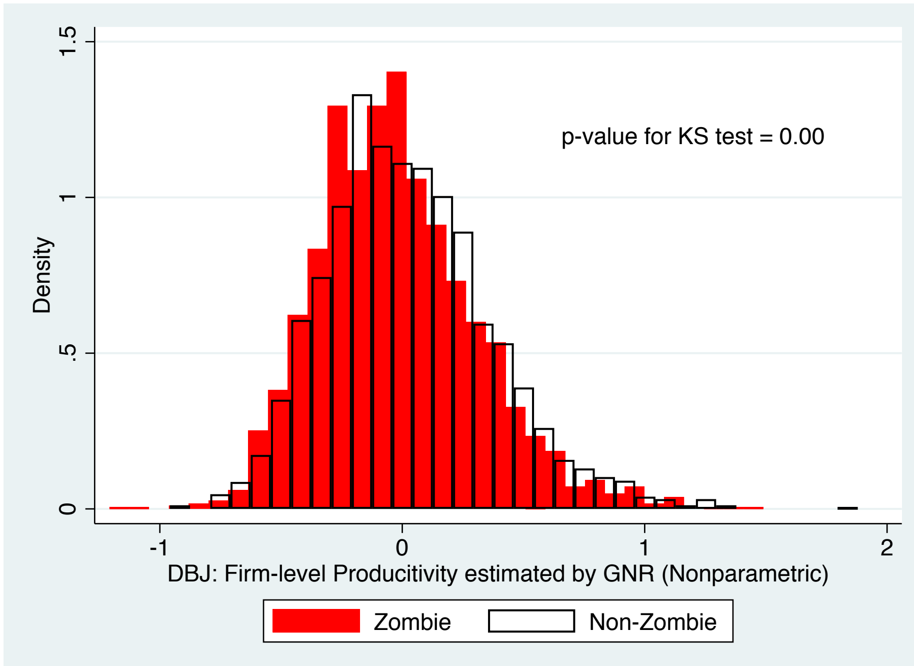
Notes: Weighted by the loan supply. The x-axis is the Basel I capital adequacy ratio less the required capital ratio.

without the capital injection in 1998 and 1999 to the actual distribution, weighted by loan amounts, where the counterfactual value of BCR_{kt} adjusts the numerator of the Basel I capital adequacy ratio by subtracting the amount of the capital injection from it, keeping risk-weighted assets (the denominator) unchanged. This comparison reveals that, without capital injections in 1998 and 1999, many banks would have struggled to meet the required capital ratios.[8]

We construct the TFP measure from a production function using revenue data between 1980 and 2008, based on the method by Gandhi et al. (2020). Firms are labeled as "Zombie" if their interest payments fall below a set minimum, as defined by Caballero et al. (2008).

[8] 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 their balance sheets during the 1990s. Despite this, we choose to 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.

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



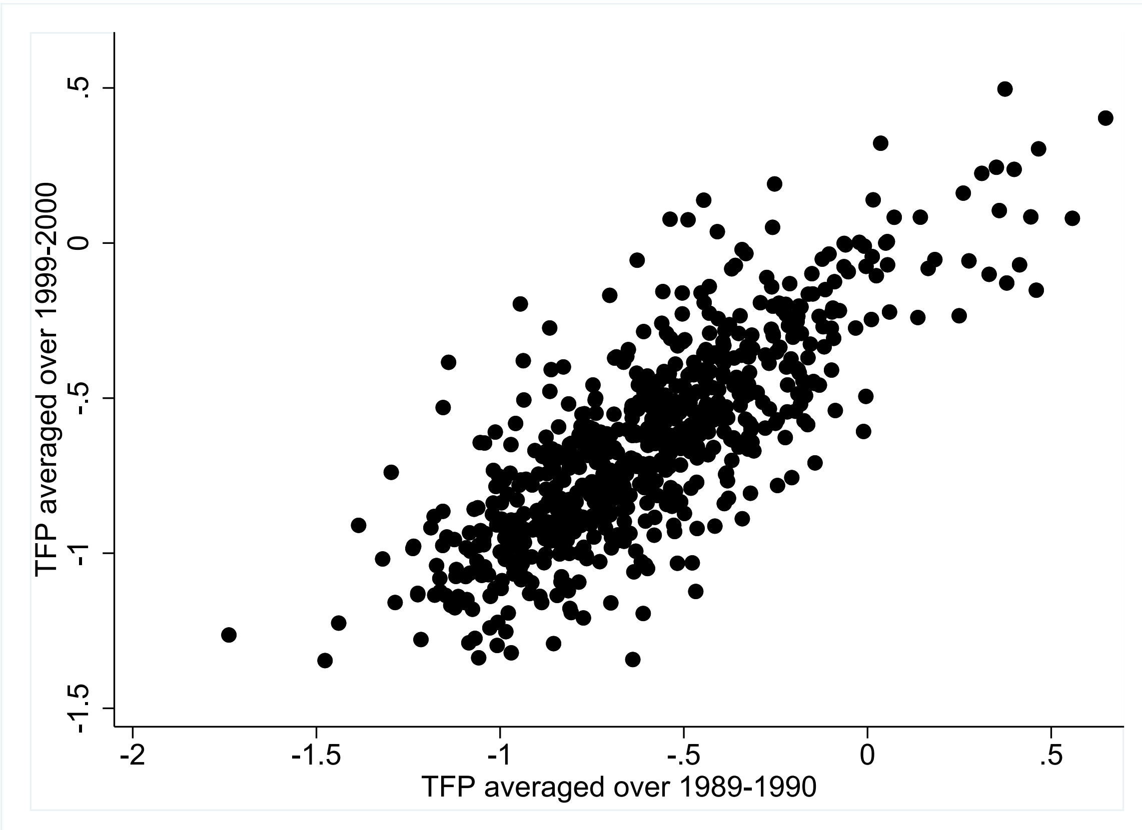
Notes: The x-axis is the log of TFP.

The detailed processes for determining TFP and the Zombie indicator can be found in Appendix A and Appendix C. Table A2 in Appendix presents the summary statistics for TFP, Zombie indicator, and other variables in our regression analysis.

Figure 5 presents a histogram of the log of the TFP of zombie and non-zombie firms, where the Kolmogorov–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 large portion of cross-sectional variation of TFP measures reflects persistent shocks, which is likely to represent persistent productivity shocks rather than temporary demand shocks.

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.

The Zombie variable is constructed from a firm's recorded interest payment as discussed in Appendix A.2 to capture the presence of credit assistance and, therefore, is more likely to reflect the firm's financial health status. We examine how the association of the capital injection and the bank capital ratios with bank loans, investment, and productivity varies across different firm categories regarding productivity and financial health status, respectively, measured by the TFP and Zombie variables.

Table 2 presents the summary statistics for the sub-sample of firms classified by zombie status and high vs. low TFP levels using their average TFP levels from 1995 to 1997, where columns (4) and (7) 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)-(3) indicate substantial heterogeneities among the firms under our study: 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 (5)-(6), 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 Event-Study Regression

To analyze the impact of capital injection on bank loan growth, we begin with an event-study analysis via the following regressions:

$$\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}} = \sum_{s=1996}^{2000} \beta_s Treat_{ik} \times \mathbb{I}(s=t) + D_k^b + D_i^f \times D_t^{\text{year}} + \epsilon_{ikt}, \tag{1}$$

$$\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}} = \sum_{s=1996}^{2000} \beta_s \omega_{ik,1995} \times Treat_{ik} \times \mathbb{I}(s=t) + D_k^b + D_i^f \times D_t^{\text{year}} + \epsilon_{ikt}. \tag{2}$$

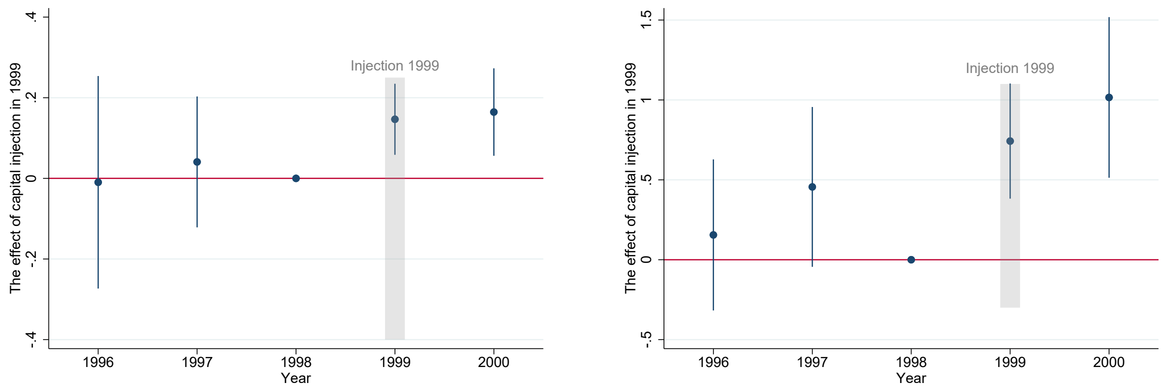
Here, ℓ_{ikt} represents the loan amount from bank k to firm i in year t; $\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}}$ denotes the growth rate of these loans between year $t-1$ and t. The treatment variable, $Treat_{ik}$, equals one if bank k's 1999 capital injection is above the average injections across banks related to firm i. $\mathbb{I}(.)$ is an indicator function that takes one if the augment is true; and zero otherwise. We incorporate both bank and firm-year fixed effects, represented by D_k^b and $D_t^{\text{year}} \times D_i^f$. Equation (1) aligns with the analysis by Khwaja and Mian (2008), identifying the treatment effect via firm-specific variations across lending banks to control for firm-side unobserved demand factors. In equation (2), we further consider the possibility that the

Table 2: Summary Statistics by TFP and Zombie Status

	All	TFP<P25	P25≤ TFP	t-stat for (3)-(2)	Zombie	Non-Zombie	t-stat for (6)-(5)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\ln Y_{it-1}$ (ln Sales)	17.380	16.914	17.557	12.477	17.050	17.599	12.389
$\ln L_{it-1}$ (ln Labor)	6.704	6.682	6.724	1.004	6.402	6.906	12.962
$\ln K_{it-1}$ (ln Capital)	16.418	16.301	16.476	3.302	16.112	16.621	10.781
$I_{m,it}/K_{m,it-1}$ (Machine investment rates)	0.092	0.083	0.094	2.484	0.086	0.096	2.118
$\overline{BCR}_{it-1}$	2.219	2.276	2.190	-1.592	2.172	2.250	1.639
$\overline{(Inject/e)}_{it}$	0.170	0.172	0.168	-0.377	0.162	0.176	1.640
$\overline{(Inject/e)}_{i,1998}$	0.085	0.085	0.085	0.059	0.089	0.081	-3.288
$\overline{(Inject/e)}_{i,1999}$	0.458	0.466	0.456	-0.824	0.462	0.456	-0.549
$\overline{(Inject/e)}_{it}$ (Tier 1)	0.121	0.123	0.119	-0.562	0.115	0.125	1.218
TFP_{it-1}	0.006	-0.349	0.129	55.210	-0.025	0.027	3.979
$Zombie_{it-1}$	0.402	0.454	0.385	-3.115	1.000	0.000	.
$\ln K_{m,t-1}$ (ln Machine Capital)	15.370	15.234	15.445	3.162	15.049	15.587	9.003
$b_{it-1}/collat_{it-1}$ (Debt-to-collateral ratios)	1.772	1.861	1.736	-1.358	1.735	1.797	0.861
$Cash_{it-1}/K_{it-1}$ (Cash-to-capital ratios)	0.313	0.226	0.342	9.010	0.311	0.314	0.208
$\overline{Domestic}_{it}$	0.065	0.069	0.063	-1.069	0.064	0.065	0.156
Number of banks	8.728	8.361	8.900	2.146	8.241	9.055	4.241

Notes: See the footnote of Appendix Table A2 for the definitions of the variables.

capital injection's effect might be tied to relationship size, with $\omega_{ik,1995}$ showing bank k's loan share to firm i in 1995, where the capital injection to the firm's main bank may have had a larger impact on bank loans than that to other banks.



(a) Equation (1)

(b) Equation (2)

Figure 7: Event Study: Effects of Capital Injection

Figure 7(a) plots the estimate of coefficients β_s for $s = 1996$ to 2000 in equation (1) with their 95% confidence intervals, indicating the positive association of capital injection with loan growth in 1999-2000. Furthermore, we observe no trend in differences between treated and control groups in the pre-treatment period from 1996 to 1998.

Figure 7(b) shows the results of the event study regression (2) under the assumption that the effect of the capital injection is proportional to the relationship size. The overall pattern is similar to that of Figure 7(a).[9]

We also estimate the average treatment effect (ATE) of the 1999 capital injection on the loan growth by the augmented inverse probability weighting (AIPW) method using the cross-sectional data from 1999. The AIPW method is a doubly-robust method in which estimate can be interpreted as the causal effect when either the unconfoundedness assumption holds or the outcome model is correctly specified (Cattaneo et al. 2013). For

[9]The estimated positive value for 1997 (although not significantly different from zero) suggests a possible violation of the pre-trend, raising a potential concern that the estimated capital injection effect in 1999 may reflect a reversion to the mean. Given this concern, we include past loan growth—together with bank fixed effects and firm-year fixed effects—as a control in our regression analysis of loan growth in Section 4.2.

the propensity score, we estimate a logit model with $Treat_{ik}$ as the dependent variable and BCR_{kt}, $Inject_{kt}/e_{k,t-1}$, $Deposit_{kt-1}$, the pre-sample average of the defaulted loans to bank equity, the regional bank dummy, TFP_{it-1}, $Zombie_{it-1}$, $\ln K_{it-1}$, $Cash_{it-1}/K_{it-1}$, and $b_{it-1}/Collat_{it-1}$ as covariates. Here, the variable $\text{Inject}_{kt}/e_{kt-1}$ is the ratio of the sum of Tier 1 and Tier 2 capital injections into bank k to its previous year's equity for year $t = 1999$, TFP_{it-1} is the log of the TFP of firm i in year $t-1$, $\ln K_{it-1}$ 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 the 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 and capital stocks where we set that $\text{Collat}_{it-1} = 0.1573\tilde{\text{K}}_{it-1} + 0.6777\text{Land}_{it-1}$, with $\tilde{\text{K}}_{it-1}$ representing the sum of machinery, instruments and tools, and transportation equipment, and Land_{it-1} is land stock.[10][11] Table A2 in Appendix reports their summary statistics.

Using the AIPW estimation, we obtain the positive and significant estimate of the ATE with the point estimate of 0.13 and the standard error clustered at the bank level of 0.05.[12] This finding is broadly consistent with that of Figure 7, suggesting that the 1999 capital injections are positively associated with increased bank lending when we compare banks with similar propensities to receive capital injections.

While the endogenous nature of the injections implies that any casual interpretation needs to be done with caution, overall, the results from both the event study analysis and the AIPW method provide supportive evidence of the impact of capital injections on increased bank lending under different identifying assumptions. We interpret this evidence as an indication that the policy eased constraints on banks, thereby promoting enhanced lending to firms.

[10] The weights (0.1573 and 0.6777) are taken from Ogawa and Suzuki (2000).

[11] For the loan growth linear regression model in Section 4.2, we use the same covariates and the complete set of the month dummies. In this cross-sectional analysis using the AIPW, we add the pre-sample average of the defaulted loans to bank equity and the regional bank dummy to account for the probability of receiving more capital injection.

[12] Table A4 of the appendix shows that the observations become more balanced once conditioned on the value of propensity scores. Figure A1 in the appendix presents the histogram for the estimated propensity score by the treatment status. We check the robustness of the AIPW estimate by restricting the sample to the observations for which the estimated propensity score is between 0.55 and 0.85, where the common support assumption is more likely to hold. The estimated ATE for this subsample is 0.078 with the standard error of 0.049.

In Appendix B, we analyze how the amount of capital injection in 1999 is related to firm-side demand factors and bank characteristics that might affect capital injection, where we find a clear distinction in the observable characteristics of treated and untreated banks, particularly in the capital adequacy and deposit-to-asset ratios. On the other hand, the lack of significance of the coefficients on the previous year's loan growth rate, TFP, and zombie status does not provide evidence that the capital injection in 1999 is strongly correlated with latent demand factors for equity.

4.2 Capital Injection and Bank Loan

We now 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 bank k by estimating the following loan growth regression model for $t = 1998, .., 2000$:[13]

$$\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}} = \beta_0 + \beta_1 \left(\frac{\text{Inject}_{kt}}{e_{k,t-1}} \times \omega_{ik} \right) + \beta_2 \left(\text{BCR}_{k,t-1} \times \omega_{ik} \right) + \beta_3 \left(\frac{\text{Inject}_{kt}}{e_{k,t-1}} \times \text{BCR}_{k,t-1} \times \omega_{ik} \right)$$
$$+ \beta_4 \omega_{ik} + \beta_b' \left(Z_{kt}^b \times \omega_{ik} \right) + D_k^b + D_i^f \times D_t^{\text{year}} + D_t^{\text{year}} \times D_i^{\text{closing month}} + u_{ikt}, \qquad (3)$$

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, $\text{Inject}_{kt}/e_{kt-1}$, and the difference between the Basel I capital adequacy ratio and the required ratio under the banking regulations in year $t-1$, denoted by $\text{BCR}_{k,t-1}$.

We include the bank fixed effects and the firm-year fixed effects, denoted by D_k^b and $D_t^{\text{year}} \times D_i^f$, respectively. The inclusion of firm-year fixed effects controls for unobserved time-varying loan demand factor from firms, 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_t^{year}, and a firm-level dummy for the fiscal year closing month, $D_i^{\text{closing month}}$. Our specification also includes bank-level variables $Z_{kt}^b = (\text{Domestic}_{kt-1}, \text{Deposit}_{kt-1}/A_{kt-1})'$, where Domestic_{kt-1} is a dummy

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

variable that is set to one if bank k operates only in the domestic market in year $t-1$, $\text{Deposit}_{kt-1}/A_{kt-1}$ is the deposit-to-asset ratio for the year $t-1$.[14]

For our robustness check, we also incorporate the lagged loan growth variable to account for potential mean reversion. Given that the lagged loan growth variable is missing when an observation of the loan variable at $t-2$ is absent, we include a dummy variable for these missing observations, denoted by $D^{\text{missing}}_{ik,t-1}$.[15]

In Equation (3), we interact the measure of relationship size, ω_{ik}, with other explanatory variables to convey the potential that capital will flow disproportionately more to those with a tighter relationship. In other words, supply shocks should be distributed unequally with a stronger response for a firm with a more significant relationship, such as being a firm's main bank. Here, ω_{ik} is the average share of bank k's loans of the total loans to firm i in the pre-sample years (1995–1997), where we use the pre-sample period's weights to mitigate concerns about the endogenous determination of the bank share of loans.

Table 3 presents the estimates of Equation (3). We use the sum of Tier 1 and Tier 2 capital injections to compute $\text{Inject}_{kt}/e_{kt-1}$ in columns (1) to (4), but use only Tier 1 capital injections in columns (5) to (8). Columns (1) and (4) present the result of a specification without an interaction term, $\text{BCR}_{k,t-1} \times \frac{\text{Inject}_{kt}}{e_{k,t-1}} \times \omega_{ik}$, while columns (3)-(4) and (7)-(8) include the interaction term, the lagged loan growth, and a dummy variable for missing lagged loan growth observations as additional explanatory variables. Given that the capital

[14] We choose these bank-level variables because, according to the Financial Reconstruction Commission (Financial Reconstruction Commission 1999), the bank's outstanding non-performing loans and unrealized losses from securities are major determinants of the injection amounts in March of 1999. The bank regulatory bank ratio (BCR) reflects the extent to which the banks have outstanding non-performing loans and unrealized losses from securities. The deposit-to-asset ratios capture the bank's profitability. The domestic status dummy is included because domestic and international banks' required capital ratios differ.

[15] Specifically, our dummy variable for missing observations, $D^{\text{missing}}_{ik,t-1}$, is defined as:

$$D^{\text{missing}}_{ik,t-1} := \begin{cases} 1 & \text{if } \ell_{ik,t-2} \text{ is missing and } \ell_{ik,t-1} > 0, \\ 0 & \text{otherwise.} \end{cases}$$

We further define $\frac{\Delta \ell_{ik,t-1}}{\ell_{ik,t-2}} \times (1 - D^{\text{missing}}_{ik,t-1})$ as:

$$\frac{\Delta \ell_{ik,t-1}}{\ell_{ik,t-2}} \times (1 - D^{\text{missing}}_{ik,t-1}) := \begin{cases} 0 & \text{if } D^{\text{missing}}_{ik,t-1} = 1, \\ \frac{\Delta \ell_{ik,t-1}}{\ell_{ik,t-2}} & \text{otherwise.} \end{cases}$$

We estimate the loan growth regression with these added controls for robustness check.

Table 3: 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)
$\text{Inject}_{kt}/e_{k,t-1} \times \omega_{ik}$	0.5818***	0.9887**	0.5478***	0.9492**	0.8296***	1.3195***	0.7906***	1.2725***
	[0.203]	[0.393]	[0.207]	[0.393]	[0.224]	[0.408]	[0.226]	[0.406]
$\text{BCR}_{k,t-1} \times \omega_{ik}$	0.2479***	0.2623***	0.2431***	0.2573***	0.2505***	0.2644***	0.2461***	0.2598***
	[0.047]	[0.053]	[0.047]	[0.052]	[0.048]	[0.052]	[0.047]	[0.051]
$\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1} \times \omega_{ik}$		-0.2441		-0.2408		-0.3014		-0.2965
		[0.194]		[0.193]		[0.193]		[0.193]
$\frac{\Delta \ell_{ik,t-1}}{\ell_{ik,t-2}} \times (1 - D^{\text{missing}}_{ik,t-1})$			-0.0318***	-0.0319***			-0.0317***	-0.0318***
			[0.005]	[0.005]			[0.005]	[0.005]
$D^{\text{missing}}_{ik,t-1}$			0.1511**	0.1503**			0.1505**	0.1496**
			[0.070]	[0.070]			[0.069]	[0.070]
ω_{ik}	-1.5834***	-1.5852***	-1.5404***	-1.5425***	-1.5542***	-1.5549***	-1.5160***	-1.5170***
	[0.279]	[0.281]	[0.282]	[0.284]	[0.272]	[0.272]	[0.274]	[0.274]
$\text{Domestic}_{kt-1} \times \omega_{ik}$	-0.6448**	-0.6761**	-0.6338**	-0.6647**	-0.6470**	-0.6827**	-0.6369**	-0.6721**
	[0.271]	[0.275]	[0.275]	[0.279]	[0.268]	[0.273]	[0.272]	[0.277]
$\text{Deposit}_{kt-1}/\text{A}_{kt-1} \times \omega_{ik}$	0.6327	0.579	0.6464	0.5935	0.5618	0.5148	0.5806	0.5344
	[0.409]	[0.427]	[0.405]	[0.422]	[0.405]	[0.416]	[0.400]	[0.412]
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,604	24,604	24,604	24,604	24,604	24,604	24,604	24,604
Number of Firms	1116	1116	1116	1116	1116	1116	1116	1116
Number of banks	110	110	110	110	110	110	110	110

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 $\Delta \ell_{ikt}/\ell_{ik,t-1}$ 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 $\text{Inject}_{kt}/e_{k,t-1}$ 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%.

injection occurs at the bank level, we report the clustered standard errors at the bank level.

Across different specifications, the estimated coefficient of $(\text{Inject}_{kt}/e_{kt-1}) \times \omega_{ik}$ is positive and significant, indicating that the banks that received government capital injections increased their supply of loans to firms. The estimated coefficient of $(\text{Inject}_{kt}/e_{kt-1}) \times \omega_{ik}$ is 0.5818 in column (1) of Table 3 while evaluating $(\text{Inject}_{kt}/e_{kt-1}) \times \omega_{ik}$ for $t = 1999$ at the sample average of 0.047 implies that the capital injection increased bank loans by $(0.5818 \times 0.047 =)$ 2.7 percentage points. Furthermore, the positive and significant coefficient of $\text{BCR}_{k,t-1} \times \omega_{ik}$ implies that 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. On the other hand, the negative and significant coefficient of $\text{Domestic}_{kt-1} \times \omega_{ik}$ suggests that international banks provide more loans than domestic banks do.

The effect of capital injection on loan growth may be larger when the capital is injected into under-capitalized banks than into well-capitalized banks, as suggested by the negative coefficient estimate of an interaction term between BCR and capital injection variables in column (2). This result on heterogeneity is plausible—if banks are well-capitalized, additional equity from the capital injection may not necessarily lead to increased loans to firms. In columns (3) and (4) of Table 3, the estimated coefficient of $(\text{Inject}_{kt}/e_{kt-1}) \times \omega_{ik}$ remains positive and significant after controlling for the lagged loan growth rate and for missing lagged loan observations. The negatively estimated coefficient of the lagged loan growth possibly captures a reversion to the mean, i.e., the high loan growth rate is followed by the low growth rate. The results are similar when using Tier 1 capital injections in columns (4)-(8).

In the appendix, Table A8 presents the regression outcomes when the explanatory variables include both interacted and non-interacted with ω_{ik}. Upon assessing the coefficient of the capital injection variables, we observe that the term interacting with the size relationship is significantly positive while the non-interacted term is insignificant. This suggests that the link between capital injections and bank lending is heterogeneous. It is especially pronounced when there's a stronger loan-share relationship. Moreover, when evaluated at the sample averages of $\text{Inject}_{kt}/e_{kt-1} \times \omega_{ik}$ and $\text{Inject}_{kt}/e_{kt-1}$, the quantitative implications are similar in magnitude between the baseline specification only with the interaction terms and the alternative specification with both terms. Since it is not straightforward to interpret the implications for the estimates under the specification with both interacting and non-interacting terms, we focus our attention on the specification (3). The appendix D.2 provides further discussion.

We now estimate the heterogeneous effects of the capital injection on bank loans by firm-level TFP and zombie status. 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 25th percentile values of the average TFP over the 1995–1997 period. Table 4 reports the result of estimating Equation (3) for each subsample.

Columns (1) and (4) of Table 4 report the results for non-zombie firms and zombie firms, respectively, without splitting the sample by TFP. The estimated coefficients of $\text{Inject}_{kt}/e_{kt-1} \times \omega_{ik}$ are positive and significant in both columns (1) and (4). The negative coefficient estimate of the interaction term $\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1} \times \omega_{ik}$ suggests that the association of capital injection with loan growth rates is stronger for low-BCR banks than for high-BCR banks, especially for zombie firms. Therefore, after the capital injection, undercapitalized banks increased their loans to zombie firms more than well-capitalized banks. These results are broadly consistent with that of Giannetti and Simonov (2013, Panel D of Table 3).

In Table 4, the results for the subsample of non-zombie firms with high- and low-TFP are presented in columns (2) and (3), respectively. The estimate coefficients of $(\text{Inject}_{kt}/e_{kt-1}) \times \omega_{ik}$ and $\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1} \times \omega_{ik}$ in column (2) of Table 4, while evaluating them at the corresponding sample average, imply that the 1999 capital injection is associated with a substantial increase in bank loans of approximately $(1.531 \times 0.043 - 0.3628 \times 0.073 =)$ 3.9 percentage points for high-productivity non-zombie firms.[16] However, for low-productivity non-zombie firms, the estimated coefficients of $\text{Inject}_{kt}/e_{kt-1} \times \omega_{ik}$ and $\text{Inject}_{kt}/e_{k,t-1} \times$

[16] Table A5 in the appendix reports the sample average of $\text{Inject}_{kt}/e_{kt-1} \times \omega_{ik}$ and $\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1} \times \omega_{ik}$ for each category defined by TFP and zombie status.

Table 4: Effect of Capital Injections on Bank Loans: Zombie vs. Non-Zombie (Dependent Variable $\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}}$)

Sample	Non-zombie			Zombie		
	All	TFP≥P25	TFP<P25	All	TFP≥P25	TFP<P25
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{Inject}_{kt}/e_{k,t-1} \times \omega_{ik}$	1.1784**	1.5310**	0.1189	0.7760**	0.2974	1.8897**
	[0.526]	[0.676]	[0.732]	[0.382]	[0.487]	[0.828]
$\text{BCR}_{kt-1} \times \omega_{ik}$	0.3231***	0.3952***	0.1321	0.1893***	0.1307*	0.3209***
	[0.083]	[0.101]	[0.096]	[0.055]	[0.077]	[0.109]
$\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{kt-1} \times \omega_{ik}$	-0.2277	-0.3628	0.1583	-0.3350*	-0.2086	-0.6391
	[0.263]	[0.309]	[0.452]	[0.182]	[0.218]	[0.471]
$\frac{\Delta \ell_{ik,t-1}}{\ell_{ikt-2}} \times (1 - D^{\text{missing}}_{ik,t-1})$	-0.0385***	-0.0466***	-0.0242*	-0.0380***	-0.0407***	-0.0491**
	[0.006]	[0.007]	[0.014]	[0.011]	[0.012]	[0.023]
$D^{\text{missing}}_{ik,t-1}$	0.0331	-0.0377	0.2122*	0.2870**	0.2319	0.4484**
	[0.055]	[0.063]	[0.113]	[0.120]	[0.144]	[0.183]
ω_{ik}	-1.7910***	-2.2151***	-0.7166	-1.0281***	-0.7446**	-1.6129***
	[0.485]	[0.622]	[0.457]	[0.284]	[0.370]	[0.482]
$\text{Domestic}_{kt-1} \times \omega_{ik}$	-0.7798*	-1.0265*	-0.0965	-0.4831	-0.2538	-1.0757
	[0.400]	[0.557]	[0.416]	[0.351]	[0.429]	[0.697]
$\text{Deposit}_{kt-1}/\text{A}_{kt-1} \times \omega_{ik}$	0.5507	0.855	-0.0842	0.1633	0.0041	0.3827
	[0.664]	[0.861]	[0.613]	[0.394]	[0.523]	[0.610]
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,830	11,289	3,541	8,507	6,130	2,377
Number of Firms	767	584	183	547	395	152
Number of banks	108	104	93	102	101	87

Notes: In this table, the lagged loan growth rate $\Delta \ell_{ikt-1}/\ell_{ik,t-2}$ is added as an additional covariate to Table 4. See footnote in Table 4 for subsamples and other covariates used. Standard errors adjusted for clustering at the bank level are in brackets. *** 1%, ** 5%, * 10%.

$\text{BCR}_{k,t-1} \times \omega_{ik}$ are not statistically significant in column (3), implying a smaller increase of approximately $(0.119 \times 0.047 + 0.1583 \times 0.082)$ 1.8 percentage points in bank loans.

Similarly, in column (2), the estimated coefficient of $BCR_{kt-1} \times \omega_{ik}$ is positive and statistically significant for high-TFP firms, whereas, in column (3), it fails to show statistical significance from zero for low-TFP firms. This suggests that better-capitalized banks increase their bank loans to high-TFP non-zombie firms compared to banks with lower bank capital ratios. However, there is no statistically significant difference in bank loans to low-TFP non-zombie firms between these two types of banks. From these observations, we infer that the enhancement in bank capital ratios through capital injection encourages banks to increase their loans to high-productivity firms, but it does not necessarily result in increased lending to low-productivity firms that have no financial difficulties. One plausible explanation for this is that low-productivity firms without financial troubles might lack profitable investment projects.

Strikingly, the opposite pattern is true for zombie firms, as shown in columns (5)–(6) of Table 4, where the estimated coefficient of $\text{Inject}_{kt}/e_{kt-1} \times \omega_{ik}$ is nonsignificant for high-TFP firms in column (5), but is positive and significant for low-TFP firms in columns (6). The estimated coefficients of $(\text{Inject}_{kt}/e_{kt-1}) \times \omega_{ik}$ and $\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1} \times \omega_{ik}$ in column (6) suggest that the 1999 capital injection is linked to a substantial increase in bank loans of approximately $(1.890 \times 0.056 - 0.639 \times 0.095 =)$ 4.5 percentage points for low-TFP zombie firms with financial difficulties while, for high-productivity zombie firms, the nonsignificant estimate implies a decrease of approximately $(0.297 \times 0.051 - 0.209 \times 0.089 =)$ -0.3 percentage points in bank loans.

The estimated coefficients of $BCR_{kt-1} \times \omega_{ik}$ are positive and statistically significant both for low- and high-TFP firms in columns (5) and (6), providing evidence that an improvement in bank capital ratios is associated with increased bank loans to firms facing financial difficulties, irrespective of their productivity levels. However, it is noteworthy that the estimate is relatively smaller for high-TFP zombie firms compared to low-TFP zombie firms.

Upon testing the null hypothesis of no difference in the coefficient of $(\text{Inject}_{kt}/e_{kt-1}) \times \omega_{ik}$ between high-TFP and low-TFP firms within the non-zombie subsample, a two-tailed test yields a p-value of 0.149.[17] This implies marginal evidence suggesting that the connection between capital injection and loan growth holds more strongly for high-TFP non-zombie firms than their low-TFP counterparts. Similarly, performing an analogous test on the disparity in the BCR variable coefficient between high and low TFP firms within the non-zombie subsample yields a p-value of 0.039, providing statistical evidence that, within the non-zombie subgroup, the positive relationship between bank capital ratios and bank loans is more pronounced for high-TFP firms than for low-TFP ones.

For the zombie subsample, assessing the difference in the coefficient of the capital injection variable between low and high TFP firms yields a p-value of 0.130, while the corresponding p-value for the difference in the coefficient of the BCR variable stands at 0.196.

We interpret the result of Table 4 as suggestive of the possibility that capital injection increased the credit supply to two very different firms: the high-productivity non-zombie firms with profitable investment projects and the low-productivity zombie firms with outstanding debts. The latter indicates a possibility that the capital injection might have contributed to a partial credit misallocation towards low-TFP firms that were experiencing financial distress. This outcome suggests that some of the injected capital might have been channeled to firms with lower productivity levels but facing financial troubles, possibly diverting resources from more productive and financially stable firms. Here, the combination of low TFP and the zombie indicator may have accurately identified what can be termed as "true" zombie firms—entities that are unable to sustain operations without financial support from banks.

Results are qualitatively unchanged when we control for the ratio of defaulted loan to equity or use a slightly different measure of the bank regulatory bank ratio (BCR), i.e., subtracting deferred tax assets and defaulted loans from bank capital as reported in Tables

[17] We estimate a bank loan regression on the combined sample of non-zombie firms, with the interaction of the capital injection variable and the high-TFP firm dummy, using low-TFP firms as the reference group and obtain the p-value for testing the null hypothesis that the coefficient of the interacted term is zero. The results are available upon request.

5 and A10-A11 in the appendix.[18][19][20]

In Table 6, we conduct a falsification test by examining the effect of a "future" injection on bank lending by replacing the capital injection variable at t and the bank capital ratios at $t-1$ with the capital injection variable at $t+1$ and the bank capital ratios at t, respectively, in the regression. Across different specifications, the estimated coefficients of the future capital injection are not significantly different from zero. Thus, we are not able to statistically detect any difference between the treated banks and the untreated ones banks in their lending behavior before the injection. This provides supportive evidence that the treated and the untreated banks may have been comparable prior to the injection.

4.3 Capital Injection, Investment, and Productivity

In the preceding section, our analysis revealed suggestive evidence that capital injection led to an increase in credit supply to firms, particularly benefiting high-TFP non-zombie firms and low-TFP zombie firms. Building on these findings, we now seek to investigate whether capital injections as well as improved bank capital ratios promoted corporate investment. To achieve this, we employ a linear investment model using firm-level panel data covering the years from 1997 to 1999:

$$\begin{aligned}\frac{I_{it}}{K_{it-1}} &= \alpha_1\overline{(\text{Inject}/e)}_{it} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1}=0) + \alpha_2\overline{(\text{Inject}/e)}_{it} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1}=1) \\ &+ \alpha_3\overline{(\text{Inject}/e)}_{it} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1}=0) + \alpha_4\overline{(\text{Inject}/e)}_{it} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1}=1) \\ &+ \alpha_f' Z_{it} + D_i^f + D_t^{\text{year}} \times D_i^{\text{closing month}} + \epsilon_{it}, \qquad (4)\end{aligned}$$

[18] We use the loan to borrowers who had gone bankrupt as our measure of defaulted loans, given the limited data available on other types of nonperforming loans.

[19] In columns (1)–(5) of Table 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). Because data on deferred tax assets and defaulted loans are not available for some banks including those that only operate domestically, columns (6)–(10) use an alternative bank capital ratio that is computed from publicly available balance sheet information, where we include the variable $\text{BCR}_{k,t-1} \times \text{Domestic}_{kt-1} \times \omega_{ik}$ and $\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1} \times \text{Domestic}_{kt-1} \times \omega_{ik}$ to distinguish between international and domestic banks.

[20] 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. The results are also similar when we re-estimate the regression specification (3) 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). The regression result is available from the authors upon request.

Table 5: 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				
Sample	All	Non-zombie		Zombie		All	Non-zombie		Zombie	
		TFP≥P25	TFP<P25	TFP≥P25	TFP<P25		TFP≥P25	TFP<P25	TFP≥P25	TFP<P25
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\text{Inject}_{kt}/e_{k,t-1} \times \omega_{ik}$	0.6721*	1.3227**	-0.278	0.0926	0.4689	4.1624***	5.9971***	0.444	3.6272***	5.5176**
	[0.356]	[0.531]	[0.699]	[0.362]	[0.822]	[1.228]	[2.059]	[2.713]	[1.242]	[2.299]
$\text{BCR}_{k,t-1} \times \omega_{ik}$	0.2345***	0.3438***	0.128	0.1396*	0.2379**	0.3128***	0.3629***	0.2674***	0.2317***	0.3223***
	[0.061]	[0.096]	[0.096]	[0.081]	[0.093]	[0.058]	[0.119]	[0.093]	[0.064]	[0.087]
$\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1} \times \omega_{ik}$	-0.3666	-0.8046	0.6252	-0.2669	0.2971	-1.0576***	-1.4999***	-0.0278	-1.0498***	-1.3914**
	[0.328]	[0.557]	[0.823]	[0.361]	[0.780]	[0.335]	[0.559]	[0.800]	[0.339]	[0.653]
$\text{Inject}_{kt}/e_{k,t-1} \times \text{Domestic}_{kt-1} \times \omega_{ik}$						-3.8140**	-11.0838***	-0.6375	0.0187	-3.9039
						[1.799]	[3.117]	[3.051]	[2.498]	[2.428]
$\text{BCR}_{k,t-1} \times \text{Domestic}_{kt-1} \times \omega_{ik}$						-0.3445***	-0.7119*	-0.002	-0.1045	-0.2149*
						[0.128]	[0.360]	[0.131]	[0.136]	[0.113]
$\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1}$						1.1987*	3.7662***	0.3393	-0.1566	1.1454
$\times \text{Domestic}_{kt-1} \times \omega_{ik}$						[0.628]	[1.035]	[1.034]	[1.443]	[0.691]
$\frac{\Delta \ell_{ik,t-1}}{\ell_{ikt-2}} \times (1 - D^{\text{missing}}_{ik,t-1})$	-0.0296***	-0.0441***	-0.0197	-0.0389***	-0.0315	-0.0325***	-0.0470***	-0.0251*	-0.0417***	-0.0453**
	[0.006]	[0.010]	[0.015]	[0.013]	[0.024]	[0.005]	[0.007]	[0.014]	[0.012]	[0.021]
$D^{\text{missing}}_{ik,t-1}$	0.1774**	-0.0138	0.1978*	0.2484	0.5769***	0.1472**	-0.0385	0.2047*	0.2271	0.4509**
	[0.076]	[0.065]	[0.113]	[0.156]	[0.170]	[0.070]	[0.063]	[0.114]	[0.143]	[0.181]
ω_{ik}	-1.1976***	-1.6911***	-0.5477	-0.6015	-1.1651***	-2.3806***	-2.8923***	-1.7068***	-1.5098***	-2.5543***
	[0.235]	[0.468]	[0.404]	[0.390]	[0.351]	[0.298]	[0.696]	[0.514]	[0.364]	[0.609]
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	21,990	10,020	3,110	5,558	2,166	24,599	11,287	3,542	6,129	2,373
Number of Firms	1114	581	183	394	152	1116	584	183	395	152
Number of banks	77	74	72	75	73	110	104	93	100	88

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 $\Delta \ell_{ikt}/\ell_{ik,t-1}$ 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 $\text{Inject}_{kt}/e_{k,t-1}$. 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 25th 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 25th 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 3 are also included in specifications. Standard errors adjusted for clustering at the bank level are in brackets. *** 1%, ** 5%, * 10%.

Table 6: 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)
$\text{Inject}_{k,t+1}/e_{k,t} \times \omega_{ik}$	-0.4053	0.5696	-0.4074	0.5503	-0.5663	0.3517	-0.5648	0.3437
	[0.385]	[0.656]	[0.392]	[0.649]	[0.416]	[0.713]	[0.424]	[0.706]
$\text{BCR}_{kt} \times \omega_{ik}$	-0.0104	0.0187	-0.0096	0.019	-0.0117	0.0097	-0.0106	0.0104
	[0.088]	[0.087]	[0.085]	[0.083]	[0.085]	[0.083]	[0.081]	[0.079]
$\text{Inject}_{kt+1}/e_{k,t} \times \text{BCR}_{kt} \times \omega_{ik}$		-0.5891		-0.5787		-0.5696		-0.5637
		[0.374]		[0.369]		[0.439]		[0.433]
$\frac{\Delta \ell_{ikt-1}}{\ell_{ik,t-2}} \times (1 - D^{\text{missing}}_{ikt-1})$			-0.0069	-0.0069			-0.0069	-0.0068
			[0.005]	[0.005]			[0.005]	[0.005]
$D^{\text{missing}}_{ikt-1}$			0.2158***	0.2151***			0.2155***	0.2154***
			[0.075]	[0.075]			[0.075]	[0.075]
ω_{ik}	-1.0264*	-1.0068*	-0.9661*	-0.9470*	-1.0536**	-1.0363**	-0.9947**	-0.9775**
	[0.553]	[0.546]	[0.541]	[0.534]	[0.503]	[0.500]	[0.488]	[0.486]
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23353	23353	23353	23353	23353	23353	23353	23,353
Number of Firms	1103	1103	1103	1103	1103	1103	1103	1103
Number of banks	110	110	110	110	110	110	110	110

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 $\Delta \ell_{ikt}/\ell_{ik,t-1}$ 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 $\text{Inject}_{k,t+1}/e_{k,t}$ 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 (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). he variable BCR_{kt} is defined as the BCR less the required capital ratio (8% for internationally operated banks and 4% for domestic banks) in year t. Other covariates in Table 3 are also included in specifications. Standard errors adjusted for clustering at the bank level are in brackets. *** 1%, ** 5%, * 10%.

where the dependent variable, I_{it}/K_{it}, is the ratio of total investment in machinery, equipment, structures, and buildings in year t to the capital stock in year $t-1$. The variable $\overline{(\text{Inject}/e)}_{it} := \sum_k \omega_{ik}(\text{Inject}_{kt}/e_{it-1})$ 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. We also examine the effect of capital injections on investments by estimating a specification similar to (4) but replacing $\overline{(\text{Inject}/e)}_{it} := \sum_k \omega_{ik}(\text{Inject}_{kt}/e_{it-1})$ with $\overline{\text{BCR}}_{it-1}$, where rhe variable $\overline{\text{BCR}}_{it-1} := \sum_k \omega_{ik}\text{BCR}_{k,t-1}$ is the weighted average of the BCR less the required capital ratio in year $t-1$ across the banks from which firm i borrows using the pre-sample loan shares in 1995–1997 as weight.

In Equation (4), we classify firms into four mutually exclusive and exhaustive groups: (i) non-zombie/high-TFP, (ii) zombie/high-TFP, (iii) zombie/low-TFP, and (iv) non-zombie/low-TFP, where low vs. high TFP firms are defined using the 25th percentile threshold value of TFP. We include the interaction of these four dummy variables with the bank capital ratio or capital injection as explanatory variables to identify group-specific coefficients. We consider a TFP measure defined by the average of the log TFP over the period 1995-1997, denoted by $\overline{\text{TFP}}_i$.

The vector Z_{it} contains $\omega_i^{bankrupt} \times D_{99,00}^{year}$, $\ln \text{K}_{it-1}$, $\text{Cash}_{it-1}/K_{it-1}$, $b_{it-1}/\text{Collat.}_{it-1}$, $\overline{\text{Domestic}}_{it-1}$, $\overline{\text{Deposit}/A}_{it-1}$, and group dummy variables for low vs. high TFP and zombie vs. non-zombie. 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 $\overline{\text{Domestic}}_{it-1}$ and $\overline{\text{Deposit}/A}_{it-1}$ are the weighted averages of domestic bank's dummy variables and deposit-to-asset ratios in year $t-1$, computed as $\overline{\text{Domestic}}_{it-1} := \sum_k \omega_{ik}\text{Domestic}_{kt-1}$ and $\overline{\text{Deposit}/A}_{it-1} := \sum_k \omega_{ik}\text{Deposit}_{kt-1}/A_{kt-1}$, 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. Appendix A.3 describes our benchmark sample for estimating our firm investment model.

Columns (1) and (2) of Table 7 present the estimates of Equation (4) using the ratio of total investment in machinery, equipment, structures, and buildings to the capital stock as a dependent variable. In column (1), the coefficient for the interaction term of $\overline{(\text{Inject}/e)}_{it-1}$

Table 7: Investment Rates, Capital Injection, and Bank Capital Ratios (Dep. Var.: Investment Rates)

Dependent Var.	I_{it}/K_{it-1}		$I_{m,it}/K_{m,it-1}$		$I_{b,it}/K_{b,it-1}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$\overline{(\text{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1}=0)$	-0.0019		-0.0066		0.0001	
	[0.027]		[0.031]		[0.040]	
$\overline{(\text{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1}=1)$	-0.031		-0.0151		-0.0634	
	[0.027]		[0.031]		[0.045]	
$\overline{(\text{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1}=0)$	-0.0202		-0.0252		-0.0328	
	[0.031]		[0.034]		[0.049]	
$\overline{(\text{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1}=1)$	-0.0828**		-0.0417		-0.1439**	
	[0.033]		[0.043]		[0.056]	
$\overline{\text{BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1}=0)$		-0.002		0.0001		-0.0041
		[0.005]		[0.005]		[0.008]
$\overline{\text{BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1}=1)$		-0.006		-0.0013		-0.0143
		[0.006]		[0.006]		[0.011]
$\overline{\text{BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1}=0)$		-0.0073		-0.0044		-0.0144
		[0.006]		[0.006]		[0.011]
$\overline{\text{BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1}=1)$		-0.0164**		-0.0084		-0.0287**
		[0.007]		[0.008]		[0.012]
$\omega_i^{bankrupt} \times D_{99,00}^{\text{year}}$	-0.1225**	-0.1212**	-0.0852	-0.0848	-0.1628**	-0.1598**
	[0.056]	[0.056]	[0.064]	[0.065]	[0.077]	[0.076]
$\ln K_{i,t-1}$	-0.7930***	-0.7918***	-0.4436***	-0.4439***	-1.2433***	-1.2413***
	[0.071]	[0.071]	[0.081]	[0.081]	[0.162]	[0.163]
$b_{it-1}/\text{Collat}_{it-1}$	-0.0072	-0.0071	-0.0073	-0.0073	-0.0081	-0.0077
	[0.006]	[0.006]	[0.006]	[0.006]	[0.015]	[0.014]
$\text{Cash}_{it-1}/K_{it-1}$	0.0272	0.0268	0.014	0.0137	0.0442	0.0438
	[0.025]	[0.025]	[0.033]	[0.033]	[0.042]	[0.043]
$\overline{\text{Domestic}}_{it-1}$	-0.0266	-0.0047	-0.0646*	-0.0526*	-0.0373	0.0034
	[0.027]	[0.032]	[0.033]	[0.032]	[0.049]	[0.061]
$\overline{\text{Deposit/A}}_{it-1}$	-0.018	-0.0146	0.0067	0.0126	-0.0584	-0.0548
	[0.064]	[0.066]	[0.079]	[0.081]	[0.108]	[0.111]
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year×Closing Month	Yes	Yes	Yes	Yes	Yes	Yes
TFP/Zombie group dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,493	2,493	2,493	2,493	2,493	2,493
Number of Firms	901	901	901	901	901	901

Notes: The matched firm–bank observations for 1998–2000 are used for estimation. For the dependent variables, I_{it}/K_{it-1} is the ratio of investment in year t to the capital stock in year $t-1$ in columns (1)-(2), $I_{m,it}/K_{m,it-1}$ is the ratio of machine investment in year t to the machine capital stock in year $t-1$ in columns (3)-(4), and $I_{b,it}/K_{b,it-1}$ is the ratio of investment in structures and buildings in year t to their capital stock in year $t-1$ in columns (5)-(6). 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 $\overline{(\text{Inject}/e)}_{it}$ 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 $\overline{\text{TFP}}_i$ is the average of the logarithm of firm i's TFP over the 1995-1997 period. $\ln K_{it-1}$ is the logarithm of capital stock for firm i in year $t-1$; $b_{it-1}/\text{Collat.}_{it-1}$ is the ratio of 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%.

with all four group dummy variables for the firm's productivities and zombie statuses is negative. This indicates that capital injections were not associated with an increase in investments in all four types of firms, including both high-productivity non-zombie firms and low-productivity zombie firms that received more credit supply after capital injection. Similarly, column (2) suggests that firms did not increase their investments after improvements in the bank capital ratios regardless of their productivity and zombie statuses. Overall, we find no evidence that improved bank capital ratios or capital injection promoted investment despite the increase in the supply of bank loans to firms.

Notably, among unproductive zombie firms with financial difficulties, we find the group-specific coefficient for $\overline{(\text{Inject}/e)}_{it-1}$ or $\overline{\text{BCR}}_{it-1}$ is significantly negative in columns (1)-(2). For example, the coefficient of $\overline{(\text{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 1)$ in column (1) implies a statistically significant *decrease* of $(0.0828 \times 0.083 =)$ 0.7 percentage points after the 1999 capital injection in their investment rates. This result is counterintuitive, as it indicates that despite the increase in bank loans following capital injection, these unproductive zombie firms *decreased* their investments.

As shown in Table A12 in the appendix, we obtain qualitatively similar results when we use the alternative bank capital ratios adjusted for deferred tax assets and defaulted loans as well as alternative firm-level TFP measures constructed using system GMM and Solow residual.

To gain further insights into the source of this counterintuitive result, we estimate Equation (4) separately for two categories of investments, (i) machinery and equipment and (ii) buildings and structures. In columns of Table 7, we continue to find that neither capital injection nor improved bank capital ratios is associated with increased investments for various investment categories across all four groups of firms, including the high-TFP non-zombie firms. Furthermore, the coefficient for the interaction term of $\overline{(\text{Inject}/e)}_{it-1}$ or $\overline{\text{BCR}}_{it-1}$ with unproductive zombie indicator $\mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 1)$ is significantly negative for buildings and structures in columns (3) and (4) but nonsignificant for machinery and equipment in columns (1) and (2). This suggests that the decrease in unproductive zombie firms' investments after the capital injection may be primarily driven by decreased investments in buildings and structures rather than machinery and equipment.

The effect of a capital injection on investment may depend on whether the banks receiving the equity are under-capitalized or not. To examine this issue, we construct separate capital injection variables for high and low bank capital ratios as

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

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

$$
\begin{aligned}
\frac{I_{it}}{K_{it-1}} &= \alpha_1 \overline{(\text{Inject}/e)}_{it-1}^{\text{H-BCR}} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 0) \\
&+ \alpha_2 \overline{(\text{Inject}/e)}_{it-1}^{\text{H-BCR}} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 1) \\
&+ \alpha_3 \overline{(\text{Inject}/e)}_{it-1}^{\text{H-BCR}} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 0) \\
&+ \alpha_4 \overline{(\text{Inject}/e)}_{it-1}^{\text{H-BCR}} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 1) \\
&+ \alpha_5 \overline{(\text{Inject}/e)}_{it-1}^{\text{L-BCR}} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 0) \\
&+ \alpha_6 \overline{(\text{Inject}/e)}_{it-1}^{\text{L-BCR}} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 1) \\
&+ \alpha_7 \overline{(\text{Inject}/e)}_{it-1}^{\text{L-BCR}} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 0) \\
&+ \alpha_8 \overline{(\text{Inject}/e)}_{it-1}^{\text{L-BCR}} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 1) \\
&+ \alpha_f' Z_{it} + D_i^f + D_t^{\text{year}} \times D_i^{\text{closing month}} + \epsilon_{it},
\end{aligned} \tag{6}
$$

where the high-TFP non-zombie firms is the baseline group for the interaction terms.

Table 8 reports the estimate of Equation (5) for the investment rates for various categories. The results are consistent with those of Table 7. Specifically, we find little evidence that capital injection promoted investments across different types of firms, regardless of how well the banks are capitalized.

Furthermore, the estimate indicates that capital injection is associated with decreased investments of unproductive zombie firms, especially for buildings and structures. In column (3), the statistically significant estimate of $\hat{\alpha}_8 = -1.0243$ suggests that 1999 capital injection

Table 8: Capital Injections and Firm Investment Rates: Low vs. High Capital Adequacy Ratios

Dependent Var.	I_{it}/K_{it-1} All	$I_{m,it}/K_{m,it-1}$ Mach./Equip.	$I_{b,it}/K_{b,it-1}$ Build./Struct.
	(1)	(2)	(3)
$(\text{Injection}/e)^{\text{H-BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 0)$	0.0038	-0.0062	0.0194
	[0.027]	[0.031]	[0.042]
$(\text{Injection}/e)^{\text{H-BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 1)$	-0.0294	-0.0137	-0.0545
	[0.027]	[0.031]	[0.045]
$(\text{Injection}/e)^{\text{H-BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 0)$	-0.0210	-0.0343	-0.0193
	[0.031]	[0.034]	[0.049]
$(\text{Injection}/e)^{\text{H-BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 1)$	-0.0883***	-0.0486	-0.1462***
	[0.032]	[0.042]	[0.054]
$(\text{Injection}/e)^{\text{L-BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 0)$	0.2403	0.0980	0.3646
	[0.171]	[0.142]	[0.344]
$(\text{Injection}/e)^{\text{L-BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 1)$	0.0239	0.2035	-0.1397
	[0.158]	[0.208]	[0.274]
$(\text{Injection}/e)^{\text{L-BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 0)$	-0.1192	-0.3158	-0.2102
	[0.182]	[0.234]	[0.327]
$(\text{Injection}/e)^{\text{L-BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 1)$	-0.4779***	-0.3477	-1.0243**
	[0.175]	[0.239]	[0.428]
$\omega_i^{bankrupt} \times D^{\text{year}}_{99,00}$	-0.1210**	-0.0832	-0.1616**
	[0.056]	[0.064]	[0.076]
$\ln K_{it-1}$	-0.7925***	-0.4422***	-1.2430***
	[0.071]	[0.081]	[0.162]
$b_{it-1}/\text{Collat}_{it-1}$	-0.0074	-0.0076	-0.0085
	[0.006]	[0.006]	[0.014]
$\text{Cash}_{it-1}/K_{it-1}$	0.0281	0.0152	0.0456
	[0.025]	[0.032]	[0.042]
$\overline{\text{Domestic}}_{it-1}$	-0.0257	-0.0647*	-0.0324
	[0.027]	[0.034]	[0.049]
$\overline{\text{Deposit/A}}_{it-1}$	-0.0170	0.0064	-0.0451
	[0.064]	[0.080]	[0.106]
Firm Fixed Effects	Yes	Yes	Yes
Year×Closing Month	Yes	Yes	Yes
TFP/Zombie Group Dummies	Yes	Yes	Yes
Observations	2493	2493	2493
Number of Firms	901	901	901

Notes: The matched firm–bank observations for 1998–2000 are used for estimation. The dependent variable $I_{m,it}/K_{m,it-1}$ is the ratio of machine investment in year t to the machine capital stock in year $t-1$. The variables $\overline{(\text{Inject}/e)}^{\text{H-BCR}}_{it-1}$ and $\overline{(\text{Inject}/e)}^{\text{L-BCR}}_{it-1}$ are defined in Equation (5) Other covariates in Table 7 are also included in specifications. Standard errors adjusted for clustering at the firm level are in brackets. *** 1%, ** 5%, * 10%.

to *under-capitalized* banks is associated with a $(1.0243 \times 0.029 =)3.0$ percentage points reduction of low-TFP zombie firms' investment rates for buildings and structures. This finding suggests that the capital injection into under-capitalized banks substantially reduced investment for buildings and structures among low-TFP zombie firms despite receiving bank loans induced by the capital injection. The estimated association of capital injection to *well-capitalized* banks on investment for buildings and structures is somewhat smaller but also statistically significant at $\hat{\alpha}_4 = -0.1462$ in column (6), implying a $(0.1462 \times 0.052 =)0.8$ percentage points reduction.

These findings raise intriguing questions about the behavior of highly productive non-zombie and unproductive zombie firms in the face of increased credit availability resulting from capital injection. Despite having access to additional funds, these firms have chosen not to increase or even reduce their investments. Why?

For unproductive zombie firms, a potential explanation for reduced investments is that the bank loans provided to low-productivity zombie firms might have been used to fund operational losses or debts rather than investment projects. Their main banks might have required these zombie firms to compress their operations to limit their future losses while prohibiting investment in buildings and structures, especially if they were under-capitalized. For high-TFP non-zombie firms, however, it is still puzzling that we find little evidence linking capital injections to increased investment, despite the suggestive evidence of the increased supply of their loans.

The bank loans may have been used for enhancing productivity through the activities beyond traditional physical investments. To further investigate this matter, we employ a similar specification to Equation (4), but with the log differences between time t and $t-1$ of various variables—labor productivity, TFP, sales, employment, average wages, and advertisement spending—as dependent variables. We define the high vs. low TFP groups using the average of the logarithm of firm i's TFP over the 1995-1997 period.

The estimates are presented in Table 9. When labor productivity and TFP growth rates are taken as dependent variables in columns (1) and (2), the group-specific coefficients for the capital injection variable are significantly positive for high-TFP non-zombie firms. This suggests that capital injection contributed to the labor productivity and TFP growth of these firms. The estimated coefficient of $\overline{(\text{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 0)$ in column (1) implies that the 1999 capital injection is associated with $(0.1231 \times 0.8267 =)$ 10.2 percentage points increase in labor productivity growth.

As for the growth rates of sales and employment, column (3) displays a significantly positive coefficient of $\overline{(\text{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 0)$, while column (4) shows an insignificant but negative coefficient. This indicates that the labor productivity growth of high-TFP non-zombie firms with capital injection was primarily driven by sales growth achieved without a corresponding increase in employment.

Column (5) provides little evidence that capital injection is associated with an increase in average wages for high-TFP non-zombie firms. This suggests that these firms neither significantly improved labor quality nor increased labor hours per employee after the capital injection.

On the other hand, in column (6), where the growth rate of advertisement spending is the dependent variable, we find significantly positive group-specific coefficients of high-TFP non-zombie firms for the capital injection variable. The point estimate of 0.3177 implies that capital injection is associated with a $(0.3177 \times 0.083 =)$2.6 percentage point increase in advertisement spending for high-TFP non-zombie firms after the 1999 capital injection. However, it is important to exercise caution here, as a considerable fraction of observations had to be dropped due to unavailability of advertisement cost data in the dataset. Nonetheless, we may interpret this result as suggestive evidence that capital injection possibly boosted sales growth by enabling these firms to invest more in advertisements with the increased supply of loans.

The analysis reveals interesting implications regarding the utilization of bank loans for enhancing productivity among high-TFP non-zombie firms. The results indicate a possibility that capital injection positively impacted labor productivity growth, primarily driven by increased sales growth without significant changes in employment or average wages.

Additionally, there are indications that capital injection may have facilitated higher advertisement spending, potentially contributing to increased sales growth.

Overall, our analysis underscores the dual nature of the credit allocation mechanisms within the Japanese capital injection policy. While capital injections appear to have favored high-productivity firms by raising their productivity (though not noticeably affecting their investment rates), they also inadvertently encouraged credit misallocation. This misallocation of funds may have particularly benefited low-productivity zombie firms, helping them manage their outstanding debt but reducing their investment. Our research suggests that both mechanisms are quantitatively significant and comparably influential in shaping credit allocation following capital injections.

5 Conclusion

In this study, we examine the effect of government capital injections into financially troubled banks on credit allocation and the level of investment during the Japanese banking crisis of the late 1990s. Using matched firm–bank data, we estimate how the effects of capital injections and banks' regulatory capital ratios on credit expansion, investment, and productivity vary based on their TFP and zombie status.

Splitting the sample by firm-level TFP and zombie status, our regression analysis finds evidence that capital injections are positively associated with increased credit supply for two distinct categories of firms: the high-productivity non-zombie firms and the low-productivity zombie firms. Interestingly, our findings indicate that, despite the evidence of increased bank credit, these recapitalization policies did not promote investment by high-productivity firms and even reduced investment by low-productivity zombie firms. When we further examine the association between capital injections and a firm's productivity growth, we find that capital injections are associated with productivity growth, mainly for high-TFP non-zombie firms. We also find evidence that increased advertising expenditures may have driven this growth.

Thus, we provide suggestive evidence that the capital injection encouraged credit alloca-

Table 9: Capital Injections and the Growth Rates of Labor Productivity, TFP, Sales, Employment, Average Wage, and advertisement spending

Dependent Var.	$\Delta \ln Y_{it}/L_{it}$	$\Delta \ln TFP_{it}$	$\Delta \ln Y_{it}$	$\Delta \ln L_{it}$	$\Delta \ln \mathrm{W}_{it}$	$\Delta \ln \mathrm{Ad}_{it}$
	(1)	(2)	(3)	(4)	(5)	(6)
$\overline{(\mathrm{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\mathrm{TFP}}_i \geq p25, \mathrm{Zombie}_{it-1} = 0)$	0.1231**	0.0741**	0.0697*	-0.0534	0.0350	0.3177*
	[0.049]	[0.033]	[0.041]	[0.036]	[0.040]	[0.185]
$\overline{(\mathrm{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\mathrm{TFP}}_i \geq p25, \mathrm{Zombie}_{it-1} = 1)$	0.0844	0.0491	0.0584	-0.0261	0.0338	0.3033
	[0.056]	[0.036]	[0.042]	[0.040]	[0.042]	[0.190]
$\overline{(\mathrm{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\mathrm{TFP}}_i < p25, \mathrm{Zombie}_{it-1} = 0)$	-0.0118	-0.0113	-0.0373	-0.0256	-0.0189	0.1758
	[0.065]	[0.047]	[0.059]	[0.042]	[0.040]	[0.257]
$\overline{(\mathrm{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\mathrm{TFP}}_i < p25, \mathrm{Zombie}_{it-1} = 1)$	0.0600	0.0188	0.0776	0.0176	-0.0622	0.2600
	[0.064]	[0.041]	[0.058]	[0.048]	[0.053]	[0.340]
$\omega_i^{bankrupt} \times D_{99,00}^{\mathrm{year}}$	0.0692	0.0153	-0.0374	-0.1066	0.0309	0.2624
	[0.114]	[0.071]	[0.094]	[0.082]	[0.095]	[0.341]
$\ln K_{it-1}$	0.0030	-0.3236***	-0.1766***	-0.1796***	0.0504	-0.2515
	[0.053]	[0.040]	[0.060]	[0.061]	[0.042]	[0.164]
$b_{it-1}/\mathrm{Collat}_{it-1}$	0.0317***	0.0184***	0.0157*	-0.0160***	-0.0056	-0.0435
	[0.009]	[0.007]	[0.009]	[0.005]	[0.006]	[0.030]
$\mathrm{Cash}_{it-1}/K_{it-1}$	-0.0904**	-0.0727***	-0.1186***	-0.0281	0.0105	0.2193**
	[0.037]	[0.024]	[0.035]	[0.020]	[0.024]	[0.090]
$\overline{\mathrm{Domestic}}_{it-1}$	0.0832**	0.0375	0.0296	-0.0536**	0.0045	0.2564
	[0.033]	[0.024]	[0.031]	[0.026]	[0.028]	[0.191]
$\overline{\mathrm{Deposit}/\mathrm{A}}_{it-1}$	0.0592	0.0675	-0.0097	-0.0689	0.0773	0.1891
	[0.158]	[0.089]	[0.124]	[0.084]	[0.119]	[0.746]
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year×Closing Month	Yes	Yes	Yes	Yes	Yes	Yes
TFP/Zombie Group Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,435	2,435	2,435	2,435	2,435	1,238
Number of Firms	881	881	881	881	881	457

Notes: The matched firm–bank observations for 1998–2000 are used for estimation. The dependent variables $\Delta \ln Y_{it}/L_{it}$, $\Delta \ln TFP_{it}$, $\Delta \ln Y_{it}$, $\Delta \ln L_{it}$, $\Delta \ln \mathrm{W}_{it}$, and $\Delta \ln \mathrm{Ad}_{it}$ is the log difference of labor productivity, TFP, sales, employment, average wage, and advertisement spending, respectively, between year t and year $t-1$. The grouping variable TFP in the indicator function is the average of the logarithm of firm i's TFP over the 1995-1997 period. Other covariates in Table 7 are also included in specifications. Standard errors adjusted for clustering at the firm level are in brackets. *** 1%, ** 5%, * 10%.

tion to high-productivity non-zombie firms to finance their productivity-enhancing activities without increasing physical investment. At the same time, the capital injection possibly led to a misallocation of credit by increasing the supply of credit to low-productivity zombie firms, which use bank loans to survive rather than to finance investment projects while curtailing their scale of production by reducing their investment in buildings and structures.

However, our research is not without limitations. First, for our regression results to be causal, it is necessary to assume that the demand for capital injections is fully represented by observed bank characteristics, bank fixed effects, firm-year fixed effects, and the previous year's loan growth. Potential unobserved determinants–such as the amount of undisclosed nonperforming loans that exceed banks' reported capital adequacy and observed deposit-to-asset ratios–could have introduced bias into our estimates.

Second, the scope of this study is limited and does not examine the broader effects of capital injections in general. This is an important limitation, as capital injections are likely to have had a substantial impact on the Japanese economy through other mechanisms, such as writing off nonperforming loans and stabilizing the financial system.

Appendix A: Data

A.1 Variable Construction from the data set compiled by the Development Bank of Japan (DBJ)

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.

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.[21] 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 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)).

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

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.

Average wage

We define average wage as the total labor cost per employee. The total labor cost is the sum of labor costs in manufacturing costs and employee compensation, employee benefits, and bonus accruals in selling, general, and administrative expenses.

Advertisement spending

The advertisement spending is the sum of advertising and promotional expenses and sales promotion expenses.

A.2 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.

A.3 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 also exclude observations with missing values for the explanatory variables. The final sample contains 2552 firm-year observations. We also note that, when we include firm fixed effects in our regression specification, a firm-level observation with a single year entry is automatically dropped from our regression analysis — in such a case, our effective sample size in terms of firm-year observations becomes 2493 observations.

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)

A.4 Summary Statistics

Table A2 reports the summary statistics for the variables used in our regression analysis for the period 1997—2000, with the definition of the variables discussed in the footnote.

Appendix B: Determinants of Capital Injection

The primary objective of this section is to examine whether the capital injections banks received in 1999 were affected by firm-side demand factors, like TFP, zombie status, and past loan growth. If a correlation exists between these observed firm-side demand factors and the magnitude of capital injections, it could suggest the injections are endogenous to these demand-side factors. Consequently, it would be important to account for these factors when assessing the bank-loan growth regression to analyze the relation between capital injections and loan growth. For this purpose, we consider the following regression:

$$\frac{\text{Inject}_{kt}}{e_{k,t-1}} = \alpha_0 + \overline{\text{TFP}}_{kt-1}\alpha_1 + \overline{\text{Zombie}}_{kt-1}\alpha_2 + \frac{\Delta\ell_{kt-1}}{\ell_{k,t-2}}\alpha_3 + \frac{\Delta_2\ell_{kt-1}}{\ell_{k,t-3}}\alpha_4 + \gamma' Z^B_{kt} + \epsilon_{kt}. \quad (7)$$

Here, $\text{Inject}_{kt}/e_{kt-1}$ measures the capital injections into bank k in 1999 relative to its prior year's equity. We also utilize a variable, $\mathbb{I}(\text{Inject}_{kt} > 0)$, indicating capital injection instead of $\text{Inject}_{kt}/e_{kt-1}$. The terms $\overline{\text{TFP}}_{kt-1}$ and $\overline{\text{Zombie}}_{kt-1}$ represent bank-level metrics, denoting the weighted average of firms' log TFP and Zombie status, using past loan proportions as weights. The expressions $\frac{\Delta\ell_{kt-1}}{\ell_{k,t-2}}$ and $\frac{\Delta_2\ell_{kt-1}}{\ell_{k,t-3}}$ signify bank k's loan growth rates over the previous and preceding two years, respectively.

We consider the bank-level explanatory variables, i.e., $Z^B_{kt} = (\text{BCR}_{k,t-1}, \text{Domestic}_{kt-1}, \text{Deposit}_{kt-1}/A_{kt-1}, \text{Defaulted loan}_{kt-1}/e_{kt-1})'$, where $\text{BCR}_{k,t-1}$ is a measure of capital adequacy ratio in year $t-1$ defined in Section 3, Domestic_{kt-1} is a dummy variable that is set to one if bank k operates only in the domestic market in year $t-1$, $\text{Deposit}_{kt-1}/A_{kt-1}$ is the deposit-to-asset ratio for the year $t-1$, and $\text{Defaulted loan}_{kt-1}/e_{kt-1}$ is the ratio of defaulted loans to bank's equity in year $t-1$ using the loans extended to borrowers who had gone bankrupt as our measure of defaulted loans.

Table A2: 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
$\text{Inject}_{kt}/e_{k,t-1} \times \omega_{ik}$ (Tier 1 + Tier 2)	24685	0.020	0.000	0.051	0.000	0.785
$\text{Inject}_{kt}/e_{k,t-1} \times \omega_{ik}$ (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						
$\text{Inject}_{kt}/e_{k,t-1}$ (Tier 1 + Tier 2)	338	0.051	0.000	0.18	0	1.257
$\text{Inject}_{kt}/e_{k,t-1}$ (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_{it}/K_{it-1}	2552	0.078	0.058	0.116	-0.501	2.478
$I_{m,it}/K_{m,it-1}$	2552	0.092	0.072	0.113	-0.580	1.647
$I_{b,it}/K_{b,it-1}$	2552	0.060	0.021	0.204	-0.477	4.191
$\overline{\text{BCR}}_{it-1}$	2552	2.219	1.792	1.179	-0.535	7.592
$\overline{(\text{Inject}/e)}_{it-1}$ (Tier 1 + Tier 2)	2552	0.170	0.076	0.216	0.000	0.840
$\overline{(\text{Inject}/e)}_{i,1998}$ (Tier 1 + Tier 2)	875	0.084	0.081	0.034	0.000	0.220
$\overline{(\text{Inject}/e)}_{i,1999}$ (Tier 1 + Tier 2)	791	0.488	0.457	0.162	0.000	0.840
$\overline{(\text{Inject}/e)}_{it-1}$ (Tier 1 Only)	2552	0.121	0.000	0.193	0.000	0.840
TFP_{it-1}	2552	0.006	-0.031	0.331	-1.056	1.879
Zombie_{it-1}	2552	0.402	0.000	0.490	0.000	1.000
$\ln K_{m,t-1}$	2552	15.370	15.335	1.543	10.354	20.128
$b_{it-1}/\text{Collat.}_{it-1}$	2552	1.772	1.326	1.750	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	0.000	1.000
$\Delta \ln Y_{it}/L_{it}$	2,531	0.006	0.004	0.136	-0.817	1.063
ΔTFP_{it}	2,531	-0.015	-0.012	0.092	-0.472	0.477
$\Delta \ln Y_{it}$	2,531	-0.037	-0.029	0.124	-0.936	0.932
$\Delta \ln L_{it}$	2,531	-0.043	-0.027	0.107	-1.132	0.927
$\Delta \ln \text{W}_{it}$	2,531	0.014	0.012	0.097	-0.937	1.064
$\Delta \ln \text{Ad}_{it}$	1,287	-0.074	-0.041	0.367	-2.841	2.650

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 3. The summary statistics for the other firm-level variables are computed from the firm-level observations used in estimating Table 7 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); $\text{Inject}_{kt}/e_{k,t-1}$ (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; $\text{Inject}_{kt}/e_{k,t-1}$ (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_{it}/K_{it-1}, $I_{m,it}/K_{m,it-1}$, $I_{b,it}/K_{b,it-1}$ are the ratio of firm i's investment to its assets in the previous year for total fixed assets less land, machinery and equipment, and buildings and structures, respectively; $\overline{\text{BCR}}_{it-1}$ is the weighted average of BCR_{kt} over the banks from which firm i borrows; $\overline{(\text{Inject}/e)}_{it-1}$ (Tier 1 + Tier 2) is the ratio of the weighted average of Tier 1 and Tier 2 injections to equity; $\overline{(\text{Inject}/e)}_{it-1}$ (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; $\Delta \ln Y_{it}/L_{it}$, ΔTFP_{it}, $\Delta \ln Y_{it}$, $\Delta \ln L_{it}$, $\Delta \ln \text{W}_{it}$, and $\Delta \ln \text{Ad}_{it}$ are the log difference in labor productivity of firm i, TFP, output, number of employees, average wage, and advertising expenditures, respectively, between $t-1$ and t.

Table A3 shows the results. The estimated coefficient of $\overline{\text{TFP}}_{kt-1}$ is positive but insignificant in all specifications. Similarly, $\overline{\text{Zombie}}_{kt-1}$ is not significantly correlated with capital injection, while the sign of its estimated coefficient changes across specifications. Thus, there is no evidence that the demand factor captured by TFP or zombie status was relevant to capital injection.

In columns (2)-(4) and (6)-(8) of table A3, the coefficients associated with the previous year's loan growth rate are estimated to be negative but insignificant. On the other hand, both the coefficients on the capital adequacy ratio and the deposit-to-asset ratio are negative and significant. This is in line with the bank recapitalization guidelines of the Financial Reconstruction Commission (Financial Reconstruction Commission 1999). The estimated negative coefficient on domestic bank status may reflect that it was easier for domestic banks to meet the required capital ratios than for international banks. The estimate of Defaulted $\text{loan}_{kt-1}/e_{kt-1}$ is negative and insignificant in columns (4) and (8), where the sign is opposite to what is conventionally expected — a plausible explanation is that the $\text{BCR}_{k,t-1}$ variable already captures the relevant information on nonperforming loans, rendering the defaulted loan variable redundant.

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

$$Y_{it} = \exp(\epsilon_{it} + \omega_{it}) F_t(L_{it}, K_{it}, M_{it}) \quad \text{with} \quad \omega_{it} = \rho_{0t} + \rho_1 \omega_{it-1} + \eta_{it}, \tag{8}$$

where Y_{it} is gross output, 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

Table A3: Determinants of Government Capital Injections

Dependent Variable Timing of Injection	$\text{Inject}_{kt}/e_{k,t-1}$ March 1999				$\mathbb{I}\{\text{Inject}_{kt} > 0\}$ March 1999			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\frac{\Delta \ell_{kt-1}}{\ell_{k,t-2}}$		-0.048		-0.0528		-0.0494		-0.0576
		[0.038]		[0.036]		[0.053]		[0.050]
$\frac{\Delta_2 \ell_{kt-1}}{\ell_{k,t-3}}$			-0.0167				-0.0168	
			[0.019]				[0.027]	
$\overline{\text{TFP}}_{kt-1}$	0.0661	0.0811	0.0671	0.0932	0.096	0.1114	0.097	0.1324
	[0.054]	[0.059]	[0.055]	[0.065]	[0.079]	[0.086]	[0.080]	[0.094]
$\overline{\text{Zombie}}_{kt-1}$	0.0077	0.0079	0.0195	0.0126	-0.0023	-0.0021	0.0095	0.0061
	[0.037]	[0.040]	[0.043]	[0.041]	[0.052]	[0.055]	[0.059]	[0.057]
$\text{BCR}_{k,t-1}$	-0.0196*	-0.0179*	-0.0193*	-0.0212	-0.0341**	-0.0324**	-0.0338**	-0.0381**
	[0.010]	[0.010]	[0.010]	[0.013]	[0.015]	[0.015]	[0.015]	[0.018]
Domestic_{kt-1}	-0.0409	-0.0454	-0.041	-0.0266	-0.0593	-0.0639	-0.0594	-0.0313
	[0.032]	[0.034]	[0.032]	[0.048]	[0.046]	[0.048]	[0.046]	[0.066]
$\text{Deposit}_{kt-1}/A_{kt-1}$	-0.9869***	-0.9665***	-0.9812***	-1.0069***	-1.4426***	-1.4215***	-1.4368***	-1.4918***
	[0.227]	[0.226]	[0.227]	[0.216]	[0.293]	[0.295]	[0.295]	[0.272]
Defaulted $\text{loan}_{kt-1}/e_{k,t-1}$				-0.0668				-0.1163
				[0.091]				[0.126]
Observations	107	107	107	107	107	107	107	107

Notes: See Equation (3) for a description of the variables. $\overline{\text{TFP}}_{kt-1}$ 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. Robust standard errors are in brackets. *** 1%, ** 5%, * 10%.

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

$$\ln\left(\frac{P_{Mt}M_{it}}{Y_{it}}\right) = \ln\left(\frac{F_{M,t}(L_{it}, K_{it}, M_{it})M_{it}}{F_t(L_{it}, K_{it}, M_{it})}E_\epsilon[e^\epsilon]\right) - \epsilon_{it} = \ln\left(\frac{\partial f(\ell_{it}, k_{it}, m_{it})}{\partial m_{it}}E_\epsilon[e^\epsilon]\right) - \epsilon_{it}. \tag{9}$$

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

$$f(\ell_{it}, k_{it}, m_{it}) = \sum_{r_l+r_k+r_m\le 2} \frac{\gamma_{r_l,r_k,r_m}}{r_m+1}\ell_{it}^{r_l}k_{it}^{r_k}m_{it}^{r_m+1} \tag{10}$$

so that

$$\frac{\partial f(\ell_{it}, k_{it}, m_{it})}{\partial m_{it}} = \sum_{r_l+r_k+r_m\le 2} \gamma_{r_l,r_k,r_m}\ell_{it}^{r_l}k_{it}^{r_k}m_{it}^{r_m}. \tag{11}$$

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 (9) by minimizing the sum of implied squared residuals, $\sum_{i,t}\epsilon_{it}^2$, as:

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

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

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

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 (8) implies that

$$\omega_{it} = y_{it} - \int_{\bar m}^{m_{it}} \frac{\partial f(\ell_{it}, k_{it}, m)}{\partial m}dm - f(\ell_{it}, k_{it}, \bar m) - \epsilon_{it}. \tag{12}$$

Then, substituting (10)-(11) to (12) 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

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

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:

$$y_{it} = \alpha_0 + \alpha_\ell \ell_{it} + \alpha_k k_{it} + \alpha_m m_{it} + \mu_i + \eta_t + \omega_{it} + \epsilon_{it} \tag{13}$$

$$\omega_{it} = \rho \omega_{i,t-1} + \eta_{it} \tag{14}$$

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 $m_i t$ 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 (13)–(14) 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 $(\alpha_\ell, \alpha_k, \alpha_m, \rho)$.

Appendix D: Additional Tables and Figures

D.1 Propensity Scores and Balancing Test

Figure A1 shows the histogram of estimated propensity scores by treatment status. The observations are substantially overlapped in the range from 0.55 to 0.85.

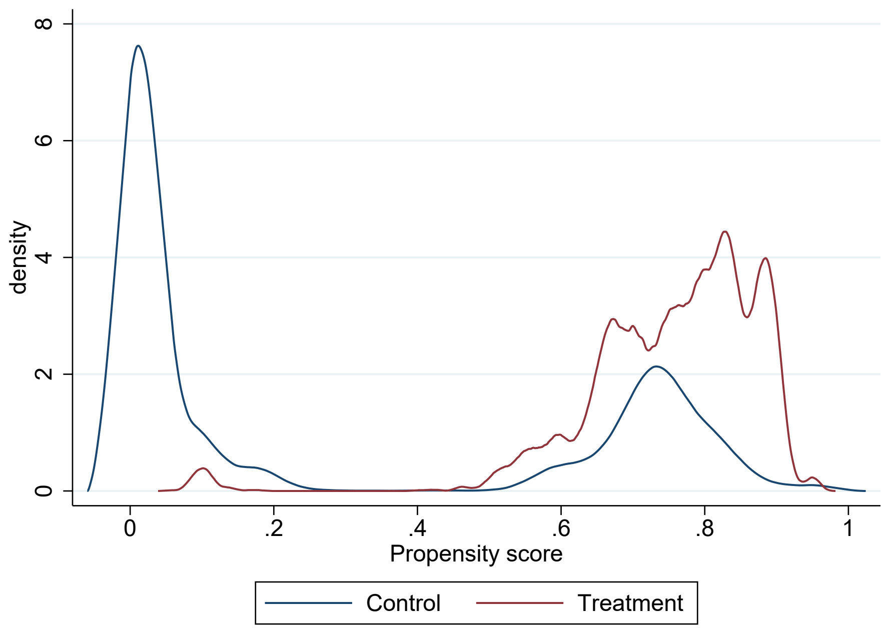
Table A4 reports the result of the t-test for the difference in means of each of the relevant variables between the treatment and control groups of the 1999 capital injection. The column labeled "All" indicates that the means of most variables are statistically different between the treatment and control groups in the whole sample. On the other hand, the means of most variables are statistically not different between the treatment and control groups for the sub-sample with propensity scores from 0 to 0.5 and that from 0.5 to 1 as reported in the columns labeled "$0 \leq p < 0.5$" and "$0.5 \leq p < 1.0$." Therefore, the observations become more balanced once conditioned on the value of propensity scores.

D.2 Additional Tables

Table A5 provides the sample average for subcategories of firms defined by their TFP and Zombie status, which in turn is used for the quantitative implications of the estimated coefficients presented in the main text.

The regression estimates for loan growth, when the explanatory variables are both non-

Figure A1: The Distribution of Propensity Score



interacted and interacted with the relationship variable ω_{ik} as well as when they only includes non-interacted terms, are detailed in Tables A6 and A7.

In Table A6, the interaction term $\text{Inject}_{kt}/e_{k,t-1} \times \omega_{ik}$ is positively significant while the non-interaction term $\text{Inject}_{kt}/e_{k,t-1}$ is insignificant, highlighting the importance of taking into account of the relationship size. When assessed against sample averages of $\text{Inject}_{kt}/e_{k,t-1} \times \omega_{ik}$ and $\text{Inject}_{kt}/e_{k,t-1}$, the coefficients in column (1) of A6 suggest that the 1999 capital injection is linked to a $(0.5450 \times 0.047 + 0.0503 \times 0.385 =)4.5$ percentage point average hike in bank loans. This is slightly larger than but similar in magnitude to the quantified implication derived from a specification solely incorporating the interaction term $\text{Inject}_{kt}/e_{k,t-1} \times \omega_{ik}$ in column (1) of Table 3, which indicates a 2.7 percentage point increase.

When a specification only includes the non-interaction terms, the estimated coefficient of $\text{Inject}_{kt}/e_{k,t-1}$ in column (1) of Table A7 translates to a $(0.1064 \times 0.047 =)0.5$ percentage point average increase in bank loans, substantially smaller than that indicated in column

Table A4: Balancing Test

Sample	All		$0 \leq p < 0.5$		$0.5 \leq p < 1.0$	
	Diff	t-stat	Diff	t-stat	Diff	t-stat
$\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}}$	0.045	1.315	0.005	0.12	0.022	0.474
ω_{ik}	0.038***	3.696	0.005	0.529	-0.002	-0.131
$\text{Inject}_{kt}/e_{k,t-1}$ (Tier 1 + Tier 2)	0.067***	7.255	0.441***	3.682	0.507***	4.194
BCR_{kt-1}	-0.840*	-1.677	-1.375*	-1.744	0.108	0.112
$\text{Deposit}_{kt-1}/\text{A}_{kt-1}$	-0.198***	-3.157	-0.135	-1.512	0.024	0.38
Regional Bank_k	-0.614***	-4.965	-0.179	-0.77	-0.001	-0.853
TFP_{it-1}	0.005	0.728	0.019	0.879	-0.008	-0.853
$Zombie_{it-1}$	0.023**	2.59	-0.049*	-1.716	0.006	0.814
$\ln K_{m,it-1}$	-0.190**	-2.042	-0.006	-0.013	0.117	1.412
$b_{it-1}/collat_{it-1}$	-0.067	-1.004	0.144	0.594	0.063	0.761
$Cash_{it-1}/K_{it-1}$	0.021*	1.71	0.013	0.342	-0.011	-0.68

Notes: The sample labelled "All" refers to the whole sample used in the AIPW estimation, "$0 \leq p < 0.5$" is the sample with propensity scores from 0 to 0.5, and "$0.5 \leq p < 1.0$" is the sample with propensity scores from 0.5 to 1. The columns labelled Diff report the difference between the mean in the treatment group and that in the control group, while the columns labelled t-stat report the t-statistic for the zero difference clustering at the bank level. *** p<0.01, ** p<0.05, * p<0.1

(1) of Table 3.

Tables A8–A9 report estimates for the subcategories of firms classified by TFP and zombie status for two alternative specifications discussed above. Overall, they are qualitatively similar to those from a baseline specification with only the interaction terms reported in Table 4. The estimates in column (6) of Table A8 imply that the 1999 capital injection is associated with a $(2.1020 \times 0.056 + 0.0634 \times 0.398 - 0.7805 \times 0.095 + 0.0031 \times 0.768 =)7.1$ percentage point increase in bank lending on average, which is slightly larger than, but similar in magnitude to, the 4.5 percentage point increase implied by column (6) of Table 4. Thus, the average quantitative associations are similar in magnitude between the full interaction specification and the specification with only the interacted terms for the subcategories of

Table A5: The Sample Averages of Injection and BCR variables by TFP and Zombie types for $t = 1999$

Sample	All	Non-Zombie		Zombie	
TFP		High	Low	High	Low
Firm-bank-level variable					
$\text{Injection}_{kt}/e_{k,t-1} \times \omega_{ik}$	0.047	0.043	0.047	0.051	0.056
$\text{BCR}_{kt-1} \times \omega_{ik}$	0.194	0.178	0.195	0.210	0.241
$\text{Injection}_{kt}/e_{k,t-1} \times \text{BCR}_{kt-1} \times \omega_{ik}$	0.081	0.073	0.082	0.089	0.095
Bank-level variable					
$\text{Injection}_{kt}/e_{k,t-1}$	0.385	0.378	0.375	0.401	0.398
BCR_{kt-1}	2.290	2.296	2.337	2.249	2.277
$\text{Injection}_{kt}/e_{k,t-1} \times \text{BCR}_{kt-1}$	0.734	0.717	0.715	0.768	0.768
Firm-level variable					
$\overline{BCR}_{it-1}$	1.945	1.913	2.016	1.943	1.998
$\overline{(Injection/e)}_{it}$	0.084	0.083	0.085	0.088	0.083
$\overline{(\text{Injection}/e)}_{it}^{\text{H-BCR}}$	0.055	0.056	0.054	0.058	0.051
$\overline{(\text{Injection}/e)}_{it}^{\text{L-BCR}}$	0.028	0.026	0.029	0.029	0.030

Notes: This table shows the sample averages of displayed variables in 1999 sample.

low-TFP non-zombie firms.

Tables A10 and A11 present the estimate of loan growth regression when the ratio of defaulted loan to equity is included as an additional regressor, which correspond to Tables 3 and 4, respectively.

Table A6: Regression Analysis of Bank Loans: Full Interaction with Loan Share (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)
$\text{Inject}_{kt}/e_{k,t-1} \times \omega_{ik}$	0.5450**	1.1413**	0.5099*	1.1290*	0.8164***	1.5460**	0.7773***	1.1481*
	[0.258]	[0.565]	[0.262]	[0.576]	[0.287]	[0.651]	[0.289]	[0.631]
$\text{Inject}_{kt}/e_{k,t-1}$	0.0503	0.0345	0.0492	0.0261	0.0339	0.0041	0.0327	0.0357
	[0.064]	[0.122]	[0.064]	[0.121]	[0.063]	[0.126]	[0.063]	[0.122]
$\text{BCR}_{k,t-1} \times \omega_{ik}$	0.1723***	0.1917***	0.1707***	0.1909***	0.1758***	0.1945***	0.1746***	0.0747
	[0.049]	[0.055]	[0.049]	[0.055]	[0.050]	[0.054]	[0.050]	[0.056]
$\text{BCR}_{k,t-1}$	0.0356***	0.0355***	0.0338***	0.0333***	0.0344***	0.0337***	0.0327***	0.0416***
	[0.011]	[0.010]	[0.012]	[0.010]	[0.011]	[0.010]	[0.011]	[0.011]
$\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1} \times \omega_{ik}$		-0.3605		-0.3720		-0.4468		-0.4496
		[0.282]		[0.286]		[0.319]		[0.322]
$\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1}$		0.0115		0.0152		0.0183		0.0173
		[0.051]		[0.050]		[0.053]		[0.050]
$\frac{\Delta \ell_{ik,t-1}}{\ell_{ikt-2}} \times (1 - D^{\text{missing}}_{ik,t-1})$			-0.0318***	-0.0319***			-0.0317***	-0.0312***
			[0.005]	[0.005]			[0.005]	[0.005]
$D^{\text{missing}}_{ik,t-1}$			0.1462**	0.1454**			0.1455**	0.1549**
			[0.070]	[0.070]			[0.070]	[0.070]
ω_{ik}	-1.3958***	-1.3942***	-1.3634***	-1.3636***	-1.3793***	-1.3785***	-1.3521***	
	[0.258]	[0.264]	[0.258]	[0.265]	[0.253]	[0.255]	[0.252]	
$\text{Domestic}_{kt-1} \times \omega_{ik}$	-0.2740	-0.3188	-0.2786	-0.3253	-0.2845	-0.3384	-0.2896	0.2173
	[0.266]	[0.283]	[0.270]	[0.288]	[0.262]	[0.282]	[0.265]	[0.257]
Domestic_{kt-1}	-0.1606***	-0.1595***	-0.1537***	-0.1516***	-0.1547***	-0.1510***	-0.1480***	-0.1893***
	[0.055]	[0.054]	[0.055]	[0.054]	[0.055]	[0.054]	[0.055]	[0.056]
$\text{Deposit}_{kt-1}/\text{A}_{kt-1} \times \omega_{ik}$	0.5628	0.4841	0.5822	0.5018	0.5023	0.4357	0.5268	-1.1785***
	[0.373]	[0.388]	[0.369]	[0.384]	[0.370]	[0.377]	[0.366]	[0.257]
$\text{Deposit}_{kt-1}/\text{A}_{kt-1}$	-0.4903	-0.4892	-0.5022	-0.4953	-0.4986	-0.4920	-0.5106	-0.4409
	[0.499]	[0.522]	[0.487]	[0.508]	[0.499]	[0.520]	[0.487]	[0.501]
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,604	24,604	24,604	24,604	24,604	24,604	24,604	24,604
Number of Firms	1116	1116	1116	1116	1116	1116	1116	1116
Number of banks	110	110	110	110	110	110	110	110

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table A7: Regression Analysis of Bank Loans: No Interaction with Loan Share (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)
$\text{Inject}_{kt}/e_{k,t-1}$	0.1064**	0.1481*	0.1017*	0.1365	0.1522***	0.2232***	0.1480**	0.2114***
	[0.053]	[0.088]	[0.053]	[0.087]	[0.056]	[0.079]	[0.057]	[0.079]
$\text{BCR}_{k,t-1}$	0.0495***	0.0519***	0.0475***	0.0495***	0.0496***	0.0532***	0.0478***	0.0511***
	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]	[0.010]	[0.011]	[0.010]
$\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1}$		-0.0209		-0.0174		-0.0359		-0.0320
		[0.038]		[0.037]		[0.034]		[0.033]
$\frac{\Delta \ell_{ik,t-1}}{\ell_{ikt-2}} \times (1 - D^{\text{missing}}_{ik,t-1})$			-0.0318***	-0.0318***			-0.0318***	-0.0318***
			[0.005]	[0.005]			[0.005]	[0.005]
$D^{\text{missing}}_{ik,t-1}$			0.1480**	0.1473**			0.1477**	0.1464**
			[0.070]	[0.070]			[0.070]	[0.070]
ω_{ik}	-0.5984***	-0.5985***	-0.5642***	-0.5645***	-0.5987***	-0.5990***	-0.5646***	-0.5653***
	[0.083]	[0.083]	[0.082]	[0.082]	[0.083]	[0.083]	[0.082]	[0.082]
Domestic_{kt-1}	-0.1929***	-0.1991***	-0.1859***	-0.1912***	-0.1880***	-0.1970***	-0.1817***	-0.1897***
	[0.053]	[0.052]	[0.054]	[0.052]	[0.053]	[0.052]	[0.053]	[0.052]
$\text{Deposit}_{kt-1}/\text{A}_{kt-1}$	-0.5788	-0.6178	-0.5907	-0.6232	-0.6064	-0.6755	-0.6166	-0.6782
	[0.529]	[0.558]	[0.517]	[0.545]	[0.540]	[0.566]	[0.526]	[0.552]
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,604	24,604	24,604	24,604	24,604	24,604	24,604	24,604
Number of Firms	1116	1116	1116	1116	1116	1116	1116	1116
Number of banks	110	110	110	110	110	110	110	110

Notes: This table shows the estimation results both with and without interacting the covariates with the loan share variable ω_{ik}. The sample and model specifications are the same as in Table 3 except for the interaction. Standard errors adjusted for clustering at the bank level are in brackets. *** 1%, ** 5%, * 10%.

Table A8: Regression Analysis of Bank Loans: Zombie vs. Non-Zombie, Full Interaction with Loan Share (Dep. Var. $\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}}$)

Sample	Non-zombie			Zombie		
	All	TFP≥P25	TFP<P25	All	TFP≥P25	TFP<P25
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{Inject}_{kt}/e_{k,t-1} \times \omega_{ik}$	1.1980*	1.3117	0.6299	1.5854**	1.4141*	2.1020*
	[0.717]	[0.871]	[0.977]	[0.743]	[0.743]	[1.229]
$\text{Inject}_{kt}/e_{k,t-1}$	0.0529	0.1107	-0.1254	-0.1408	-0.2419*	0.0634
	[0.130]	[0.148]	[0.199]	[0.136]	[0.141]	[0.165]
$\text{BCR}_{k,t-1} \times \omega_{ik}$	0.2586***	0.3237***	0.0933	0.1335**	0.0872	0.2315*
	[0.094]	[0.113]	[0.112]	[0.058]	[0.070]	[0.133]
$\text{BCR}_{k,t-1}$	0.0241*	0.0277*	0.0017	0.0412**	0.0341*	0.0599**
	[0.013]	[0.015]	[0.025]	[0.017]	[0.019]	[0.026]
$\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1} \times \omega_{ik}$	-0.2709	-0.2842	-0.1272	-0.7236*	-0.7255**	-0.7805
	[0.367]	[0.402]	[0.574]	[0.382]	[0.357]	[0.673]
$\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1}$	-0.0045	-0.0297	0.0634	0.0789	0.1156**	0.0031
	[0.053]	[0.062]	[0.069]	[0.055]	[0.055]	[0.065]
$\frac{\Delta \ell_{ik,t-1}}{\ell_{ikt-2}} \times (1 - D^{\text{missing}}_{ik,t-1})$	-0.0384***	-0.0464***	-0.0249*	-0.0380***	-0.0405***	-0.0496**
	[0.006]	[0.007]	[0.014]	[0.010]	[0.012]	[0.024]
$D^{\text{missing}}_{ik,t-1}$	0.0317	-0.0385	0.2154*	0.2763**	0.2203	0.4326**
	[0.054]	[0.062]	[0.116]	[0.121]	[0.146]	[0.175]
ω_{ik}	-1.6365***	-2.0154***	-0.7279*	-0.9099***	-0.6513*	-1.4202***
	[0.471]	[0.599]	[0.417]	[0.285]	[0.334]	[0.513]
$\text{Domestic}_{kt-1} \times \omega_{ik}$	-0.4213	-0.5976	-0.0498	-0.3243	-0.1715	-0.8314
	[0.416]	[0.609]	[0.372]	[0.429]	[0.468]	[0.964]
Domestic_{kt-1}	-0.1455*	-0.1673	-0.0172	-0.0915	-0.0708	-0.1197
	[0.083]	[0.110]	[0.091]	[0.081]	[0.082]	[0.181]
$\text{Deposit}_{kt-1}/\text{A}_{kt-1} \times \omega_{ik}$	0.5009	0.7598	0.0467	0.0798	-0.1165	0.3683
	[0.628]	[0.802]	[0.592]	[0.378]	[0.469]	[0.633]
$\text{Deposit}_{kt-1}/\text{A}_{kt-1}$	-0.8130	-0.4380	-2.0493**	0.1750	0.2254	0.0607
	[0.618]	[0.731]	[0.817]	[0.590]	[0.611]	[0.743]
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,830	11,289	3,541	8,507	6,130	2,377
Number of Firms	767	584	183	547	395	152
Number of banks	108	104	93	102	101	87

Notes: This table shows the estimation results without interacting the covariates with the loan share variable ω_{ik}. The sample and model specifications are similar to those in Table 4. Standard errors adjusted for clustering at the bank level are in brackets. *** 1%, ** 5%, * 10%.

Table A9: Regression Analysis of Bank Loans: Zombie vs. Non-Zombie, No Interaction with Loan Share (Dependent Variable $\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}}$)

Sample	Non-zombie			Zombie		
	All	TFP≥P25	TFP<P25	All	TFP≥P25	TFP<P25
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{Inject}_{kt}/e_{k,t-1}$	0.1765*	0.2459**	-0.0543	0.0074	-0.1213	0.3009**
	[0.093]	[0.115]	[0.150]	[0.090]	[0.096]	[0.122]
$\text{BCR}_{k,t-1}$	0.0450***	0.0537***	0.0098	0.0540***	0.0423**	0.0848***
	[0.011]	[0.013]	[0.021]	[0.017]	[0.019]	[0.023]
$\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1}$	-0.0322	-0.0582	0.0474	0.0182	0.0586	-0.0752*
	[0.040]	[0.048]	[0.054]	[0.037]	[0.040]	[0.044]
$\frac{\Delta \ell_{ik,t-1}}{\ell_{ikt-2}} \times (1 - D^{\text{missing}}_{ik,t-1})$	-0.0385***	-0.0463***	-0.0250*	-0.0374***	-0.0402***	-0.0469**
	[0.006]	[0.007]	[0.014]	[0.010]	[0.012]	[0.022]
$D^{\text{missing}}_{ik,t-1}$	0.0330	-0.0372	0.2161*	0.2799**	0.2226	0.4358**
	[0.054]	[0.063]	[0.116]	[0.122]	[0.147]	[0.179]
ω_{ik}	-0.6480***	-0.7357***	-0.4041**	-0.5064***	-0.4917***	-0.5409***
	[0.129]	[0.137]	[0.179]	[0.083]	[0.088]	[0.169]
Domestic_{kt-1}	-0.1971**	-0.2392**	-0.0272	-0.1307*	-0.0944	-0.2154
	[0.077]	[0.099]	[0.089]	[0.072]	[0.078]	[0.130]
$\text{Deposit}_{kt-1}/\text{A}_{kt-1}$	-0.9939	-0.6381	-2.1366***	0.0610	0.1381	-0.1286
	[0.662]	[0.797]	[0.793]	[0.595]	[0.610]	[0.772]
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,830	11,289	3,541	8,507	6,130	2,377
Number of Firms	767	584	183	547	395	152
Number of banks	108	104	93	102	101	87

Notes: This table shows the estimation results both with and without interacting the covariates with the loan share variable ω_{ik}. The sample and model specifications are the same as in Table 4. Standard errors adjusted for clustering at the bank level are in brackets. *** 1%, ** 5%, * 10%.

Table A10: Regression Analysis of Bank Loans with Defaulted Loans (Dependent Var. $\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}}$)

Definition of Injection	Tier 1 + Tier 2				Tier 1 Only			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{Inject}_{kt}/e_{k,t-1} \times \omega_{ik}$	0.4011**	0.7640*	0.3762**	0.7339*	0.6808***	1.1263***	0.6514***	1.0896***
	[0.189]	[0.394]	[0.188]	[0.387]	[0.238]	[0.413]	[0.233]	[0.403]
$\text{BCR}_{k,t-1} \times \omega_{ik}$	0.2700***	0.2828***	0.2639***	0.2765***	0.2680***	0.2806***	0.2623***	0.2746***
	[0.052]	[0.057]	[0.051]	[0.056]	[0.051]	[0.055]	[0.051]	[0.054]
$\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{k,t-1} \times \omega_{ik}$		-0.2174		-0.2142		-0.2734		-0.2688
		[0.186]		[0.184]		[0.188]		[0.186]
$\frac{\Delta \ell_{ik,t-1}}{\ell_{ik,t-2}} \times (1 - D^{\text{missing}}_{ik,t-1})$			-0.0318***	-0.0318***			-0.0317***	-0.0318***
			[0.005]	[0.005]			[0.005]	[0.005]
$D^{\text{missing}}_{ik,t-1}$			0.1501**	0.1494**			0.1497**	0.1489**
			[0.069]	[0.069]			[0.069]	[0.069]
ω_{ik}	-1.7758***	-1.7774***	-1.7222***	-1.7240***	-1.7120***	-1.7116***	-1.6627***	-1.6627***
	[0.302]	[0.303]	[0.309]	[0.311]	[0.298]	[0.298]	[0.305]	[0.304]
$\text{Domestic}_{kt-1} \times \omega_{ik}$	-0.8373**	-0.8658***	-0.8128**	-0.8409**	-0.7794**	-0.8114**	-0.7564**	-0.7880**
	[0.321]	[0.324]	[0.327]	[0.330]	[0.321]	[0.325]	[0.327]	[0.330]
$\text{Deposit}_{kt-1}/\text{A}_{kt-1} \times \omega_{ik}$	0.6577	0.6099	0.6686	0.6216	0.5928	0.5498	0.6077	0.5655
	[0.415]	[0.434]	[0.410]	[0.429]	[0.412]	[0.425]	[0.407]	[0.420]
$\text{Defaulted loan}_{kt-1}/e_{k,t-1} \times \omega_{ik}$	0.8451**	0.8439*	0.8016*	0.8005*	0.6233	0.619	0.5829	0.5787
	[0.425]	[0.430]	[0.432]	[0.436]	[0.440]	[0.444]	[0.445]	[0.448]
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,570	24,570	24,570	24,570	24,570	24,570	24,570	24,570
Number of Firms	1116	1116	1116	1116	1116	1116	1116	1116
Number of banks	110	110	110	110	110	110	110	110

Notes: In this table, $\text{Defaulted loan}_{kt-1}/e_{k,t-1} \times \omega_{ik}$, which is the ratio of bank k's defaulted loans outstanding to bank k's equity capital in year $t-1$ interacted with the loan share ω_{ik}, is added as an additional covariate to Table 3. See footnote in Table 3 for other covariates used. Standard errors adjusted for clustering at the bank level are in brackets. *** 1%, ** 5%, * 10%.

Table A11: Regression Analysis of Bank Loans with Defaulted Loans: Zombie vs. Non-Zombie (Dependent Var. $\frac{\Delta \ell_{ikt}}{\ell_{ik,t-1}}$)

Sample	Non-Zombie			Zombie		
	All	TFP≥P25	TFP<P25	All	TFP≥P25	TFP<P25
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{Inject}_{kt}/e_{k,t-1} \times \omega_{ik}$	1.0917**	1.4582**	0.09	0.4591	0.0353	1.4120*
	[0.529]	[0.652]	[0.823]	[0.380]	[0.507]	[0.795]
$\text{BCR}_{kt-1} \times \omega_{ik}$	0.3366***	0.4114***	0.1363	0.2033***	0.1743**	0.2563***
	[0.097]	[0.119]	[0.099]	[0.054]	[0.075]	[0.072]
$\text{Inject}_{kt}/e_{k,t-1} \times \text{BCR}_{kt-1} \times \omega_{ik}$	-0.2332	-0.3884	0.1603	-0.2566*	-0.1912	-0.4077
	[0.263]	[0.318]	[0.458]	[0.140]	[0.197]	[0.405]
$\frac{\Delta \ell_{ik,t-1}}{\ell_{ikt-2}} \times (1 - D^{\text{missing}}_{ik,t-1})$	-0.0385***	-0.0466***	-0.0241*	-0.0380***	-0.0409***	-0.0454**
	[0.006]	[0.007]	[0.014]	[0.011]	[0.012]	[0.022]
$D^{\text{missing}}_{ik,t-1}$	0.0325	-0.0387	0.2126*	0.2860**	0.2284	0.4543**
	[0.054]	[0.063]	[0.113]	[0.119]	[0.144]	[0.183]
ω_{ik}	-1.9002***	-2.3588***	-0.7425	-1.2115***	-1.0791***	-1.4293**
	[0.570]	[0.715]	[0.530]	[0.273]	[0.307]	[0.576]
$\text{Domestic}_{kt-1} \times \omega_{ik}$	-0.9176	-1.1775	-0.1402	-0.5695*	-0.7	-0.3990
	[0.569]	[0.738]	[0.409]	[0.329]	[0.445]	[0.483]
$\text{Deposit}_{kt-1}/\text{A}_{kt-1} \times \omega_{ik}$	0.5708	0.8855	-0.0818	0.1815	0.0922	0.3347
	[0.669]	[0.869]	[0.613]	[0.387]	[0.484]	[0.669]
$\text{Defaulted loan}_{kt-1}/e_{k,t-1} \times \omega_{ik}$	0.4583	0.5933	0.1102	0.8745**	1.2478***	-0.0925
	[0.950]	[1.254]	[0.746]	[0.433]	[0.449]	[1.061]
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,814	11,275	3,539	8,490	6,119	2,371
Number of Firms	767	584	183	547	395	152
Number of banks	108	104	93	102	100	87

Notes: In this table, $\text{Defaulted loan}_{kt-1}/e_{k,t-1} \times \omega_{ik}$, which is the ratio of bank k's defaulted loans outstanding to bank k's equity capital in year $t-1$ interacted with the loan share ω_{ik}, is added as an additional covariate to Table 4. See footnote in Table 4 for subsamples and other covariates used. Standard errors adjusted for clustering at the bank level are in brackets. *** 1%, ** 5%, * 10%.

Table A12: Effect of Capital Injections on Firm Machine Investment Rates: Robustness Check (Dependent Var. $\frac{I_{it}}{K_{it-1}}$)

	Adjusted BCR 1	Adjusted BCR 2	System GMM		Solow Residual	
	(1)	(2)	(3)	(4)	(5)	(6)
$\overline{(\text{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 0)$				-0.0272		-0.0064
				[0.026]		[0.027]
$\overline{(\text{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 1)$				-0.0296		-0.0336
				[0.028]		[0.027]
$\overline{(\text{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 0)$				0.0301		-0.0121
				[0.042]		[0.031]
$\overline{(\text{Inject}/e)}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 1)$				-0.1050***		-0.0758**
				[0.033]		[0.033]
$\overline{\text{BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 0)$	-0.0024	-0.0021	-0.0057		-0.0029	
	[0.006]	[0.008]	[0.006]		[0.005]	
$\overline{\text{BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 1)$	-0.0048	-0.005	-0.0054		-0.0063	
	[0.007]	[0.008]	[0.006]		[0.006]	
$\overline{\text{BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 0)$	-0.0015	-0.0026	0.0019		-0.0048	
	[0.007]	[0.011]	[0.006]		[0.007]	
$\overline{\text{BCR}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 1)$	-0.0135**	-0.0163*	-0.0183***		-0.0151**	
	[0.007]	[0.009]	[0.007]		[0.007]	
$\overline{\text{BCR}}^{\text{Domestic}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 0)$		0.0126				
		[0.015]				
$\overline{\text{BCR}}^{\text{Domestic}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i \geq p25, \text{Zombie}_{it-1} = 1)$		0.0003				
		[0.016]				
$\overline{\text{BCR}}^{\text{Domestic}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 0)$		-0.0093				
		[0.018]				
$\overline{\text{BCR}}^{\text{Domestic}}_{it-1} \times \mathbb{I}(\overline{\text{TFP}}_i < p25, \text{Zombie}_{it-1} = 1)$		0.0051				
		[0.024]				
$\omega_i^{bankrupt} \times D^{\text{year}}_{99,00}$	-0.0985*	-0.1224**	-0.1247**	-0.1245**	-0.1196**	-0.1217**
	[0.055]	[0.056]	[0.056]	[0.056]	[0.056]	[0.056]
$\ln K_{i,t-1}$	-0.7544***	-0.7892***	-0.7854***	-0.7879***	-0.7896***	-0.7913***
	[0.070]	[0.072]	[0.071]	[0.070]	[0.071]	[0.071]
$b_{it-1}/\text{Collat}_{it-1}$	-0.0072	-0.0073	-0.0073	-0.0073	-0.007	-0.0072
	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]
$\text{Cash}_{it-1}/K_{it-1}$	-0.0003	0.0254	0.0276	0.0283	0.0274	0.0275
	[0.021]	[0.025]	[0.025]	[0.025]	[0.025]	[0.025]
$\overline{\text{Domestic}}_{it-1}$	-0.0107	-0.0374	-0.0037	-0.0257	-0.0071	-0.0276
	[0.044]	[0.066]	[0.031]	[0.027]	[0.032]	[0.027]
$\overline{\text{Deposit/A}}_{it-1}$	-0.012	-0.0361	-0.0081	-0.0171	-0.0083	-0.0150
	[0.086]	[0.088]	[0.068]	[0.064]	[0.066]	[0.064]
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year×Closing Month	Yes	Yes	Yes	Yes	Yes	Yes
TFP/Zombie Group Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,314	2,482	2,493	2,493	2,493	2,493
Number of Firms	850	898	901	901	901	901

Notes: The matched firm–bank observations for 1998–2000 are used for estimation. The dependent variable $\frac{I_{it}}{K_{it-1}}$ is the ratio of machine investment in year t to the machine capital stock in year $t-1$. The variable TFP is the logarithm of firm i's TFP in year $t-1$. Other covariates in Table 8 are also included in specifications. Standard errors adjusted for clustering at the firm level are in brackets. *** 1%, ** 5%, * 10%.

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