RIETI Discussion Paper Series 21-E-021

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NISHIOKA, Shuichiro
West Virginia University

OKUBO, Toshihiro
Keio University

TANAKA, Mari
Hitotsubashi University

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Research Institute of Economy, Trade & Industry, IAA

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https://www.rieti.go.jp/en/

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March 2021

Regional Banking and Plant Survival in Japan*

Shuichiro Nishioka (West Virginia University)

Toshihiro Okubo (Keio University)

Mari Tanaka (Hitotsubashi University)

Abstract

Since the burst of the bubble economy in the early 1990s, the stock and real estate prices collapsed in Japan. Among financial institutions, city banks were impacted the most. As a result, city banks reduced lending markedly, whereas regional banks kept credit flowing to borrowers. We use the plant-level data from the manufacturing sector to examine how regional differences in the share of city banks influenced plant survival. Using the historic share of city banks for each prefecture, we show that survival rates of plants in the mid-1990s were significantly lower in the prefectures with a high share of city banks. However, prefectures that underwent aggressive restructuring of city banks saw no improvements in employment and the prevalence of zombies as well as the reduction of regional markups and productivity.

Keywords: Regional banking, Plant survival, Zombies, Japanese manufacturing, Markup, TFP

JEL classification: G14, G21, L22, R12

*This study is conducted as a part of the Project "East Asian Industrial Productivity" undertaken at the Research Institute of Economy, Trade and Industry (RIETI). This study utilizes the micro data of the questionnaire information based on "the Census of Manufacture" which is conducted by the Ministry of Economy, Trade and Industry (METI), and its converters for establishment panel and industry panel, which are provided by RIETI. The author is grateful for helpful comments and suggestions by Kyoji Fukao (Hitotsubashi Univ.), Masayuki Morikawa (RIETI and Hitotsubashi Univ.), and Hiroyuki Okamuro (Hitotsubashi Univ.).

1 Introduction

Japanese asset, stock, and real estate prices surged from 1986 to 1991. In early 1992, the price bubble crashed and since then Japan's economy has remained stagnate, becoming Japan's lost decades. The literature tends to argue that the slow recovery from the crash stemmed from the banking practices in Japan. Peek and Rosengren (2005) argue that Japanese banks continued to provide nonperforming loans until the mid-1990s. This continued for a long period of time because bank regulation and supervision policies in Japan provide little incentive for the banks to be strict with troubled borrowers. Caballero et al (2008) also focus on the role of the widespread practice of Japanese banks' continued lending to nonperforming loans. Moreover, they argue that keeping these zombies in markets had caused market distortions: the stagnating output prices, the high wage rates, and congestion in the markets they participated, discouraging potential entrepreneurs from entering markets or healthy firms from investing.

We revisit Japan's lost decades by examining the causes and consequences of survival of manufacturing plants over the burst of the bubble economy. Our contribution is threefold. First, while the literature overwhelmingly examines zombies at the firm level (e.g., Caballero et al, 2008; Imai, 2016; Goto and Wilber, 2019), little is known about the survival dynamics at the plant level. Figure 1 illustrates the number of Japanese manufacturing plants over the period we consider.[1] The number of Japanese manufacturing peaked with over 50,000 plants in the early 1990s, and then the number of plants declined to less than 40,000 in the early 2000s. Over the same period, the number of manufacturing firms did not decline at all (i.e., from in 13,729 in 1994 to 13,354 in 2007). While the literature points out the prevalence of zombies at the firm level, it appears that the manufacturing sector had restructured themselves by shutting down some of their plants. Second, we estimate markups (e.g., De Loecker et al, 2020) and use the share of the plants with a markup less than one as a measure of the prevalence of zombies. Because we use plant-level data and plant-level information on banking and financing is not available, we use markups to proxy plants' profitability.[2] Lastly, while the literature focuses only on the prevalence of zombies across industries, we examine that across prefectures, arising from their local banking system. Japan is

[1]The data is from the Census of Manufacture from the Ministry of Economy, Trade, and Industry (METI). The figure shows the number of plants with at least 30 employees that are observed in the data. For plants with missing observations in between some years they are observed, we interpolate the missing observations.

[2]In addition, Caballero et al's (2008) zombie index is sensitive to the slight change in the definition of zombies (see Fukuda and Nakamura, 2011; Imai, 2016; and Goto and Wilber, 2019).

considered to be a bank-centered economy (Hoshi and Kashyap, 2000). Japanese firms rely more on bank debt than bond financing. Thus, the health of Japanese banks is an important factor for Japanese manufacturing firms.[3]

The literature generally argues that Japanese banks continued to provide nonperforming loans until the mid-1990s (Peek and Rosengren, 2005). Credit provided by Japanese banks, however, was very different in the 1990s, depending on the types of banks. Figure 2 illustrates the share of city banks in total lending in Japan. Since the mid-1980s to the mid-1990s, the share of city banks declined by 5 percentage points from 48% to 43%. In fact, over the burst of the bubble, city banks were forced to reduce their lending mainly because stock and real estate prices declined.[4] In contrast, regional banks continued to provide loans during the period for several reasons. First, the bubble was created in the metropolitan areas particularly in Tokyo, Osaka, and Hokkaido in the construction and real estate sectors. Second, regional banks were conservative in lending relative to city banks: lending did not exceed deposits. Furthermore, they have the advantage of close relationships with firms in their region. Shinkin banks (regional cooperative banks), for example, play an important role in the financial systems at the local level. Rather than maximizing their profits or discontinuing loans to nonperforming firms, they focus on members' benefits and provide stability and sustainability in the long run.

Historically and institutionally, the share of city banks versus regional banks differs substantially across prefectures. Figures 3 and 4 show that there is substantial variation in the share of city banks, first-tier regional banks, second-tier regional banks, and Shinkin banks across prefectures in Japan. While the share of city banks is higher in big cities like Tokyo, Osaka, and Hokkaido, the share of Shinkin banks is higher in the inland areas such as Kyoto and Gifu prefectures partly because Shinkin banks originated, for example, from the unions of silk producers in some regions (Hoffmann and Okubo, 2013). This regional structure of banks has been stable over time.

Our paper first examines how the difference in regional banking systems influenced the survival dynamics of manufacturing plants over the burst of the bubble in the early 1990s. Our empirical strategy to identify the causal relationship is the cross-regional difference in the share of city banks,

[3]Using data that cover the period we study, Amiti and Weinstein (2011) show an empirical link between the health of banks and the change in the ratios of exports to domestic sales. Raff et al (2018) find evidence that financial shocks impact foreign direct investment.

[4]In addition, since August 1995, Japanese banks had to pay a premium on Eurodollar and Euroyen inter-bank loans relative to their U.S. and U.K. competitors (Peek and Rosengren, 2001). This so-called Japan-premium provides a market indicator of investor anxiety about the ability of Japanese city banks to repay loans.

combined with the implicit differential trend in lending across bank categories. For example, in the post-bubble economy, city banks reduced their lending, while regional banks and Shinkin banks kept lending to their customers and members. We show that there is a statistically significant difference in survival rates between the prefectures with a high share of city banks and those with a low share of city banks. We also find that the difference is the largest in the mid-1990s when city banks were forced to discontinue underperforming loans.

We next examine whether or not city banks' aggressive restructure leads to creative destruction (Schumpeter, 1939; Caballero and Hammour, 1994). To do so, we examine how the reduction in underperforming loans by city banks over the bubble burst had influenced subsequent regional employment, the prevalence of zombies, productivity, and markups over Japan's lost decades. We find that the reduction in underperforming loans, however, did not improve employment, led to the prevalence of zombies, and even reduced regional productivity and markups. While keeping zombies alive would distort competition throughout the rest of the economy, our results suggest that shutting down manufacturing plants in the regions with a high presence of city banks did not lead to better resource allocation. Manufacturing plants died, and new manufacturing jobs did not take their place, so regional productivity and markups declined after the death of plants. Our results suggest that in the wake of the crisis, it is not necessarily beneficial for local economies to discontinue credit to underperforming firms. Similar to Guiso et al's (2004) findings from Italy, even though financial markets became integrated globally, local financial institutions matter for local economies.

Our paper is related to Nishimura et al (2005) and Fukao and Kwon (2006) who examine the exit and entry dynamics in Japan. Nishimura et al (2005) use firm-level, not plant-level, data and find that productive firms were more likely to exit.[5] Fukao et al (2011) use the same plant-level data as ours, but their focus is to investigate spatial selection between core and periphery (Baldwin and Okubo, 2006). We are interested in the exit dynamics, resulting from the regional difference in banking institutions.

We are not the first to focus on the zombies beyond listed firms. Imai (2016) and Goto and

[5]There are two distinct confidential surveys conducted by the Ministry of Economy, Trade and Industry: the Basic Survey of Japanese Business Structure and Activities and the Census of Manufacture. The Basic Survey of Japanese Business Structure and Activities covers firms with more than 50 employees and whose paid-in capital or investment fund is over 30 million yen. The Census of Manufacture is conducted on all plants with more than four regular employees. The response rates tend to be higher for the Census of Manufacture than the Basic Survey.

Wilbur (2019) examine the presence of zombies among small- and medium-sized enterprises (SME) and show that many zombie firms exist among SME and that the zombie-firm ratio increases as firm size decreases. We examine a much smaller unit, plants, and examine the exit dynamics in Japanese manufacturing over Japan's lost decades. We do not attempt to use Caballero et al's zombie index because we are unable to find financial information (e.g., bank borrowings; the issued amount of corporate bonds) at the plant level. Instead, we use markups and productivities to proxy plants' performance.

The rest of the paper proceeds as follows. In the second section, we explain our data. In the third section, we discuss the survival rates of manufacturing plants. In the fourth section, we describe the post-bubble performance of plants at the industrial and regional levels. In the last section, we conclude.

2 Data

2.1 Credit by Bank Types

Over the burst of the bubble economy, the share of city banks in total lending declined in Japan (see Figure 2). We divide banks into the two broad categories. First, city banks are large lenders and operate nationwide. They also have access to global financial markets. Some city banks date back as far as the middle of the Edo period (1603-1867). Sanwa Bank (one of the city banks merged to Mitsubishi-UFJ Group) and Sumitomo Bank (one of the city banks merged to Sumitomo-Mitsui Group), for example, were engaged in businesses that exchange rice, coin, and paper money during the era.[6] Second, there are three types of regional banks in Japan. The first group is the first-tier regional banks, which are small commercial banks, operating branches within one prefecture or neighboring prefectures. Although there are no longer legal regulations on single prefecture operation, regional banks tend to concentrate on lending at the regional level. The history of regional banks goes back to the policy for "one regional bank per prefecture" (Ikken Ikkou Shugi) as proposed by Eiichi Baba, the Minister of Finance in the late 1930s. The banking regulations and banking crises in the 1920s promoted large-scale mergers across many small regional banks.

[6] See, for example, Shizume (2017). During the Edo period, the Tokugawa Shogunate levied taxes by rice. Feudal lords shipped their rice to Osaka to sell to merchants in exchange for money, which created nationwide informal banking system ranging from deposit-taking to lending.

Until the early 1940s, one regional bank was operated in each prefecture for regional finance. The second and third groups are mutual banks, Sogo bank, referred to as the second-tier regional bank, and Shinkin bank as the industrial credit association. These two types of regional banks are aimed at providing finance to local small business. Sogo banks were originated from Mujin, mutual cooperative in traditional local communities, which lasted for a long time in Japan. Many of them were integrated or merged by the first-tier banks and city banks in the 1980s. On the other hand, Shinkin banks are credit cooperatives, which lend exclusively at city level and to their members. The member is limited to small business or individuals, which have less than 300 employees or capital assets of less than 900 million yen (around $9 million US dollar).

There were 13 city banks in the 1980s, which declined to 7 in 2005. Afterward, they were further consolidated into four large city banks: Mitsubishi-UFJ, Sumitomo-Mitsui, Mizuho, and Resona Group. As is detailed in Hosono et al (2007), the number of first-tier regional banks did not change over the 1980s and the 1990s (63 in 1980 and 64 in 2005), whereas the number of second-tier regional banks decreased from 71 in 1980 to 48 in 2005. The number of Shinkin banks dropped from 462 in 1980 to 301 in 2005.

We derive the share of city banks in total lending at the prefecture level from "Kinyu Journal", which is a monthly journal published by Nihon Kinyu Tsuushin. The journal publishes prefecture-level data on outstanding loans with breakdown by bank types once a year. We use the data as of March 1989, which is the oldest year available. The prefecture-level data by bank type are compiled by aggregating the whole lending registered at the headquarters and branch offices located in the prefecture. In other words, the data is based on lender's location.

We use cross-prefecture difference in the share of different bank categories (i.e., city banks and the three types of regional banks) to identify the causal relationship between regional banking and plant survival. Although we use the 1989 shares throughout the paper, the distribution of bank categories was stable even if we use the data from other sources (with different bank categories) from much earlier years.[7] This is because local banking system originated from unique regional institutions. Rajan and Zingales (2003) discuss some potential reasons why financial institutions emerge. In Japan, the development of regional financial institutions depends partially on their

[7]The Japanese firms tend to keep long-run relationships with their main banks. At least until the 1990s, larger firms tend to have a main bank system, where the main bank monitored the firm and intervened governance (Aoki et al. 1994; Miwa and Ramseyer, 2005).

historical background. Because of this, we believe the regional difference in the prevalence of city banks is exogenous to sudden shocks like the burst of the bubble economy.

Figure 3 illustrates the regional distributions of four types of banks in 1987: city banks, first-tier regional banks, second-tier regional banks, and Shinkin banks. The figure shows that there was a clear regional difference in the share of different types of banks. The share of city banks was high in Tokyo, Osaka, Hokkaido, Hyogo, and Aichi prefectures. The share of Shinkin banks was high in inland area including Kyoto, Gifu, and Nagano prefectures.

2.2 Japanese Manufacturing Plant Data

We use plant-level data from the Census of Manufacture in 1987–2007 and examine the survival of plants over the period of Japan's lost decades. We choose to use plant-level data because the exit and entry was more frequent at the plant level. For example, the number of manufacturing firms did not decline over Japan's two lost decades (i.e., from in 13,729 in 1994 to 13,354 in 2007), whereas the number of manufacturing plants declined substantially over the same period (Figure 1).

The Census of Manufacture is an annual survey conducted by the Ministry of Economy, Trade and Industry (METI). Plant-level variables, such as shipments, employment, wage bills, spending on intermediate inputs (materials, fuel, electricity, and outsourcing), and investments are from the plant subset; and product-level variables, such as shipments and physical quantities, are from the product subset. In the analysis, we use only the sample that covers all manufacturing plants that have 30 or more regular employees. We exclude plants that have less than 30 employees because these plants are not required to report the data on tangible capital assets and investment necessary to compute their capital stock. We exclude the resource-intensive industries (tobacco, oil and coal refinery) and focus on the 49 industries (the industry category from the Japan Industry Productivity (JIP) database 2015). Although we do not include smaller plants, the data cover around 60% of Japanese manufacturing plants in terms of total shipments. Over the period 1987-2009, we have 1,029,545 observations at the plant level. On average, we have around 42,900 plants for each year.

Table 1 reports the summary statistics for the years 1987 and 2007. In 1987, there were 44,817 plants, which declined by 11.6% to 39,641 in 2007. Among the 44,817 plants in 1987, 31.5% of the plants survived in 2007. The survival rate we refer to in the paper is based on the sample of the

44,817 firms in 1987. As is shown in Figure 1, the number of Japan's manufacturing plants peaked in 1992, right before the burst of the bubble economy, and then declined throughout the 1990s. One notable finding in the table is that the average size of manufacturing plants increased over time, whereas the number of plants decreased. The average sale increases by 53.6% from 4 billion yen in 1987 to 6.2 billion yen in 2007. Moreover, the average size of capital stock also increased by 101.2% from 1987 to 2007, and the average size of employment remained constant over the same period.

Table 2 reports the summary statistics for selected industries: textile, steel, electronics, and transport equipment. The table illustrates that the exit and entry dynamics were very different across industries. For example, the survival rates over the 1987-2007 period were much lower in textile and electronics industries: 18.8% for textile and 19.6% for electronics (i.e., the corresponding rates are 44.4% for steel and 39.4% for transportation equipment). Although both textile and electronics experienced low survival rates, the number of plants in 2007 was quite different: the number of plants declined from 5,721 to 2,071 in textiles, while it was almost constant for electronics. Consistent with the results in Table 1, we confirm that the average sizes of plants in terms of shipments and capital stock increased over the period at the industry level, implying that smaller plants were consolidated or exited over the period.

2.3 Markups and Productivities

In this section, we briefly explain how we estimate markups and productivities. See Appendices II and III for detailed discussion. To measure the share of zombies in industries, we do not use the zombies index introduced in Caballero et al (2008) partly because our data is plant-level, not firm-level, and does not contain detailed data on debts and borrowings. Moreover, their zombies index is sensitive to the slight changes in the definitions (e.g., Fukuda and Nakamura, 2011): for example, see Goto and Wilbur (2019) who show that levels and trends in zombies differ substantially across different definitions. In our paper, we instead use the share of plants that have markups less than one as the index to capture the prevalence of zombies at the industry and regional level. We follow the literature and use supply-side information on outputs and inputs to compute markups (e.g., Hall, 1988; Diewert and Fox, 2008; De Loecker and Warzynski, 2012; and De Loecker et al, 2016; De Loecker et al, 2020). Our approach is a variant of the supply-side approach. The assumptions we impose to derive markups are: (1) intermediate inputs and labor are variable inputs over a year (see Ackerberg et al, 2015); and (2) the sum of output elasticities of variable inputs is constant over the period. The second assumption implies that plants are able to adjust between variable inputs freely any point within a year (e.g., substitution between labor and outsourcing) but are not able to adjust between variable and fixed inputs (e.g., substitution between labor and capital). Our measure of markups does not change even if we assume that capital can be adjusted over a year (Diewert and Fox, 2008).

Our measure is similar to a specification in De Loecker et al (2020):

$$\mu_{it} = \frac{\rho_j P_{it} Q_{it}}{p_{it} M_{it} + w_{it} L_{it}} \tag{1}$$

where ρ_j is the sum of the estimated output elasticities of variable inputs in industry j (i.e., intermediate inputs and labor), $P_{it}Q_{it}$ is a plant's revenues, $p_{it}M_{it}$ and $w_{it}L_{it}$ are spending on four types of intermediate inputs (materials, energy goods, electricity, and outsourcing) and labor compensation, respectively.[8]

To obtain the output elasticity of variable inputs (ρ_j) at the industry level as well as our productivity measure, we need to estimate production functions at the industry level. Here, we assume the Cobb-Douglas production function that does not restrict returns to scale:

$$Q_{it} = \Omega_{it} \left(M_{it}\right)^{\alpha_{Mj}} \left(L_{it}\right)^{\alpha_{Lj}} \left(K_{it}\right)^{\alpha_{Kj}} . \tag{2}$$

We estimate industry-level output elasticities of inputs from the production function estimation strategy similar to De Loecker et al (2016) and De Loecker et al (2020). Our estimate for ρ_j is the sum of output elasticities of labor and intermediate inputs. Although we have the product-level price and quantity data, we use the standard approach by using the output and input deflators from the JIP database 2015 (Fukao et al, 2007) for several reasons. First, our sample declines substantially when we use the plant-product matched data. We are unable to estimate output elasticities for more than 10 industries. Second, we examine the estimated output elasticities of inputs and show that these estimates do not differ substantially. We report our detailed estimation strategy and estimated output elasticities of inputs in Appendix III. Finally, our measure of productivity is the

[8]See Appendix II for detail.

Solow residual:

$$ln(\Omega_{it}) = ln(Q_{it}) - \alpha_{Mj} ln(M_{it}) - \alpha_{Lj} ln(L_{it}) - \alpha_{Kj} ln(K_{it}). \quad (3)$$

Table 1 reports the summary statistics of markups and productivities. Typically, markup is a measure for competition. Markup is roughly one when a market is perfectly competitive, and markup is higher than one as market competition weakens. There are several papers that examine the trends of markups in Japan over the period we study. While Kiyota et al (2009) find declining trends in markups, our results suggest that markups were stable or slightly increasing over the period. See also Karabarbounis and Neiman (2018) and De Loecker and Eeckhout (2020) who show increasing markup trends in Japan from publicly traded firms as a part of global markup trends. The average value of markups in 1987 was 1.365, which increased slightly to 1.403 in 2007. Over the period, the weighted average of markups did not change. The share of the plants with markups less than one, which is our proxy for the prevalence of zombies, increased slightly from 8.8% in 1987 to 10.6% in 2007. Figure 5 illustrates that there is an unconditional difference in the prevalence of zombies between the prefectures with a high share of city banks (above the median) and those with a low share of city banks (below the median). In the early 1990s, the share of zombies declined substantially more in the prefectures with a high share of city banks, suggesting that, consistent with anecdotes, city banks aggressively cut off lending nonperforming firms. In the late 1990s and early 2000s, however, the prefectures with a high share of city banks had a higher share of zombies. Not surprisingly, over the period of the financial crisis in 2007-2009, the share of zombies increased for both regions.

The trends in markups and the prevalence of zombies differ also across industries, and there appear to be industry-specific reasons why they differ over Japan's lost decades. Table 2 reports the industry-specific values for markups. The textile industry had the highest share of the plants with a markup less than one in years 1987 and 2007. Electronics had the highest levels of markups for both years. Overall, we do not find the sharp rise of markups similar to the United States (e.g., De Loecker et al, 2020; Autor et al, 2020), which is consistent with the findings in De Loecker and Eeckhout (2020). We also find that productivity was stable over the period; the average increased slightly from 2.63 in 1987 to 2.84 in 2007.

3 Plant Survival

3.1 Main Results

This section examines the survival dynamics of manufacturing plants over the burst of the bubble economy. Our empirical specification is similar to those in Kovenock and Phillips (1997), Zingales (1998), and Foster et al (2008). We are interested in the regional difference in the survival rate due to the difference in regional banking systems. Our empirical strategy to identify the causal relationship is to use the cross-regional difference in the share of city banks in year 1989, combined with the implicit differential trend in lending across bank categories. Admittedly, this is not a perfect variable to apply to the plant-level data. Ideally, we like to have plant-specific information on the type of their main banks; however, we do not have such data. We use the Linear Probabilistic Model (LPM) and estimate conditional probability of survival:

$$Survive_{it} = F(s_p^{cb}, \ln lending_p, \ln TFP_{i,1987}, Nproducts_{i,1987}, Land_{i,1987}, X_j, X_p) \tag{4}$$

Our dependent variable is the survival dummy variable at the plant level ($Survive_{it}$). Using the sample of 44,817 manufacturing plants in 1987, the survival binary variable is one when plant i in prefecture p in industry j operated in year t where t is a year after 1987 (e.g., our baseline specification examines the survival rate from 1987 to 1997), otherwise the variable is zero.

We regress the survival variable with initial conditions in 1987. The literature generally shows that productive firms are more likely to survive (e.g., Foster et al, 2008), and multi-product firms are more productive (e.g., De Loecker et al, 2016). Conditional on these plant-specific characteristics as well as industry fixed effects and prefecture control variables, we examine how the share of city banks in total lending at the prefecture level in 1989 (s_p^{cb}) influenced the survival rate. The control variables at the plant level include the log of productivity of plant i in 1987 ($TFP_{i,1987}$), the number of products of plant i in 1987 ($Nproducts_{i,1987}$), and a dummy variable indicating that the establishment owns a land ($Land_{i,1987}$).[9] We also control for industry fixed effects and prefecture characteristics, namely the log of total lending in the prefecture in 1987 ($lending_p$), the log of population in 1995, the prefecture's share of revenue among all prefectures in Japan for the industry (a proxy for industrial agglomeration), and the change in land price from 1992 to 1995.

[9] We do not have the data on plant age.

We include plant-level variable on land ownership and prefecture-level variable on the change in land price. These variables are important for us to disentangle the direct channel of the burst of the real estate bubble on plant survival from the channel of the regional banking system.

Table 3 reports our baseline results. Columns (1) and (2) report the results from the entire sample, and columns (3) and (4) report the results when we drop the plants located in Tokyo, Osaka, and Hokkaido. The results in columns (1) and (3) suggest that over the period of 1987 to 1997, plants that were co-located with high levels of city banks were more likely to exit. Those in columns (2) and (4) show that the difference in the survival rates arising from the share of city banks in lending disappeared in the midst of the financial crisis in 2008. In addition, consistent with the literature, the productive plants are more likely to survive across all the specifications. We also find that whether or not a plant owned land plays a statistically significant role for plant survival.

Figure 6 reports the estimated coefficient on s_p^{cb} when we move the survival year t from 1990 to 2008. The negative impact of the city bank share had increased substantially after the burst year 1993. Then, it peaked in 1997, and then decreased after the mid-1990s. At the period around 2007, the coefficient becomes statistically insignificant.

3.2 Robustness Checks

Table 4 reports various robustness checks for the results using the survival rates from 1987 to 1997. Column (1) reports the results when we focus on the sample of the plants with the size of employment less than 300, which is the maximum size of plants that Shinkin banks can lend. Column (2) reports the results when we exclude multi-plant firms from the sample. Column (3) reports the results when we use the sample of the industries with above median external finance dependency index (Rajan and Zingales, 1998).[10] As is reported in Table 2, the iron and steel industry is one of the industries with the above-median Rajan-Zingales index. Columns (4) and (5) report the results when we include the interaction terms with productivity and the land dummy variable, respectively. Finally, column (6) reports the results when we replace the shares of city banks with those of first-tier regional banks and second-tier and Shinkin bank shares.

Overall, the results are consistent with the baseline results reported in Table 3. The results

[10] We use the Rajan-Zingales index calculated for Japan reported by Takizawa (2013).

do not change with the sample of smaller plants or the sample without multi-plant firms. The coefficient on the share of city banks is slightly higher when we use the sample of the industries with high external finance dependence (i.e., the high Rajan-Zingales index). We also find that the interaction of productivity and city bank share carries a statistically significant negative sign, suggesting that relatively unproductive plants are less likely to survive in the prefectures with a high presence of city banks.

4 Regional Markups and Productivity over the Crash

We next examine how the reduction in nonperforming loans by city banks over the bubble burst had influenced subsequent regional employment, the prevalence of zombies, markups, and productivity over Japan's lost decades. In particular, we try to associate our discussions with regional and industrial creative destruction within manufacturing (Schumpeter, 1939; Caballero and Hammour, 1994). We estimate the following equation:

$$Y_{pjt} = \gamma_1 s_p^{cb} + \gamma_2 \ln lending_p + \theta_p + \omega_j + \epsilon_{pjt}, \tag{5}$$

where Y_{pjt} is an outcome variable such as the number of plants, the number of employees, the average log productivities, the average markups, and the share of zombies in prefecture p in industry j in year t that we constructed from the plant-level data.

4.1 Results

Table 5 reports the results. We use the industry × prefecture aggregate, mean, or weighted averages over time. For example, column (1) reports the results when we regress the number of plants with the interactions of 5-year interval dummy and the share of city banks. Conditional on the year-, prefecture-, and industry-fixed effects, this should capture if the regions with a high prevalence of city banks increased or decreased the number of plants over time. As we discussed before, we show that the number of plants decreased more in the prefectures with a high share of city banks. The results are consistent with those reported in Table 3 and Figure 6. Over the period of 1991-1995, the prefectures with high share of city banks experienced a decrease in the number of plants, which continued over the period of 1996-2000, but disappeared over the period of 2001-2005.

Columns (2) through (6) report the results when we use employment, the share of plants with a markup less than one, and the mean and weighted mean of markups and productivities. We find that the reduction in nonperforming loans did not improve regional employment and the prevalence of zombies and even reduced their regional markups and productivities. While Caballero et al (2008) argue that keeping zombies alive would distort competition throughout the rest of the economy, our results suggest that shutting down unproductive manufacturing plants in the mid-1990s by city banks did not lead to better resource allocation to more productive plants at the regional level at least within manufacturing. Our results also share some insights with Nishimura et al (2005) and Fukao et al (2011) who find that the productive firms exited and caused distortions in the manufacturing sector. By adding regional dimension, we show that the channel through the banking sector appears to play an important role for the exit dynamics as well as productivity and markup dynamics over the period.

4.2 Robustness Checks

Table 6 reports the results with markups. Columns (1) and (2) report the results when we include or exclude Tokyo, Osaka, and Hokkaido from the sample. Columns (3) and (4) report the results when we use the subsets of industries with high and low values of the Rajan and Zingales (1998) index. The results suggest that the decline in regional markups appear to be concentrated in Tokyo, Osaka, and Hokkaido and the industries that rely heavily on financing from banks. Our results from productivities are similar to those from markups. We find that productivities declined more in the early 2000s in the prefectures with high presence of city banks. Our results are also consistent across different industries although they are not always statistically significant.[11]

5 Conclusion

Since the burst of the bubble economy in the early 1990s, the stock and real estate price collapsed in Japan. Among financial institutions, city banks were impacted the most. As a result, city banks reduced credit markedly, whereas regional banks and credit unions kept credit flowing to borrowers. Caballero et al (2008) argue that the Japanese economy stagnated in the following decades because banks kept credit flowing to insolvent firms, and credit did not flow from less

[11] See Appendix Tables A1 and A2.

productive to more productive firms. We use the plant-level data from the manufacturing sector to revisit the argument at the regional level. We first examine how regional differences in the share of city banks influenced the exit dynamics and find that survival rates of plants were lower in the prefectures with a high share of city banks. However, the restructuring of city banks saw no employment improvements, no increase in the number of plants, and no increase in markups at the prefecture level, suggesting that the restructuring did not necessarily improve regional-level market conditions within manufacturing.

Appendix

I. Capital Stock

Consider that K_{it}^k is the quantity of the kth capital service to produce good i in year t, and r_t^k is its corresponding price for the capital service. We also introduce the following notation: I_{it}^k is the quantity of the kth investment good newly acquired to produce good i in time t, and p_t^k is its corresponding price of the investment good. Following the perpetual inventory method, the accumulated stock of past investments in the kth capital good has the following property:

$$K_{it}^k = (1 - \delta^k) K_{i,t-1}^k + I_{it}^k \tag{6}$$

where δ^k is the depreciation rate of the kth investment good, which is derived from the JIP database.

We have the accounting value of tangible assets from (1) non-residential buildings and structures; (2) machinery and equipment; and (3) transport equipment. We also have investment values from these three distinct tangible assets. First, we use the perpetual inventory method and develop total capital stock from the real investment values. We then allocate total capital stock across plants by their share of the accounting value of tangible assets. This value is used only for the first year when a plant appears in the data. Second, we take plant-level first year value of capital stock and real investment values. We then apply equation (6) at the plant level to obtain capital stock after the first year.

Total capital stock value any point in time is around 50% of the corresponding capital stock in the JIP database. There are several reasons why our capital stock is smaller. First, our sample limits the plants with more than 30 employees, and we drop the three industries (tobacco, oil refinery, and coal refinery). Second, the JIP database covers a broader set of assets including some intangible assets (e.g., computer software). Although our estimates do not perfectly match with the JIP database, we have an aggregate trend that is similar to the JIP database.

II. Markups

A plant i that produces a good at time t uses a production function that converts materials (M_{it}), labor (L_{it}), and capital (K_{it}) into real output (Q_{it}). The corresponding input prices, material prices (p_{it}), wages (w_{it}), and capital service prices (r_{it}), are strictly positive, exogenous for producers, and plant-specific. Production function is plant-specific. The only assumption we impose is that the sum of output elasticities of variable inputs does not change over time. This means that a plant is able to adjust between variables inputs at any point in time (e.g., the substitution between power purchase from power plants and purchase of gas to generate power) but is not able to adjust between a variable and a fixed input (e.g., substitution between capital and labor) within a year. In particular, we have the following general form of production function that allows variable returns to scale:

$$Q_{it} = \Omega_{it} F_{it}\left(M_{it}, L_{it}, K_{it}\right) \tag{7}$$

where the production technique is differentiable, and Ω_{it} is a total factor productivity measure that is a source of plant-level heterogeneity to generate exit and entry of plants.

We also define the output elasticity of input X as follows:

$$\alpha_{it}^{X} \equiv \frac{\partial Q_{it}/Q_{it}}{\partial X_{it}/X_{it}}. \tag{8}$$

We derive markups when materials and labor are variable inputs. This is consistent with Ackerberg et al's (2015) timing assumption where a producer is able to adjust intermediate inputs any point in time and labor within a year. We set up the following Lagrangian function for a plant to minimize its total cost:

$$\mathcal{L} = \tilde{p}_{it} M_{it} + w_{it} L_{it} + r_{it} K_{it} + \lambda_{it}\left[Q_{it} - \Omega_{it} F_{it}\left(M_{it}, L_{it}, K_{it}\right)\right]$$

where the Lagrange multiplier (λ_{it}) is its marginal cost.

We consider that a plant adjusts variable inputs to produce the target level of output (Q_{it}). Using the first order conditions of the variable inputs, and imposing $Q_{it} = \Omega_{it} F_{it}(M_{it}, L_{it}, K_{it})$ by treating all inputs as variable inputs, we can find the optimal value of M_{it}, L_{it}, and λ_{it} to produce Q_{it}. Then, we can find the following formula for marginal cost:

$$\lambda_{it} = \left(\frac{p_{it}}{MP_{it}^{M}}\right)^{\bar{\alpha}_{it}^{M}} \left(\frac{w_{it}}{MP_{it}^{L}}\right)^{1-\bar{\alpha}_{it}^{M}} \tag{9}$$

where $\bar{\alpha}_{it}^{M} = \alpha_{it}^{M}/(\alpha_{it}^{M} + \alpha_{it}^{L})$ and MP_{it}^{X} is marginal product of a variable input (i.e., $MP_{it}^{L} = \alpha_{it}^{L} Q_{it}/K_{it}$ and $MP_{it}^{K} = \alpha_{it}^{K} Q_{it}/K_{it}$).

Here, we assume that the sum of output elasticities of variable inputs does not change over time: $\rho_j = \alpha_{it}^{M} + \alpha_{it}^{L}$, which we will use the sum of estimated output elasticities of variable inputs. Then, we have our measure of markups ($\mu_{it} = P_{it}/\lambda_{it}$):

$$\mu_{it} = \frac{\rho_j P_{it} Q_{it}}{p_{it} M_{it} + w_{it} L_{it}}. \tag{10}$$

This measure is one specification used in De Loecker at al (2020), which is empirically close to a plant's revenue divided by total cost.

III. Production Function Estimation

We follow an approach proposed by De Loecker et al (2016) and obtains the production function parameters and unobserved input price parameters for the 49 manufacturing industries. While De Loecker et al (2016) propose to control for input price variations across firms using information on firm-level output prices by assuming producers of more expensive products use more expensive inputs, our sample declines substantially when we use the direct measure of output prices. Thus, we follow their intuition and approximate unobserved input price biases by market shares of each plant.

To estimate the production function at the industry level, we use the timing assumption in Ackerberg et al (2015) that firms need more time to optimize labor and install capital than to purchase intermediate inputs. It follows from this timing assumption that a plant's demand for intermediate inputs depends on its productivity and the predetermined amounts of labor and the current stock of capital. We also follow De Loecker et al (2016) and handle unobserved input price biases with log domestic market share (ms_{it}):

$$m_{it} = h_t \left(\omega_{it}, l_{it}, k_{it}, ms_{it} \right)$$

where lower-case variables represent the logged values (e.g., $l_{it} = \ln(L_{it})$).

Following Ackerberg et al (2015), we assume the above equation can be inverted with productivity:

$$\omega_{it} = h_t^{-1} \left(m_{it}, l_{it}, k_{it}, ms_{it} \right).$$

We then approximate q_{it} with the second-order polynomial function of the three inputs and that interacted with the variable for input price biases:

$$q_{it} \approx \Phi_t \left(m_{it}, l_{it}, k_{it}, ms_{it} \right) + \epsilon_{it}. \tag{11}$$

Next, we obtain the predicted value of equation (11), $\hat{\Phi}_t$, and compute the corresponding value of productivity for any combination of parameters Ω. The parameter we need to estimate not only a constant term and output elasticities ($\alpha_{M,j}$, $\alpha_{L,j}$, and $\alpha_{K,j}$) but also unobserved input price biases, the interactions of the market share ms_{it} with m_{it} (β_j). This enables us to express the log of productivity as the predicted log output minus the logged contribution of three inputs:

$$\bar{\omega}_{it}(\Omega) = \hat{\Phi}_t - \left(c_j + \bar{\alpha}_{M,j} m_{it} + \bar{\alpha}_{L,j} l_{it} + \bar{\alpha}_{K,j} k_{it} + \bar{\beta}_j m_{it} ms_{it} \right).$$

Our generalized method of moments (GMM) procedure assumes that plant-level innovations to productivity, $\zeta_{it}(\Omega)$, do not correlate with the predetermined choices of inputs. To recover $\zeta_{it}(\Omega)$, we assume that productivity for any set of parameters, $\bar{\omega}_{it}(\Omega)$, follows a first order Markov process. As De Loecker (2013) argue, we introduce the two dummy variables in the Morkov process because these variables influence the evolution of firm-level productivities. Thus, we can approximate the productivity process with the following function:

$$\bar{\omega}_{it}(\Omega) = \gamma_0 + \gamma_1 \bar{\omega}_{i,t-1}(\Omega) + \zeta_{it}(\Omega).$$

From the equation above, we can recover the innovation to productivity, $\zeta_{it}(\Omega)$, for a given set of the parameters. Since the productivity term, $\bar{\omega}_{it}(\Omega)$, can be correlated with the current choices of variable inputs, l_{it} and m_{it}, but it is not correlated with the fixed input, k_{it},the innovation to productivity, $\zeta_{it}(\Omega)$, will not be correlated with $\mathbf{Y}_{it} = \{k_{it}$, $l_{i,t-1}$, $m_{i,t-1}$, and $ms_{i,t-1}m_{i,t-1}\}$. Thus, we use the following moment condition:

$$E\left[\zeta_{it}(\Omega)\mathbf{Y}_{it}\right] = 0 \tag{12}$$

and search for the optimal combination of the parameters by minimizing the sum of the moments (and driving it as close as possible to zero) using the standard weighting procedure for plausible values of Ω.

Table A3 reports the summary statistics for the estimated output elasticities at the industry level. Overall, the sum of all output elasticities (or scale elasticities) are close to one. The output elasticities of labor, capital, and intermediate inputs are 0.36, 0.08, and 0.59, respectively.

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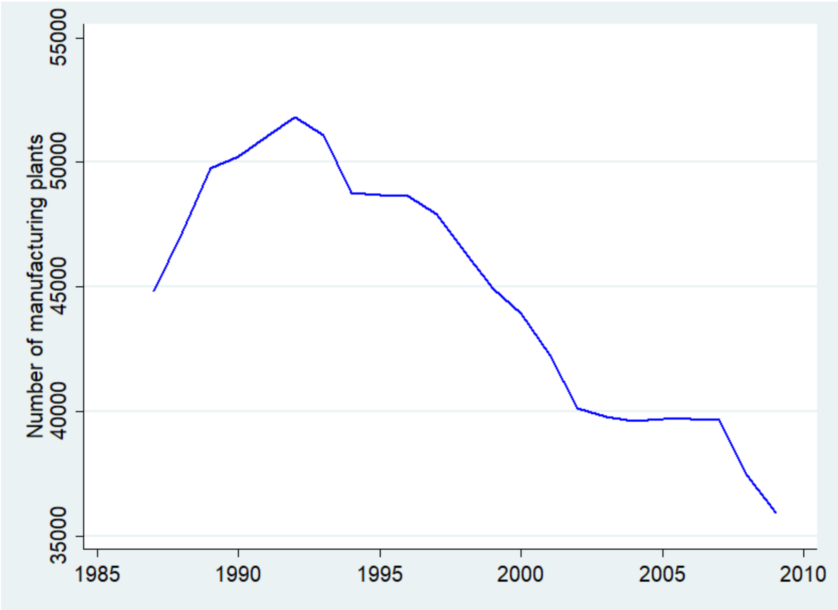
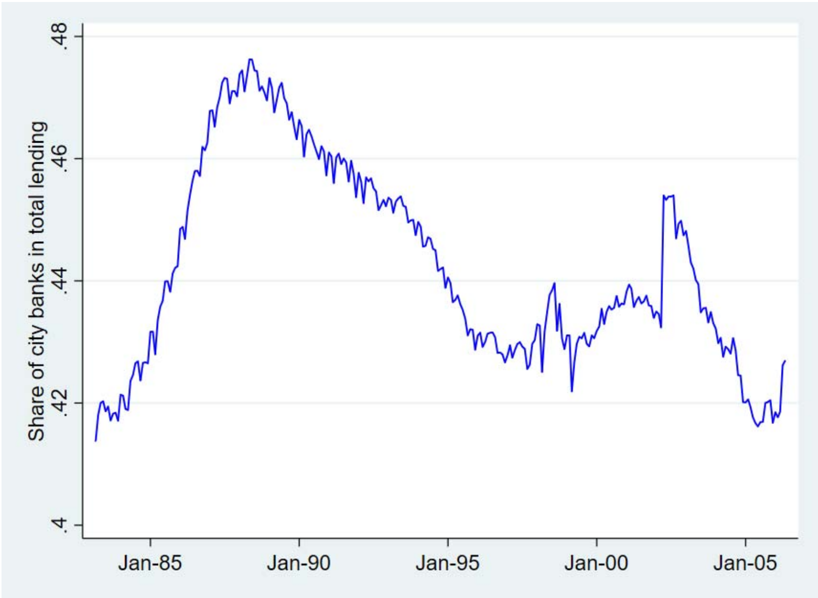
Figures and Tables

Figure 1. The number of manufacturing plants in Japan



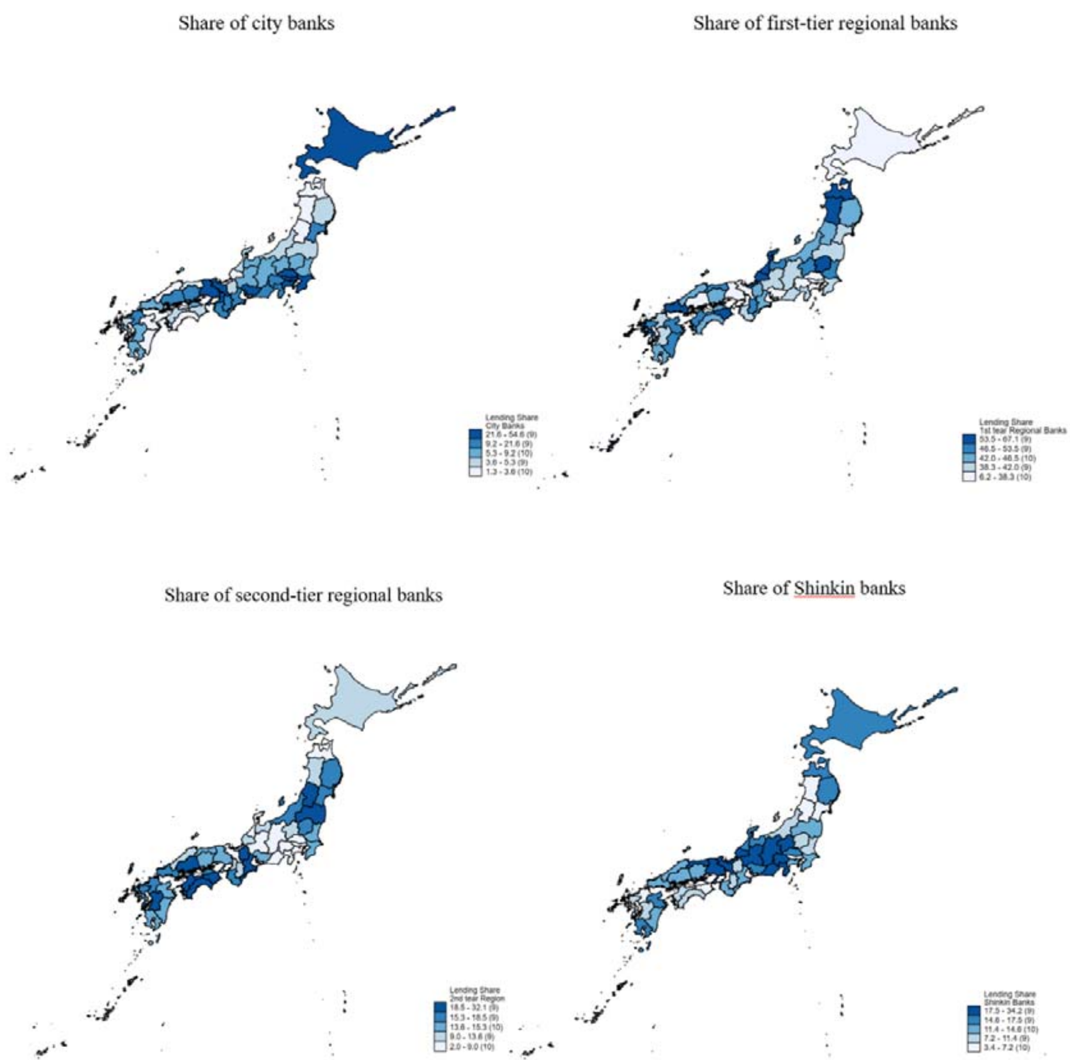
Note: We use the sample of the plants with their employment size greater than 30.

Figure 2. The share of city banks in total lending



Note: We use the monthly data from the Bank of Japan.

Figure 3. Regional patterns in lending shares by bank categories



Note: The data is based on 1989 regional lending information reported in Kinyu Journal (1999).

Figure 4. Regional share of city banks in total lending in 1989

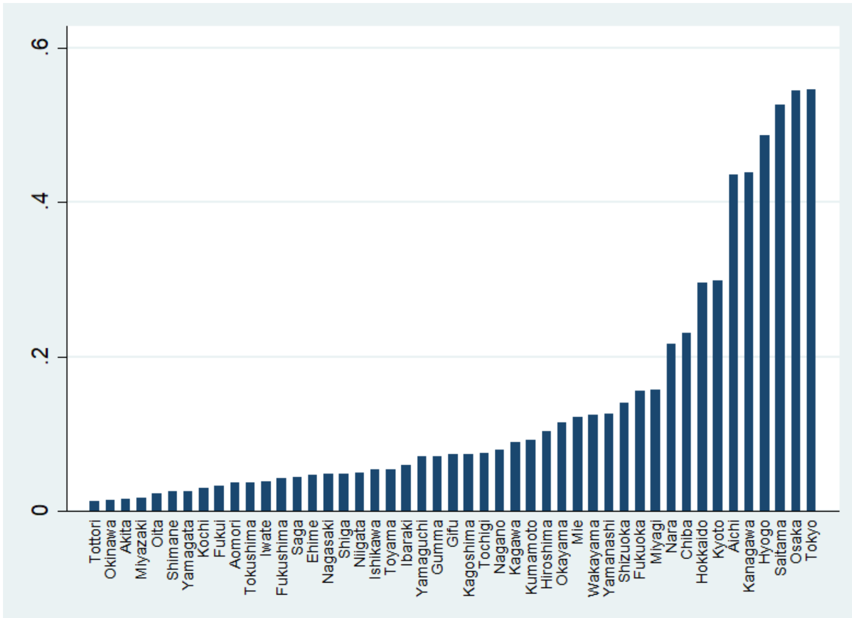


Table 1. Summary statistics

	1987	2007
Number of plants	44,817	39,641
Survival rate from 1987	1	0.315
Shipments (million yen, mean)	4,038	6,203
Employment (mean)	134	138
Capital stock (million yen, mean)	1,388	2,793
Log TFP (mean)	2.732	2.877
Markups		
Mean	1.365	1.403
Weighted	1.436	1.435
Share of less than one	0.088	0.106

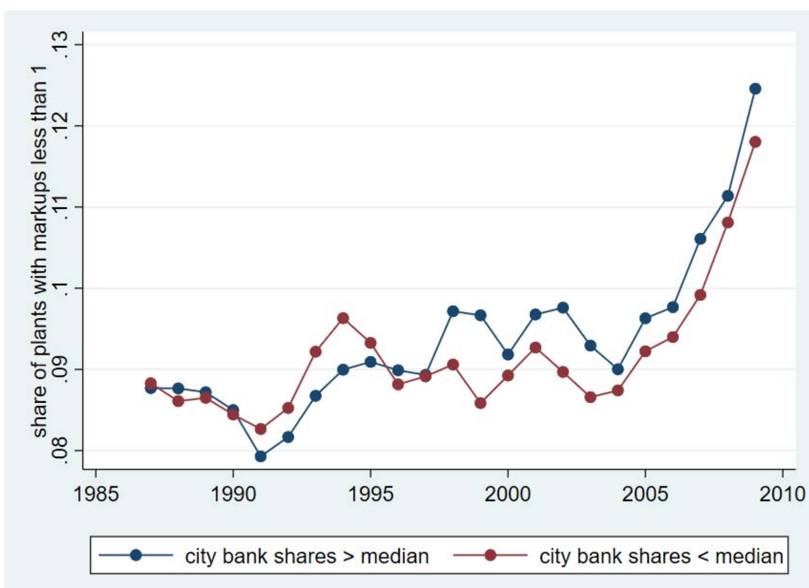
Note: (1) See Section ** for the development strategy of capital stock and capital cost. (2) See Section ** for the definitions of markups and TFP. (3) We drop top and bottom 1% of markups for each year as outliers.

Table 2. Summary statistics for some selected industries

	Textile		Steel		Electronics		Transport	
	1987	2007	1987	2007	1987	2007	1987	2007
Number of plants	5,721	2,071	1,190	1,106	2,472	2,374	2,579	2,983
Survival rate from 1987	1	0.188	1	0.444	1	0.196	1	0.394
Shipments (million yen, mean)	1,085	1,164	9,882	16,597	6,032	10,260	12,592	16,756
Employment (mean)	88	76	233	158	218	233	276	281
Capital stock (million yen, mean)	298	543	7,949	8,761	2,048	6,732	3,141	5,959
Log TFP (mean)	3.247	3.307	2.761	2.749	2.402	3.491	2.914	3.117
Markups								
Mean	1.263	1.310	1.385	1.422	1.557	1.648	1.287	1.323
Weighted	1.287	1.421	1.396	1.416	1.607	1.765	1.332	1.330
Share of less than one	0.119	0.125	0.045	0.061	0.082	0.087	0.069	0.085
Rajan and Zingales (1998) index	0.382	0.382	0.500	0.500	0.365	0.365	0.440	0.440

Note: (1) See Table 1. (2) Rajan and Zingales (1998) index is from Takizawa (2013). (3) We use the following industry code from the 2012 JIP database: textile (15); iron and steel (36 and 37); electronic equipment (48, 50, 51, and 52); and transportation equipment (54, 55, and 56).

Figure 5. Share of plants with markups less than one
by regional share of city banks



Note: We divide the sample according to the shares of city banks in total lending at the prefecture level in 1989. See Figure 4.

Table 3. Banking and survival of Japanese plants

Dependent variable:	Survival binary variable			
Sample:	All plants		w/o Tokyo, Osaka, and Hokkaido	
	1987-1997	1987-2008	1987-1997	1987-2008
	(1)	(2)	(3)	(4)
Prefecture-level variables				
City bank share in 1989	-0.266***	-0.067	-0.293***	-0.104**
	(0.077)	(0.057)	(0.074)	(0.047)
Log total lending in 1989	-0.010	-0.021	0.027	0.023
	(0.012)	(0.012)	(0.021)	(0.015)
Change in land price over the bubble	-0.018	-0.011	-0.017	0.011
	(0.015)	(0.014)	(0.012)	(0.010)
Plant-level variables				
Log TFP in 1987	0.089***	0.087***	0.091***	0.089***
	(0.013)	(0.009)	(0.015)	(0.010)
Number of products	0.002	0.003**	0.002	0.003
	(0.002)	(0.002)	(0.002)	(0.002)
Land owner dummy	0.120***	0.107***	0.122***	0.110***
	(0.006)	(0.006)	(0.007)	(0.006)
Control variables				
Prefecture control variables	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	44,817	44,817	37,645	37,645
R-squared	0.057	0.070	0.059	0.073

Note: (1) Standard errors that are clustered at the prefecture level are in the parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% confidence level, respectively. (2) We take 44,817 plants in 1987. Survival binary variable is 1 when a plant operated from 1987 to year *t* (1997 or 2008). Otherwise, it is 0.

Figure 6. Coefficients on the shares of city banks

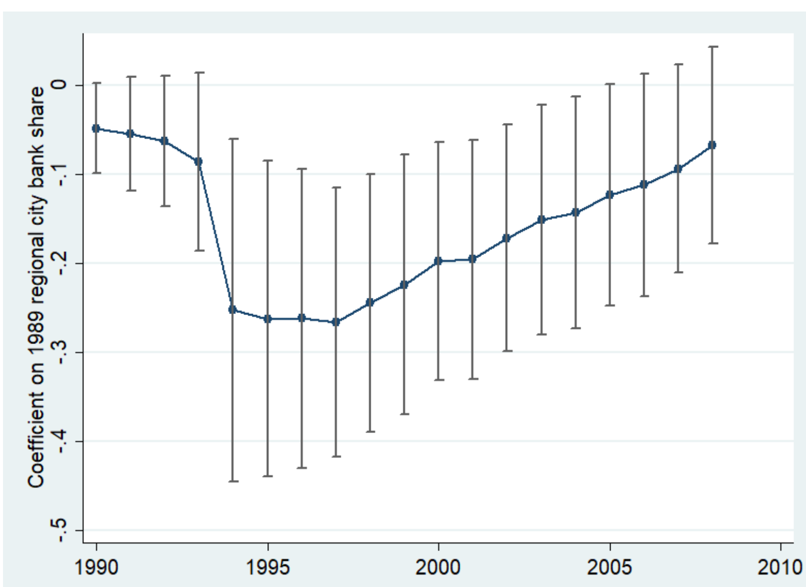


Table 4. Robustness checks

Dependent variable:	Survival binary variable (1987-1997)					
	Sub-samples			Other specifications		
	Small plants	Single plants	High RZ	TFP	Land	Bank types
	(1)	(2)	(3)	(4)	(5)	(6)
Prefecture-level variables						
City bank share in 1989	-0.257***	-0.247***	-0.284***	-0.125	-0.258***	
	(0.084)	(0.076)	(0.089)	(0.079)	(0.077)	
City bank share in 1989 × log TFP in 1987				-0.051***		
				(0.016)		
City bank share in 1989 × land dummy					-0.010	
					(0.012)	
First-tier regional bank share in 1989						0.242***
						(0.089)
Second-tier and Shinkin bank share in 1989						0.191*
						(0.099)
Log total lending in 1987	-0.017	-0.016	-0.001	-0.009	0.039	0.002
	(0.015)	(0.016)	(0.009)	(0.012)	(0.023)	(0.014)
Change in land price over the bubble	-0.018	-0.016	-0.011	-0.018	0.011	-0.004
	(0.015)	(0.015)	(0.014)	(0.015)	(0.010)	(0.012)
Plant-level variables						
Log TFP in 1987	0.092***	0.097***	0.080***	0.102***	0.089***	0.087***
	(0.013)	(0.017)	(0.020)	(0.013)	(0.013)	(0.013)
Number of products	-0.003	-0.002	0.005***	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Land owner dummy	0.102***	0.105***	0.140***	0.142***	0.123***	0.120***
	(0.008)	(0.008)	(0.007)	(0.009)	(0.010)	(0.007)
Control variables						
Prefecture control variables	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	25,316	20,447	21,425	44,817	44,817	44,817
R-squared	0.051	0.050	0.044	0.057	0.057	0.057

Note: (1) Standard errors that are clustered at the prefecture level are in the parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% confidence level, respectively. (2) We take 44,817 plants in 1987. Survival binary variable is 1 when a plant operated from 1987 to 1997. Otherwise, it is 0. (3) Small plants are the plants with their employment size less than 300. Single plants exclude multi-plant plants. And, high RZ represents the industries with greater than median Rajan and Zingales (1998) index in the manufacturing sector.

Table 5. Levels of performance variables by city bank shares

	Number of plants and labor		Markups and TFP				
Dependent variable:	ln(plants)	ln(L)	Markups			TFP	
Aggregate, mean or sales weighted:	Aggregate	Aggregate	Mean	Weighted	Share	Mean	Weighted
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
City bank share × 1991-95 year dummy	-0.229***	-0.230***	0.028	-0.070	-0.020	-0.030	-0.053
	(0.045)	(0.071)	(0.034)	(0.076)	(0.017)	(0.026)	(0.029)
City bank share × 1996-00 year dummy	-0.189*	-0.335**	0.019	-0.155	-0.003	-0.062	-0.088
	(0.100)	(0.131)	(0.061)	(0.120)	(0.037)	(0.048)	(0.061)
City bank share × 2001-06 year dummy	-0.023	-0.233	-0.088	-0.385***	0.028	-0.109*	-0.139**
	(0.167)	(0.217)	(0.082)	(0.120)	(0.052)	(0.063)	(0.062)
Control variables							
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	37,946	37,946	37,946	37,946	37,946	37,946	37,946
R-squared	0.726	0.647	0.608	0.507	0.518	0.910	0.863

Note: (1) Standard errors that are clustered at the prefecture level are in the parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% confidence level, respectively. (2) We use the aggregate, mean, or shipments-weighted mean at the industry and prefecture level.

Table 6. Robustness checks

Dependent variable:	Markups (weighted)			
Sample:	Tokyo, Osaka and Hokkaido		Rajan-Zingales index	
	With	Without	High RZ	Low RZ
	(1)	(2)	(3)	(4)
City bank share × 1991-95 year dummy	-0.070	-0.035	-0.051	-0.049
	(0.076)	(0.076)	(0.095)	(0.104)
City bank share × 1996-00 year dummy	-0.155	-0.064	-0.138	-0.113
	(0.120)	(0.115)	(0.142)	(0.161)
City bank share × 2001-06 year dummy	-0.385***	-0.305**	-0.350**	-0.388**
	(0.120)	(0.124)	(0.148)	(0.166)
Control variables				
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	37,946	35,356	22,413	14,663
R-squared	0.507	0.465	0.546	0.466

Note: (1) Standard errors that are clustered at the prefecture level are in the parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% confidence level, respectively. (2) We use the aggregate, mean, or shipments-weighted mean at the industry and prefecture level.

Table A1. Survival rates at the industry level

Dependent variable:	Survival dummy variable (1987-1997)			
Sample:	Textile	Steel	Electronics	Transport
	(1)	(2)	(3)	(4)
Regional variables				
City bank share in 1989	-0.151	-0.578***	-0.276*	-0.280*
	(0.147)	(0.085)	(0.157)	(0.154)
Log total lending in 1987	-0.012	0.007	0.022	-0.017
	(0.015)	(0.019)	(0.022)	(0.026)
Plant-level variables				
Log TFP in 1987	0.094***	-0.001	0.075***	0.033
	(0.022)	(0.049)	(0.027)	(0.013)
Number of products	0.021***	0.006*	0.002	-0.003
	(0.004)	(0.003)	(0.006)	(0.005)
Log land size	0.058 ***	0.097**	0.156***	0.157***
	(0.016)	(0.043)	(0.018)	(0.025)
Control variables				
Prefecture control variables	Yes	Yes	Yes	Yes
Sub-industry fixed effects	Yes	Yes	Yes	Yes
Observations	5,721	1,190	2,472	2,579
R-squared	0.013	0.025	0.056	0.034

Table A2. Markups at the industry level

Dependent variable:	Markups (weighted)			
Sample:	Textile	Steel	Electronics	Transport
	(1)	(2)	(3)	(4)
City bank share × 1991-95 year dummy	-0.193	-0.297	-0.003	0.126
	(0.199)	(0.185)	(0.243)	(0.074)
City bank share × 1996-00 year dummy	-0.098	-0.404	-0.072	-0.064
	(0.263)	(0.307)	(0.321)	(0.102)
City bank share × 2001-06 year dummy	-0.323	-0.798*	-0.272	-0.226
	(0.463)	(0.407)	(0.298)	(0.216)
Control variables				
Sub-industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	893	1,502	3,221	2,016
R-squared	0.587	0.382	0.370	0.228

Table A3. Estimated output elasticities

	Mean	s.d.	Min	Max
	(1)	(2)	(3)	(4)
Labor	0.363	0.074	0.102	0.488
Capital	0.082	0.026	0.019	0.207
Intermediate inputs	0.591	0.059	0.466	0.897