Wall of Main bank: Mega Bank-Merger and Lending Adjustment

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Abstract

In a financial system where the bank loan share ranking in a firm's borrowing portfolio holds importance , changes in ranking due to bank mergers can incur additional costs for firms and banks. Using a large mega-bank merger in 2000s, we find that (1) merged bank reduces lending volume after the merger to avoid being top loan share ranking (2) however, this reduction does not harm the firm's investment and funding, because the top share bank at the pre-merger increases its lending. Based on the findings of lending adjustment by the merged bank, we employ fuzzy bunching estimator to quantify the net adjustment costs, reaching up to 16% of profit on margin. Our results reveal a new mechanism by which bank mergers generate costs and who bears those costs.

Keywords: Bank merger, Main bank, Borrowing portfolio, Bunching estimator
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1. Introduction

The effect of bank mergers on the position of merged banks in financial markets has been a subject of significant interest both academically and practically. In academics, researchers have analyzed how mergers, by altering a specific bank's market position, influence bank lending behavior (e.g., Sapienza, 2002; Erel, 2011; Fraisse et al., 2018). In practice, financial regulators in various countries closely monitor the position of merged banks to ensure financial stability and maintain competitive market conditions.

However, the changes in a bank's position caused by mergers are not limited to the market level. At a more micro level, mergers can alter a bank's relative importance in a firm's borrowing portfolio. For instance, when two merging banks have provided loans to the same firm, the merger may result in the merged bank holding a significantly larger share of the firm's borrowing portfolio, potentially becoming its primary lender. In financial systems where a bank's rank within a firm's borrowing portfolio holds strategic importance, mergers may reveal mechanisms of lending behavior previously unexplored.

This study focuses on Japan's main bank system, a financial system in which a position within firm's borrowing portfolio holds significant importance for banks. Traditionally, Japan has been characterized as having a main bank system where main banks play a pivotal role in corporate financing. A main bank incurs costs by providing financial assistance when a firm faces financial distress and by fulfilling its role as a delegated monitor of the firm. In return, the main bank can benefit from additional revenue sources, such as interest income and non-lending services like underwriting securities.

One of the important factors for the designation of a "main bank" is the relative position of a bank in a firm's borrowing portfolio. Hirota (2009) highlights that loan officers in Japan's megabanks view the rank of the commitment line and loan share as key indicators of a main bank relationship. Indeed, the study shows that in 92% of cases where a lending relationship exists between a firm and its main bank in 2008, the main bank ranked first in lending share within the borrowing firm's portfolio, underscoring the significance of lending rank in Japan.

The purpose of this paper is to examine how the lending behavior of the merged bank changes when the merger potentially alters the banks' ranking within a firm's borrowing portfolio. Specifically, we use a mega-merger between Japanese banks and shed light on the cases where the merged bank's share surpass the existing main bank's share. If the merger results in the merged bank becoming the largest lender, it would assume the responsibilities and costs associated with being the main bank, such as providing financial rescue and monitoring. If these costs are deemed excessive, the merged bank may

strategically adjust its lending to avoid becoming the main bank. Conversely, if the benefits of being the main bank, such as increased interest income and non-lending service revenue, outweigh the costs, the merged bank may retain or even increase its lending to secure a stable position. Determining which of these outcomes prevails is an empirical question. Therefore, our study aims to uncover a new mechanism linking bank mergers and bank lending.

Our empirical strategy focuses on shifts in loan share ranking within firm's borrowing portfolios, induced by a bank mega-merger in Japan during the 2000s. We compare the following two groups. The treatment group comprises cases where the combined pre-merger loans of the merging banks exceeded the loan amount of the top-ranked lender in the borrowing portfolio. In contrast, the control group comprises cases where the combined pre-merger loans of the merging banks are not expected to surpass the loan amount of the top-ranked lender at the post-merger.

In the treatment group, two potential changes in the merged bank's lending behavior can be considered. First, the merged bank may reduce its lending to avoid becoming the top share lender. As the main bank, a lender gains various additional revenues while bearing responsibilities for the rescue and monitoring of borrowing firms. If the merged bank perceives these costs as substantial, it may strategically reduce its lending post-merger to avoid becoming top share lender—an important indicator of the main bank. Second, the merged bank might maintain or even increase its lending. If the benefits of becoming the main bank outweigh the associated costs, the merged bank may choose to sustain or expand its lending to surpass the existing top lender and establish a more stable position.

First, we investigated how frequently firms in the treatment group had the merged bank as their top lender after the merger was completed. In principle, firms in the treatment group should have the merged bank as their top lender unless the merged bank significantly reduced its lending post-merger. However, in practice, only about 34% of firms in the treatment group retained the merged bank as the top lender. This finding suggests that the merged bank actively reduced its lending to avoid becoming the main bank.

Based on this finding, we analyzed how much the merged bank reduced its lending using a difference-in-differences (DID) estimation. Our results show that, in the treatment group, the lending share of the merged bank decreased by approximately 4-7% after the merger.

The reduction in lending by the merged bank may have acted as a funding shock for firms, potentially negatively affecting their investment and financing. To examine this,

we used a similar DID specification to estimate the impact on firms' capital investment and total borrowing from banks. However, we found no evidence of negative effects. One possible explanation for this result is that other banks stepped in to compensate for the reduction in lending by the merged bank. To investigate this, we analyzed changes in the lending share of the main bank as of 2003, just before the merger. The analysis revealed a greater increase in the lending share of the main bank within the treatment group.

In summary, the findings suggest that the merged bank tended to reduce its lending more significantly in cases where it was highly likely to become the top lender, thereby avoiding the role of the main bank. At the same time, the lending share of the pre-merger main bank increased. This implies that the pre-merger main bank offset the reduction in lending by the merged bank, mitigating potential negative effects on firms' capital investment and financing activities.

To assess whether the results of our analysis are robust to various potential biases, we conducted a battery of robustness checks. First, we addressed potential biases stemming from firm-level demand factors. For instance, the treatment group might disproportionately include firms with weaker external funding needs or lower growth prospects, leading to a reduction of lending by the merged bank. Following Khwaja and Mian (2008), we incorporated firm-year fixed effects, bank-year fixed effects, and firm-bank fixed effects into our analysis using loan-level data. These adjustments confirmed the robustness of our findings.

Second, while these fixed effects address many concerns, they do not fully resolve issues related to omitted firm-bank-year variables. To address this issue, we employed a regression discontinuity design. Specifically, we used "the ratio of loans from merging banks to loans from the main bank" just before the merger as the running variable, with a threshold set at 1. This approach allowed us to examine whether crossing this threshold led to a reduction in lending by the merged bank in 2006, the year the merger was completed. The results were consistent with our main analysis.

Third, to address concerns about potential violations of the parallel trends assumption in our DID analysis, we conducted a synthetic DID analysis using a longer balanced panel dataset. This additional analysis further confirmed the robustness of our findings. These robustness checks collectively support the validity of our main results and mitigate concerns about potential biases.

We confirmed that merged banks tend to reduce their lending after a merger to avoid taking the top lending share and incurring associated costs. Our next objective is to quantitatively evaluate these costs, which include obligations such as rescuing distressed firms and undertaking monitoring responsibilities.

Using a fuzzy bunching estimation approach, we estimate the magnitude of these costs for marginal bunchers—cases where the bank is indifferent between reducing its lending to remain below the existing top lender and accepting the increased lending share that comes with incurring these costs. Our results indicate that the size of these costs is approximately 16% of the bank's net interest margin revenue. Given that one standard deviation of year-over-year changes in net interest margin revenue during the same period is 26%, these costs can be considered substantial.

Our study contributes to the literature on the relationship between bank mergers and lending. Previous research has identified several mechanisms through which bank mergers affect lending, including changes in lending technology (Berger et al., 1998; Peek and Rosengren, 1998), Efficiency gains (Amel et al., 2004) and Market power (Sapienza, 2002; Erel, 2011). We find evidence that the merged bank adjusts their lending to avoid taking the top lending rank in firms' borrowing portfolios. Our analysis highlights a previously unexplored mechanism through which bank mergers influence lending: the ranking or balance of powers within firms' borrowing portfolios. This finding adds a novel perspective to the existing literature by identifying the role of intra-firm lender hierarchy in shaping post-merger lending behavior.

Our study is also related to the existing literature on main banks and relationship banking. Previous studies have examined the role of main banks in Japan and the associated costs (Hoshi et al. (1990), Fukuda and Hirota (1996), Weinstein and Yafeh (1998)). A key contribution of our study is the quantitative assessment of the costs borne by banks when they become main banks, using fuzzy bunching to exploit the shock of potential changes in main banks following a merger.

While our analysis focuses on the unique Japanese setting of main banks, recent research on relationship banking (Bolton et al., 2016; Banarjee et al., 2021; Beck et al., 2018) suggests that, similar to Japanese main banks, relationship lenders are also expected to play a role in rescuing firms in distress. The quantitative results and methodology of this study could provide valuable insights into the costs associated with relationship banking.

This paper is structured as follows. Chapter 2 discusses the institutional background related to the bank mega-merger and main banks, along with the hypotheses examined in this study. Chapter 3 introduces the research design, the data used in the analysis, and the descriptive statistics. Chapter 4 investigates whether the merged bank reduces their lending to avoid changes in lending rank induced by the merger. Chapter 5 quantitatively evaluates the extent of the costs borne by banks when they take the top lending share.

Chapter 6 presents additional analyses. Finally, the conclusion summarizes the key findings of this study.

2. Institutional background and hypothesis

2.1 Main bank

Unlike US, Japanese firms have relied on banks for financing. The main bank has played an important role. Horiuchi et al. (1988) defined the main bank if a bank supplies the largest amount of loans to a particular firm following the Economic Research Association's definition. In general, it has the largest shares in a firm's loan portfolio, has some shareholdings, and supplies funds and information firm wants. The main banks are often expected to save firms in their financial difficulty (Aoki, 1990).

The main bank system allows firms to secure a long-term and stable source of financing and support during difficult situations. There are various papers which show that relationship banking provides more credits when firms faces financial distress (Beck et al., 2018; Banerjee et al., 2021; Bolton et al.,; 2016; Schafer 2019). Firms also benefit from efficient monitoring by the main banks. For example, Fukuda and Hirota (1995) showed that the main banks act as quasi-insider monitors and main bank relationships increase the debt capacity of the firm by reducing the agency cost of debts. Kojima et al. (2017) also showed that equity holdings of the main banks significantly enhance firms' earnings quality.

The main bank system also provides benefits to banks. They obtain stable business partners and insider information which can mitigate the information asymmetry between firms and banks and decrease the probability of defaults for loans. Bolton et al. (2016) theoretically showed that firms pay higher borrowing costs for relationship banking in normal times to secure better continuation financing terms in a crisis.

The liberalization of the bond market began from the late 1970s in Japan, which allowed firms to raise funds without relying on banks. In 1980, financial transactions with foreign countries were allowed and firms could raise funds from outside Japan.

Although it becomes easier, especially for large firms, to raise funds in the market and bank relationships in Japan are weaker than they used to be before, the main bank still plays an important role. Allen et al. (2014) showed the high percentage of bank assets and bond market capitalization to GDP and suggested that Japan is a bank and market-based economy. When a firm issues bonds, the main banks perform trustee administration in general, which brings significant income fees to banks (Aoki et al., 1995). It is crucial for banks whether they are the main banks for a particular firm or not.

2.2 Mergers

As Japanese firms could raise funds through markets, Japanese banks had excess funds and speculated heavily in stocks and lands. Banks expanded their lending using land and other assets as collateral. They received high profits during the bubble in the late 1980s, but they struggled with large amounts of non-performing loans after bubble crashed. The land prices sharply fell. Because many loans are collateralized by real estate, these loans became uncollectible.

Japanese banks tried to survive not only by receiving the government's public funds, but also by mergers among themselves. There were 13 city banks in Japan before the bubble, 1986. Most of them received public funds and there were only five city banks after the bubble, 2003. They were called megabanks. Only one bank went bankrupt, and the other banks merged with each other.

Among these banks, the Bank of Tokyo-Mitsubishi (BTM) was formed in 1996 through the merger of the Bank of Tokyo with the Bank of Mitsubishi. It has not merged with any other banks since then. On the other hand, UFJ bank (UFJ) was formed by the merger of Sanwa Bank and Tokai Bank in 2002.

UFJ recorded large amounts of deficits for the fiscal year of 2004 March, and it was in danger of its capital adequacy ratio falling below 8% which is required for international trading banks. UFJ attempted to maintain its capital adequacy ratio by selling its trust division to Sumitomo Trust and subsequent capital increase. In fact, there was a press conference on May 21, 2004 which announced the sale of the trust division. At this point, the market did not imagine that UFJ itself would merge with another bank, and even if it would, it was difficult to imagine that the partner was BTM.

On June 18, 2004, the Financial Services Agency (FSA) of Japan instructed UFJ to take further action on its non-performing loans. UFJ gave up on its own survival and decided to merge with BTM. It was scooped by a newspaper on July 14 that UFJ made an offer to BTM for a merger. The basic agreement was officially signed on August 11. The merger officially took place on January 1, 2006, and new Bank of Tokyo Mitsubishi UFJ was established. It rebranded as MUFG Bank(MUFG).

This merger was unique in that the whole period was short and difficult for anyone to predict; UFJ did not contact BTM until July and this contact was a top-secret one, which is only known to a few executives of UFJ. The merger decision was quickly made by the top managements. It took only two months from UFJ's deficit announcement to the merger agreement. It is difficult to believe that UFJ's and BTM's lending behavior had prepared for this merger in advance.

This merger was also distinctive in terms of the size. BTM and UFJ were the third and fourth among megabanks in Japan in terms of the assets. By merger, MUFG became the largest megabank. There were mergers among city banks in Japan, but it is the only megabank mergers and the last large-size merger in the banking industry in Japan.

2.3 Hypothesis

It is less known about how merged banks restructure their lending portfolio. Alessandrini et al. (2007) did not find a clear tendency in how merging banks modify the assets of acquired banks. Although some papers suggest that relationship-based transactions are terminated after bank mergers (Stein, 2002; Berger and Udell, 2002) it is not clear whether this argument can be applied to the economy where bank-firm relationship is important. Therefore, we hypothesize the merging bank's behavior and examine by using bank merger in Japan.

Firms borrow from several banks, but the main bank is a profitable position for banks. Horiuchi et al. (1988) found that Japan's major firms depend on main bank borrowing for about 30-40% of all bank borrowings in general. Since the main banks are expected to take care of firms in any circumstances, loan rates are set to be favorable to the main bank in normal times (Weinstein and Yafeh, 1998). When firms raise funds through syndicated loans, the main banks usually become the originator and earn administrative fees. Since the bond market is as important as bank lending market shown by Allen et al. (2014), these fees are huge incentives for banks to be the main bank. In addition, there are also commission fees for equities. When firms issue shares, securities firms affiliated with its main banks are more likely to be the lead underwriters and able to obtain fees.

Although the main bank is profitable for banks, it involves some costs. Firms bear relatively higher costs for main banks in return for banks' support in financial distress. Therefore, if the main banks do not support firms, their reputation would be impaired and no subsequent transactions would be expected. To fulfill their role, main banks accumulate internal information about firms through their long-lasting transactions and relationships and monitor their management. Several papers show the importances of accumulated knowledge. Goedde-Menke and Ingermann (2024) showed that default rates increased when the specialized loan officers retired and informational advantages decreased. Fungacova et al. (2017) also found that banks put more weight on their soft information if the bank competition increases.

**********Figure1**********

In normal times, it is not common that the main bank changes, but the situation is very different if there is a bank merger. Figure 1 graphically shows this situation. Assume that bank A has the highest shares in loans of a particular firm, followed by bank B and C. Now bank B merges with bank C and the new merged bank B' is established. The loans of bank B' is the total of merging bank B and C so that it exceeds bank A and has the largest shares. Bank B' could be a main bank without any actions but a merger.

Consider the case where there are some gaps in original lending shares, corresponding to Figure 1 – Panel C. As a result of the merger of bank B and C, lending share of bank B' is slightly larger than Bank A's lending share. In this situation, the main bank cost may exceed the benefit of becoming the main bank. Firstly, the main bank has to monitor a firm and provide financial and nonfinancial support if a firm is in distress. Secondly, since the main bank system is long-lasting custom in Japan and it is rare that the main bank changes in normal time, bank B' must incur nonfinancial costs stemming from unusual actions, such as frictions with other banks. Thirdly, bank B' needs to consider the informational gap between itself and the current main bank, bank A. Accumulated soft information about a firm is required for the role of the main bank. Given that bank A's lending share is at the level of which other banks do not take, bank A is more likely to have private information about firms that others do not have. For these reasons, we expect that "the main bank cost" is costly for bank B' to take the position of the main bank and it decreases the lending volumes below the main bank.

Next, consider another case where there are little gaps in original lending shares, shown in Figure1-Panel A. After the bank merger, bank B's lending share is sufficiently larger than bank A's. In this case, bank B' may prefer to maintain their lending shares even at the expense of the main bank cost. If bank B' decides to avoid the main bank, it needs to decrease lending volumes below the main bank. It directly lowers the bank profits. The larger the adjustment in lending volumes, the larger the decrease in profits. In addition, bank A is less likely to have private information because its lending volume is not as high as the level that other banks do not afford. Therefore, in the case of Figure1-Panel A Figure1-Panel A, bank B' has less incentive to avoid becoming the main bank and keep lending shares high.

In summary, we hypothesize that the main bank costs depend on the lending shares of the current main banks and merged banks. In particular, the costs would be large(small) for merged banks when the differences in the lending shares are small(large). We argue that the main bank costs are negatively associated with the lending share differences. We examine this relation by using various techniques and estimate the main bank costs in subsequent chapters.

3. Research design, data and summary statistics

3.1 Research design

This study employs the merger between the Bank of Tokyo-Mitsubishi (BTM) and UFJ Bank (UFJ) to conduct a Difference-in-Differences (DID) estimation. Our goal is to examine whether the newly established Mitsubishi UFJ Financial Group (MUFG), formed through the merger, demonstrates a tendency to reduce its lending and avoid taking on the role of the main bank post-merger. Hereafter, we treat MUFG and the merged bank interchangeably. Also, we call BTM and UFJ "the merging banks".

For this analysis, we define the treatment group as "the set of firms for which the combined lending of the merging banks exceeded the lending provided by their main bank as of 2003, prior to the merger". At the post-merger stage, the merged bank's continued lending at the same level would position it as the largest lender in a firms' borrowing portfolio, effectively establishing it as the main bank. On the one hand, if the merged bank values the benefits of being the main bank, such as obtaining additional interest income, it would be expected to maintain or even increase its lending to these firms after the merger. On the other hand, if the merged bank perceives the costs associated with becoming the main bank—such as the obligation to rescue distressed firms or monitor their performance—as substantial, it would be anticipated to reduce its lending to this group. The control group, in contrast, consists of firms for which the combined loans from the merging banks did not exceed those provided by their main bank as of 2003, prior to the merger.

The treatment variable, $OverMB_{it}$, is defined as a dummy variable that takes a value of 1 if firm i belongs to the treatment group and 0 if it belongs to the control group. For the post-merger period variable ($Post_t$), we consider two specifications: one based on the year of the merger announcement in 2004, and the other based on the year of merger completion in 2006. The dependent variable is the share of combined lending of BTM and UFJ prior to the merger (or lending of MUFG after the merger) divided by total borrowing for firm i (denoted as $RatioMUFG_{it}$)[1]. We include leverage, ROA, and the cash-to-assets ratio as control variables. Additionally, we account for firm fixed effects and year fixed effects. The estimation equation is as follows.

$$RatioMUFG_{it} = \beta_1 OverMB_{it} * Post_t + Controls + FirmFE + YearFE + \epsilon_{it} \qquad (1)$$

[1] Following Fraisse et al. (2018), we treat the loans from the merging banks as if they were already merged.

3.2 Data

The analysis utilizes financial data of publicly listed companies in Japan, along with loan data disaggregated by financial institution. Both datasets are sourced from Nikkei NEEDS Financial Quest.

The sample for the analysis is restricted to firms among all publicly listed companies in Japan that meet the following three criteria. First, they must have borrowed from both Bank of Tokyo-Mitsubishi (BTM) and UFJ Bank (UFJ) as of 2003, the year preceding the merger. Second, neither BTM nor UFJ should have been the top share lender to the firm in 2003. Third, sufficient data must be available for the entire analysis period. Specifically, data should be available for the two years prior to the merger announcement in 2004 (i.e., 2002-2003), the merger period from 2004 to 2006, and the four years following the merger completion in 2006 (i.e., through 2010).

3.3 Summary statistics

Table 1 presents variable definitions, while Table 2 shows summary statistics. Our primary variable of interest, $\mathrm{RatioMUFG}$, shows an average value of 27% in the treatment group and 17% in the control group. The median value of the total borrowing variable, $TotalVolume$, is 7,287 million yen for the treatment group, whereas it is 10,568 million yen for the control group. This result suggests that firms in the control group may be more dependent on bank borrowing. The potential biases arising from such differences in firm characteristics will be addressed through several robustness checks later in the analysis. For other variables, no substantial differences are observed between the two groups.

**********Table 1 & 2**********

4. Results

4.1 Univariate results

First, using the cross-tabulation in Table 3, we examine how often changes in main bank relationships occurred for the treatment and control groups by the time the merger was completed in 2006. Among the control group, over 90% of cases retained the same main bank as of 2006. This result suggests that, in the absence of a shock where the merging banks are expected to surpass the pre-merger main bank in lending, main bank relationships remain largely unchanged, consistent with prior studies (Hirota, 2009).

In contrast, 36% (34/95) of cases in the treatment group experienced a change in their main bank, indicating a higher frequency of main bank turnover compared to the control group. However, by the definition of treatment status, if MUFG, the merged bank, had not reduced lending after the merger, most of the cases would have experienced a change in their main bank. In other words, MUFG reduced its lending to fall below the pre-merger main bank lending volume in 64% of treatment group cases. This finding suggests that MUFG strategically reduced its lending in many treatment group cases to avoid becoming the top share lender and thus the main bank.

**********Table 3 & Figure2**********

Figure 2 of Panel A examines whether there is a tendency for lending to decrease in the treatment group. From 2003, the year prior to the merger, to 2006, the year the merger was completed, lending from the merged bank to the treatment group declined to approximately 68% of its pre-merger level. In contrast, lending to the control group decreased to 78%, indicating a more significant reduction in lending within the treatment group. These findings align with the cross-tabulation results in Table 3, which indicated that the merged bank actively avoided becoming the main bank in many cases within the treatment group.

A reduction in lending from the merged bank due to the merger could be a credit supply shock for firms. To investigate this, Figure 2 of Panel B examines changes in corporate capital investment from pre-merger year to merger completed year. No significant changes in capital investment are observed for either the treatment or control groups. Similarly, Panel C analyzes changes in total borrowing over the same period, revealing no substantial shifts. These results suggest that the decline in lending from the merged bank did not have a negative impact on firms' capital investment or overall financing. At the same time, they imply that the reduction in lending by the merged bank may have been offset by other banks stepping in to fill the gap.

To investigate this point, Figure 2 of Panel D examines changes in the lending amounts from the main bank as of pre-merger year, comparing them to the changes between pre-merger year and merger completed year. In the treatment group, lending from the main bank increased by approximately 17%. In contrast, the control group experienced a 13% decrease, showing opposite trends between the two groups. These results suggest that the reduction in lending from the merged bank, as observed in Panel A, may have been offset by an increase in lending from the main bank.

4.2 DID analysis

In Panel A of Table 4, we analyze whether the merged bank that was expected to surpass the main bank's lending before the merger reduced their lending share after the merger, estimating Equation (1) using a Difference-in-Differences approach. In column (1), post variable ($Post_t$) is defined as the period after the merger announcement in 2004. Column (2) redefines the post variable as the period following the merger completion in 2006. In both cases, the coefficient on the interaction term is significantly negative. Column (3) decomposes the effect of the treatment variable, $OverMB_{it}$, by year. For each year after the merger's completion in 2006, the coefficients range from -4% to -7% and are significantly negative. These results suggest that the merged bank reduced its lending after the merger to avoid becoming the largest lender in the firm's borrowing portfolio. Panel A of Figure 2 plots the lending share from MUFG by year, separated by treatment status. Additionally, Panel B of Figure 2 plots the coefficients from Table 4 - Panel A - Column (3).

The reduction in lending by the merged bank following the merger could potentially serve as a credit supply shock for firms, negatively affecting their investment behavior and financing. In Table 4 - Panel B, we employ the same specification as in Panel A but replace the dependent variable with investment. Columns (1) and (2) present results using different definitions for the *Post* period. While the coefficients are negative, they are not statistically significant. Column (3) further disaggregates the treatment effect by year, yielding largely same results. In Table 4, Panel C, we implement DID using the logarithm of firms' total bank borrowing (*Log(TotalVolume)*) as the dependent variable. Similar to Panel B, none of the coefficients in Columns (1) through (3) are statistically significant. Figure 3 plots the coefficients of these estimates. Considering the results from Panels B through C collectively, it is evident that despite the reduction in lending by the merged bank, there has been no negative impact on either firms' financing or investment. These findings imply the presence of other banks compensating for the reduction in lending by the merged bank.

In Table 4, Panel D, we replace the dependent variable with the share of lending from the main bank in 2003, the year prior to the merger ($MBRatio_{it}$). In Columns (1) and (2), the coefficient of interaction term is positive and statistically significant. When decomposing the treatment effect by year in Column (3), we observe that, from 2006 onward—the year the merger was completed—the coefficients remain positive and statistically significant, with values ranging from 3% to 4%. These results suggest that the reduction in lending by the merged bank is offset by the main bank.

Our findings can be summarized as follows: First, when the lending volume of the merging banks exceeds that of the pre-merger main bank, the merged bank tends to reduce its lending post-merger. Second, despite the reduction in lending from the merged bank, no negative effects are observed on either investment or total bank borrowing of firms. Third, the share of lending from the main bank prior to the merger tends to increase after the merger. These results indicate that the reduction in lending by the merged bank is mitigated by the main bank, thereby alleviating negative impacts on firms.

**********Table4, Figure2 to 4**********

4.3 Loan level data analysis

One may wonder if the DID analysis in Section 4.2 may be subject to bias due to firm-specific time variant factors. For example, the reduction in lending from the merged bank could reflect the fact that the treatment group consists of firms with relatively low financing needs. To address this issue, we follow the approach of Khwaja and Mian (2008) and conduct an analysis using loan-level data between firm and bank. By using loan-level data, we can incorporate firm-year and bank-year fixed effects, which allows us to control for time-varying firm-specific and bank-specific factors. Additionally, we include firm-bank fixed effects to control for time-invariant factors specific to each firm-bank relationship. We estimate the following equations[2].

$$FocalLoanRatio_{ijt} = \gamma_1 OverMB_{it} * MUFG_{jt} + \gamma_2 OverMB_{it} * MUFG_{jt} * Post_t + Firm * YearFE + Bank * YearFE + Firm * BankFE + \varepsilon_{ijt} \quad (2)$$

$$FocalLoanRatio_{ijt} = \delta_1 OverMB_{it} * MBDummy_{ijt} + \delta_2 OverMB_{it} * MB_{ijt} * Post_t + \delta_3 MBDummy_{ijt} * Post_t + \delta_4 MBDummy_{ijt} + Firm * YearFE + Bank * YearFE + Firm * BankFE + u_{ijt} \quad (3)$$

The dependent variable, $FocalLoanRatio_{ijt}$, is defined as the ratio of loans from bank j to firm i relative to the total borrowing of firm i. $MUFG_{jt}$ is a dummy variable that takes the value of 1 if the lending bank is MUFG (or BTM+UFJ prior to the merger in 2003). $MBDummy_{ijt}$ is a dummy variable that takes the value of 1 if the lending bank j was the main bank of firm i in 2003. The variable $Post_t$, representing the post-

[2] The definitions of the variables used in this analysis, along with the basic summary statistics, are provided in Appendix A.

merger period, is defined as a dummy variable that takes the value of 1 for the years 2006 and onward, in line with the results presented in Section 4.2.

We focus on the coefficient γ_2 and δ_2 for equations (2) and (3). The coefficient γ_2 in equation (2) indicates how lending from the merged bank, MUFG, changes post-merger when the lending volume of the merging bank exceeded that of the main bank in 2003. Based on the DID estimates from Section 4.2, we expect γ_2 to be negative. Similarly, the coefficient δ_2 in equation (3) reflects how the lending from the main bank in 2003 changes post-merger, depending on the treatment status. If the results from Section 4.2 hold, δ_2 is expected to be positive.

Table 5 Panel A presents the estimated results from equation (2), which examines loans from MUFG. The coefficient of the triple interaction term in column (1) is negative and statistically significant. In column (2), we decompose the treatment effect by year, with negative and statistically significant results for all years from 2005 onward. Panel B presents the estimated results from equation (3), which examines loans from the main bank in 2003. The coefficient of the triple interaction term in column (1) is positive and statistically significant. In column (2), the treatment effect is decomposed by year, with negative and statistically significant results for all years from 2004 onward. These results are consistent with the findings from Table 4 in Section 4.2, demonstrating robustness against biases arising from demand factors (firm-year), supply factors (bank-year), and firm-bank level factors.

**********Table5, Figure5**********

4.4 Regression discontinuity design

Another potential source of bias is the firm-bank-year level factors. For example, based on the definition of the treatment variable $OverMB_{it}$, the treatment group is expected to have initially higher borrowing amounts from the merging banks. The substantial post-merger declines in lending observed within the treatment group may be attributed to rebalancing effects driven by changes in the banks' lending standards following the merger.

To address the issues raised above, this section conducts regression discontinuity design[3]. Specifically, the ratio of "the merging banks' lending volume" to "the main bank's lending volume" in 2003 is used as the running variable. We set the threshold at 1,

[3] The definitions of the variables used in this analysis, along with the basic summary statistics, are provided in Appendix B.

which means the lending volume of the merging banks prior to the merger exceeds the lending volume of the main bank at that time. Then we test how the outcome variable, growth rate of loans from MUFG defined as the ratio of "the merged bank lending volume in 2006" to "the merging banks' lending volume in 2003," changes when the running variable exceeds the threshold of 1. Based on the results from Section 4.2, we expect the outcome to decrease once the threshold of 1 is exceeded. We estimate the following model.

$$[\hat{\alpha}, \hat{\beta}] \equiv argmin_{\alpha,\beta} \sum_{i=1}^{n} K\left(\frac{|S_i - 0|}{h}\right)(Y_i - \alpha - S_i\beta)^2 \quad (4)$$

where K denotes the triangular kernel, h represents the optimal bandwidth, and S_i is the running variable normalized to zero.

**********Table6, Figure6**********

To verify the randomization around the threshold, we conduct two analyses. First, following Cattaneo et al. (2020), we examine whether the density distributions on either side of the threshold are substantially different. Figure 6 - Panel A presents the results of the density test, showing the 95% confidence intervals for both endpoints around the threshold largely overlap. This suggests that there is no evidence of manipulation around the threshold.

Second, we verify whether covariates are balanced around the threshold by checking for a discontinuity in total loan amounts. We use bin plots and local linear regression (as in equation (4)) to detect any jump in the total loan amount. Figure 6 - Panel B displays the bin plot results, which show a relatively small jump in total loan amounts. Table 6 shows the estimated value of -0.66 with a standard error of 0.73, and the 95% confidence interval [-2.10, 0.73] includes zero. Thus, there is no clear jump in total loan amounts, and no imbalance in covariates around the threshold is observed. These results support the idea of local randomization near the threshold.

Figure 7 presents the bin plot results for the outcome variable, "2006 loan amount from the merged bank" / "2003 loan amount from the merging bank". A clear drop in the outcome is observed when the threshold exceeds 1, indicating a significant jump. Panel A of Table 7 shows the estimated difference of the constant term from the local linear regression, with an estimate of -0.71, which is relatively large compared to a standard error of 0.37. The 95% confidence interval of [-1.44, 0.02] barely includes zero, but it is mostly within the negative range. Panel B shows the results after bias adjustment using a

pilot bandwidth, where the 95% confidence interval of [-1.53, -0.06] remains entirely negative. These results are consistent with the findings from the DID analysis in Section 4.2.

**********Table7, Figure7**********

4.5 Synthetic DID analysis

One may concern the violations of the parallel trends assumption for the DID results presented in Section 4.2. To address this issue, we employ the Synthetic DID method proposed by Arkhangelsky (2021) to construct a control group that satisfies the parallel trends assumption and estimate the following equation.

$$min_{\alpha,\beta,\mu,\tau} \sum_{i=1}^{I} \sum_{t=1}^{T} (Y_i - \mu - a_i G_i - b_t T_t - Z_{it}\tau)^2 \widehat{\omega_i}\, \widehat{\lambda_t} \qquad (5)$$

where Y_i is outcome variable, G_i and T_t are fixed effects, Z_{it} is binary treatment, $\widehat{\omega_i}$ are weights that align pre-exposure trends in the outcome of unexposed units with those for the exposed units and $\widehat{\lambda_t}$ are weights that balance pre-exposure time periods with postexposure ones.

A sufficient amount of historical data and a balanced panel is required for the Synthetic DID analysis. In this analysis, the sample is restricted to firms for which data from all years between 1980 and 2010 is available. As a result, the number of firms in the treatment group is 7. The post period is set after 2006.

Figure 8 displays the gap plots for the Synthetic DID analysis. Panel A shows the ratio of the merged bank's loans to the firm's total borrowing portfolio. Up until the announcement year of the merger, 2004, there is no significant divergence between the treatment group and the synthetic control group, indicating that the construction of the control group is successful. After 2006, the outcome for the treatment group decreases substantially compared to the synthetic control group, with an estimated value of -0.04. Panel B shows the ratio of loans from the main bank to the firm's borrowing portfolio. Again, there is no significant divergence between the treatment group and the synthetic control group up until 2004. From 2006 onwards, the outcome for the treatment group is higher than the synthetic control group until 2008, with an estimated value of 0.02. These results suggest that our DID results presented in Section 4.2 is not biased by the parallel trends assumption.

********** Figure8**********

5. Quantification the adjustment cost

In Section 4, we confirmed that even in cases where the pre-merger lending of the merging banks exceeded that of the main bank, two-thirds of the lending amounts were adjusted downward post-merger to fall below the main bank's lending volume. Our next goal is to estimate the cost of such adjustments—i.e., the cost borne by the bank in becoming the main bank—using fuzzy bunching, proposed by Alvero and Xiao (2020). This section is structured as follows: In Section 5.1, we examine the conditions under which the merged bank might avoid becoming the main bank and identify the key focus points of the model. In Section 5.2, we introduce the model. Section 5.3 outlines the estimation methodology, and Section 5.4 presents the estimation results.

5.1 The factor of switching main bank

To consider what factors should be focused on in the model, we analyze the cases in which the merged bank would avoid becoming the main bank. Several reasons could influence the decision of whether the merged bank becomes the main bank. First, one factor is the existing relationship between the merged bank and pre-merger main bank. For example, if the existing main bank is a major institution, the merged bank may reduce its lending and avoid becoming the new main bank to prevent potential deterioration in its relationship with the existing main bank.

Secondly, firm profitability can be a decision factor. As noted by Hoshi et al. (1990), when a firm faces financial distress, the main bank is expected to take the lead in providing support. If a firm's profitability is low, the expected cost of this support increases, making the merged bank more likely to avoid becoming the main bank for such a firm.

Third, the balance between the costs associated with adjusting lending levels and the costs of becoming the main bank can affect the decision. While the main bank obtains the advantage of additional interest income (Weinstein and Yafeh, 1998), it also comes with the obligation to rescue the firm in case of financial distress, as well as the cost of monitoring the firm. To avoid these costs, the merged bank tries to reduce its lending to a level below that of the main bank. However, if the post-merger lending volume significantly exceeds that of the main bank, adjusting lending downwards would incur a huge loss in revenue. If such adjustment cost is greater than the cost of becoming the main bank, the merged bank may choose not to adjust its lending and instead become the main bank.

Table 8 examines the three possibilities outlined above[4]. Column (1) examines whether firms with a mega-bank as their main bank (MegaBankDummy) before the merger switch to the merged bank as their main bank after the merger (MBSwitch). While the coefficient is positive, it is not statistically significant. Column (2) investigates whether firms with higher profitability tend to switch their main bank to the merged bank. Return on assets (ROA) is used as the profitability measure. Again, the coefficient is positive but not statistically significant. Column (3) explores whether a large difference in pre-merger lending from the merging banks compared to the main bank's lending (DiffMUFG) influences the likelihood of the main bank switching to MUFG. This coefficient is positive and statistically significant. Column (4) estimates a model that includes all three factors simultaneously. The results remain unchanged, with only the difference in lending between the merging banks and the main bank before the merger being statistically significant. This suggests that the decision to avoid becoming the main bank for the merged entity is primarily driven by the difference in pre-merger lending.

**********Table8**********

5.2 Model

In the previous section, we established that the gap between post-merger lending and the main bank's lending amount plays a critical role in the merged bank's decision to avoid becoming the main bank. Based on this finding and the framework of Alvero et al. (2023), we develop a bank profit maximization model for estimating adjustment costs.

The intuition behind our model is as follows. A merged bank selects its lending amount to maximize its own profit. However, if the bank lends an amount exceeding the main bank's lending (=M), it incurs an additional cost τ associated with becoming the main bank (e.g. the obligations to rescue clients and the costs of monitoring).

When the bank's original optimal lending amount (=Q^*) is "slightly" above the main bank's lending M, it is optimal for the bank to reduce its lending to fall below M to avoid bearing cost τ. In contrast, when the optimal lending amount Q^* exceeds the main bank's lending M by a substantial margin, reducing the lending amount to below M would result in a significant loss of interest income. Consequently, it becomes optimal to bear the cost of becoming the main bank τ while maintaining the optimal lending level

[4] The analysis is conducted using firm-level cross-sectional data in 2003. The summary statistics and variable definitions are provided in the Appendix B.

Q^*. Thus, the difference between the merged bank's lending and the main bank's lending emerges as a crucial factor for lending adjustments.

In this model, A marginal buncher exists such that the following two actions are indifferent: (1) reducing lending to avoid becoming the main bank and (2) bearing the cost of becoming the main bank τ while maintaining the lending amount. The subsequent analysis solves the model based on the preferences of this marginal buncher to derive the reduced form equation for the cost of becoming the main bank τ, which is estimated by fuzzy bunching approach.

Formally, we introduce a theoretical model for bunching. There are one bank, mass of firms, and household. Firms are indexed by their productivity z_i. Bank can raise funding from depositors at a cost r. We denote Q_i as a quantity of loan to firm i. The lending rate is given by $R(Q_i|z_i)$ where it is increasing function in z_i.

To consider the cost of becoming the main bank, we assume that a bank incurs an additional cost if its loan volume exceeds threshold ($\underline{Q_i}$). This approach is close to Alvelo et al. (2022) which studied bank size regulation. The additional cost is equivalent to τ fraction of loan's profit. One can also interpret τ as the fraction of bank value loss due to the role of main bank without accumulation of internal information. Threshold $\underline{Q_i}$ can be interpreted as the level of the main bank's lending. Taking account of this main bank cost, bank chooses loan volumes to maximize its profits

$$\max_{\{Q_i\}} \pi(Q_i|z_i) = (R(Q_i|z_i) - r)Q_i \left(1 - \tau \mathbb{I}_{Q_i \geq \underline{Q_i}}\right) \tag{6}$$

where $\mathbb{I}_{Q_i \geq \underline{Q_i}}$ is an indicator function which takes one if $Q_i \geq \underline{Q_i}$. Because main bank cost is incurred only if bank's lending volume is large, there is a kink in the relation between bank's profit and lending volume.

We firstly solve for the optimal undistorted loan volume when there is no additional cost by setting $\tau = 0$.

$$Q_{i0} = \arg\max_{Q_i} (R(Q_i|z_i) - r)Q_i \tag{7}$$

Taking the first order condition, the optimal undistorted loans are given by

$$R_Q(Q_i|z_i) = -\frac{1}{Q_i}(R(Q_i|z_i) - r) \tag{8}$$

Next, we solve for the optimal loan volume when there is an additional cost. Because the main bank cost is incurred only when banks' loan exceeds $\underline{Q_i}$, bank can avoid the main bank cost by reducing loan volume lower than $\underline{Q_i}$. However, this strategy is costly

because it deviates from optimal undistorted loan volume and gives up profits bank could have. The cost of this strategy is increasing in the firm's productivity. Bank adjusts its loan volume below the threshold up to some point ($\overline{Q}_i$), but bank finds that loan volume just above some point ($\overline{Q}_i$) is more profitable with incurring the main bank cost than decreasing loan volume. Formally, we can derive the optimal loan volume as a function of firm's productivity.

$$Q_i^* = \begin{cases} \underline{Q}_i, & z_i \in [\underline{z}_i, \overline{z}_i] \\ Q_{i0}, & z_i \notin [\underline{z}_i, \overline{z}_i] \end{cases} \tag{9}$$

where $\underline{z}_i$ is the productivity of a firm whose undistorted loan volume is equal to the main bank cost threshold

$$\underline{Q}_i = Q_{i0}(\underline{z}_i) \tag{10}$$

and $\overline{z}_i$ is the productivity of a marginal firm that is indifferent between staying below the threshold and paying the main bank costs,

$$\overline{Q}_i = Q_{i0}(\overline{z}_i) \tag{11}$$

The indifference condition of the marginal firm is given by

$$\left(R(\overline{Q}_i|\overline{z}_i) - r\right)\overline{Q}_i(1-\tau) = \left(R\left(\underline{Q}_i\middle|\overline{z}_i\right) - r\right)\underline{Q}_i \tag{12}$$

We solve this condition for τ and substitute the first order condition of undistorted loan volume. Then, we obtain the proposition regarding the main bank cost.

Proposition 1

The net main bank cost τ is given by the following formula:

$$\tau \cong \left(\frac{\overline{Q}_i - \underline{Q}_i}{\underline{Q}_i}\right)^2 \tag{13}$$

Equation (13) shows that the main bank cost τ only depends on the marginal firm's loan volume $\overline{Q}_i$ and the main bank threshold $\underline{Q}_i$.

We now turn to the firm side. Firms have a Cobb-Douglas production function. They borrow capital from bank and produce output. The only difference is their productivity.

$$\max_{K_i} \Pi_i = A z_i K^{\alpha} - R\,K \tag{14}$$

where $Y_i = Az_iK^{\alpha}$ is the output, K is the capital, and A is the total factor productivity. The optimal capital is derived by the first order condition.

$$K = \left(\frac{R}{\alpha\ A\ z_i}\right)^{\frac{1}{\alpha-1}} \tag{15}$$

The household is endowed with initial wealth W. They deposit the money in the bank, which is repaid in the next period with interest $(1 + r)$. Given that household is the ultimate owners of the firms and bank, they solve the utility maximization problem:

$$\max_{C_t, D_t} U(C_t) + \beta E[U(C_{t+1})] \tag{16}$$

$$s.t. C_t + D_t \leq W \tag{17}$$

$$C_{t+1} \leq (1 + r)D_t + \pi + \sum_i \Pi_i \tag{18}$$

where C_t is current consumption, C_{t+1} is next period's consumption, D_t is current deposit, and $U(\cdot)$ is a utility function. By the first order condition, we have following formula about deposit rate

$$\frac{1}{1 + r} = \beta E\left[\frac{U'(C_t)}{U'(C_{t+1})}\right] \tag{19}$$

We define the equilibrium in this economy. It is defined by bank's lending $\{Q_i\}_{i=1}^N$, firm's capital $\{K_i\}_{i=1}^N$, and household's consumption and deposit (C_t, D_t) such that:

1. Bank's lending maximizes bank's profit (6).
2. Firms' capital maximizes firms' profit (14).
3. Household's consumption and deposit maximize their expected utility (16).

Loan market and deposit market clear:

$$Q_i = K_i \tag{20}$$

$$D_t = \sum_i Q_i \tag{21}$$

5.3 Estimation

To identify the cost of being the main bank, denoted as $\tau \cong \left(\frac{\overline{Q}_i - \underline{Q}_i}{\underline{Q}_i}\right)^2$, estimating both $\overline{Q}_i$, the loan amount for the marginal buncher, and $\underline{Q}_i$, the threshold at which the cost of

being the main bank arises, is needed. In this study, $\underline{Q_i}$ is defined as the loan amount of the main bank to firm i.

The estimate of $\overline{Q_i}$ is derived using fuzzy bunching. Fuzzy bunching, as proposed by Alvero and Xiao (2020), addresses a key issue with traditional bunching estimators, namely, the impact of noise in small sample data. By utilizing the cumulative distribution function rather than the probability density function, this method mitigates such noise effect and implements more accurate estimation of the bunching range.

Following Alvero and Xiao (2020), the estimation proceeds as follows. First, an initial exclusion range $[x_l, x_u]_0$ is specified, and polynomial regression is performed on the data excluding this range to estimate the counterfactual cumulative distribution function, $F_0(x)$.[5] Then, the difference between the cumulative distribution function of the observed data $F(x)$ and the counterfactual distribution $F_0(x)$ is integrated to derive the bunching bulge $A(\equiv \int(F(x) - F_0(x))dx)$. Additionally, using the estimated counterfactual distribution, the average counterfactual density, f_0, within the excluded range $[x_l, x_u]_0$ is calculated. The estimated bunching range $\widehat{\Delta Q}$ is derived from the following equation.

$$\widehat{\Delta Q} = \sqrt{\frac{2A}{f_0}}$$

The obtained bunching range $\widehat{\Delta Q}$ is used to update the excluded range $[x_l, x_u]$ such that it precisely encompasses the bunching range. This procedure is repeated iteratively until it converges.

In many bunching analysis settings, agents may optimally engage in bunching behavior, but friction may make adjustment difficult. In our setting, for example, even if the merged bank attempts to reduce lending, adjustment may be challenging when long-term lending amount is significant. Considering the presence of agents for whom adjustment is difficult, Alvero and Xiao (2020) propose a method to estimate the non-optimization ratio $\hat{\alpha}$, which is the proportion of agents expected to engage in bunching behavior but do not, as well as a method to estimate the bunching range $\widehat{\Delta Q}$ while taking friction into account. We adopt this approach and report the results based on these formulas.

[5] In this study, the initial range was set to [0.5,2.0], and the degree of the polynomial was chosen to be 2.

$$\hat{\alpha} = \frac{2\left(F(\overline{Q}) - F\left(\underline{Q}\right)\right)}{f_0(\underline{Q})(\overline{Q} - \underline{Q})} - 1$$

$$\widehat{\Delta Q} = \sqrt{\frac{2A}{(1-\alpha)f_0\left(\underline{Q}\right)}}$$

In conducting the bunching analysis, we need to standardize the lending amount variable Q. We assume that the merged bank adjusts its lending behavior based on the lending amount of the main bank. Under these conditions, no bunching should appear in the merged bank's lending when the lending amount is plotted on the horizontal axis. To investigate the lending adjustment of the merged bank, a comparison with the lending amount of the main bank is needed. Figure 9, Panel A plots the horizontal axis as the ratio of the merged bank lending to main bank lending. Bunching is observed below the threshold of 1. Figure9 – Panel B plots the empirical cumulative distribution function. Bunching bulge is observed on the left side of threshold 1. Based on these findings, we estimate the lending amount $\overline{Q_i}$ normalized by the main bank's lending. Similarly, $\underline{Q_i}$ is also normalized using the main bank's lending, resulting in $\underline{Q_i}$ being fixed at 1.

**********Figure9**********

5.4 Results

Table 9 presents the estimation results of the fuzzy bunching analysis and the corresponding cost, τ. The value of $\overline{Q_i}$ is 1.4, representing the lending amount of the merged bank as 1.4 times that of the main bank. This indicates that merged bank whose lending is 1.4 times larger than that of the main bank is the Marginal Buncher and it is indifferent between reducing lending to the level of the main bank or maintaining the lending amount and incurring the cost of becoming the main bank. Substituting this estimation result into the reduced form of cost, we obtain τ = 0.16. This result implies that the cost of becoming the main bank for the Marginal Buncher is equivalent to 16% of the lending margin $\left(R\left(\overline{Q_i}\middle|\overline{z_i}\right) - r\right)\overline{Q_i}$. Notice that the standard deviation of the year-over-year change in the lending margin for Japanese banks in 2005 (during the merger period) was approximately 26%. Therefore, compared to this value, τ = 16% appears to be sufficiently large.

Among the agents expected to engage in bunching behavior, the proportion of those not engaging in bunching behavior (the non-optimization ratio) is approximately 0.4. This result is relatively consistent with values found in previous studies. It suggests that in the context of lending behavior adjustments, various frictions exist—such as difficulties in reducing lending when there is a high proportion of long-term loans—which may impede adjustments.

**********Table9, Figure10**********

6. Additional analysis

6.1 Interest payments

In Panel D of Table 4, we observe that treated firms tend to experience an increase in the lending share from their pre-merger main bank following the completion of the merger. As noted by Weinstein and Yafeh (1998), borrowing from the main bank may involve additional costs. The observed increase in the lending share from the main bank post-merger could potentially result in a higher interest burden for firms. Since our loan data do not include information on individual interest rates, we conducted firm-year level DID estimation similar to Table 4, using the average firm-year interest rate as the dependent variable.

The results, presented in Appendix Table A, do not show any statistically significant effects. As confirmed in Section 4.2, firms did not experience negative impacts in terms of capital investment or total borrowing. Similarly, no adverse effects were observed from the perspective of increased interest payment burdens.

7. Conclusion

Previous research on the impact of bank mergers on lending has highlighted factors such as changes in lending technology, efficiency gains, and market power. In this study, we focus on the ranking of banks within firms' borrowing portfolios and uncover a novel mechanism. Specifically, we empirically demonstrate that the merged bank reduces its lending to prevent becoming the top-ranked lender in the borrowing portfolio, thereby avoiding the costs associated with the role of the main bank. This result is robust to analyses using loan data and regression discontinuity design, confirming its resilience to endogeneity concerns.

Additionally, we quantify the cost of becoming the main bank using fuzzy bunching techniques. Our findings reveal that for marginal bunchers, the cost of becoming the main bank is approximately 16% of the net interest margin, a substantial amount.

A key strength of our analysis lies in its focus on Japan's main bank system, which emphasizes the ranking of firms within their borrowing portfolios, alongside an examination of specific, exogenous bank mergers. However, the external validity of our findings may not be immediately clear. Nonetheless, as highlighted in recent studies on relationship banking, such systems share features with the main bank system, including the notion of corporate rescue. The cost quantified in our study is also valuable for understanding the costs associated with corporate rescue in relationship banking.

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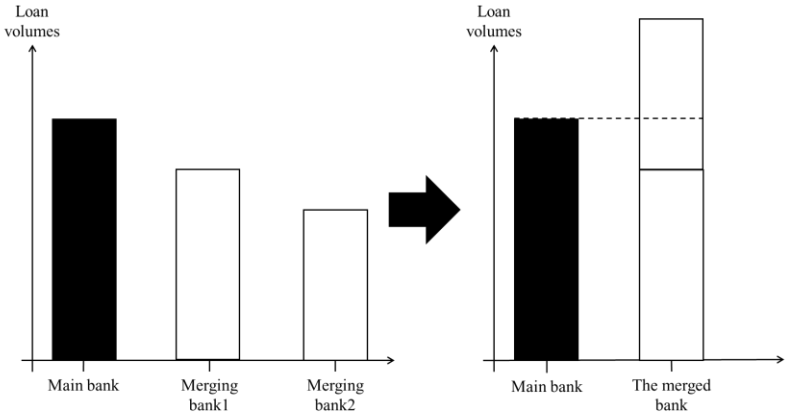
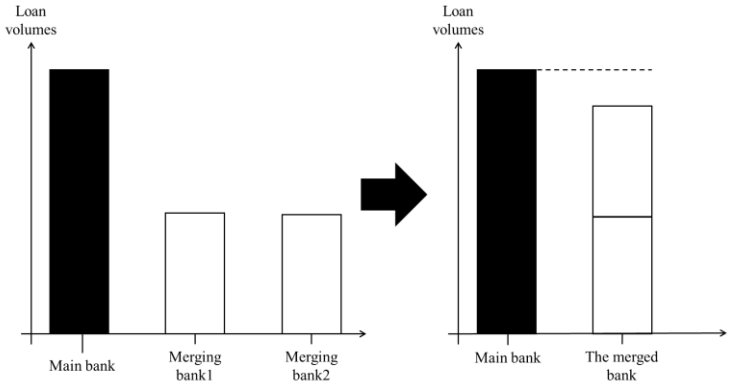
Figure 1 Treatment status in our setting

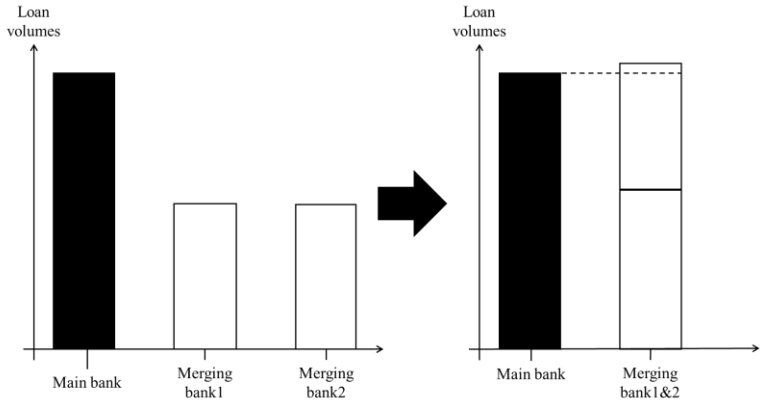
Panel A



Panel B



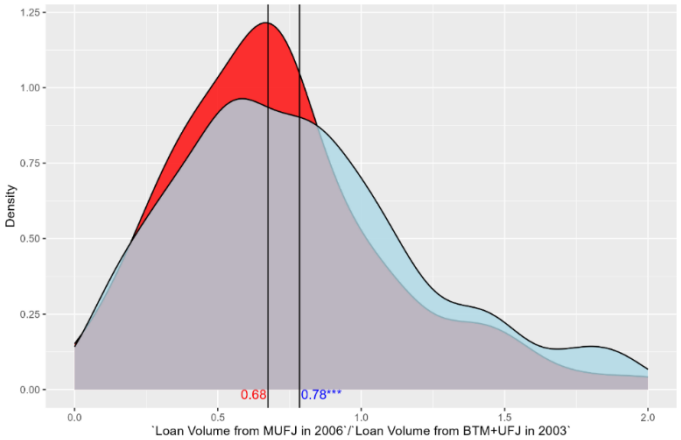
Panel C



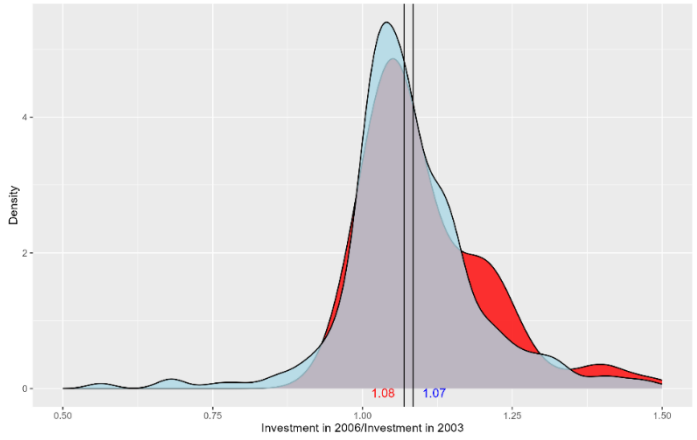
Note: The Panel A represents the status of the treatment group, the combined lending of the merging banks exceeded the lending provided by their main bank as of 2003, prior to the merger. The Panel B represents the status of the control group, the combined lending of the merging banks did not exceed the lending provided by their main bank as of 2003.The Panel C exhibits the combined lending volume slightly exceeds that of the main bank.

Figure 2

Panel A: Loan volume from MUFG

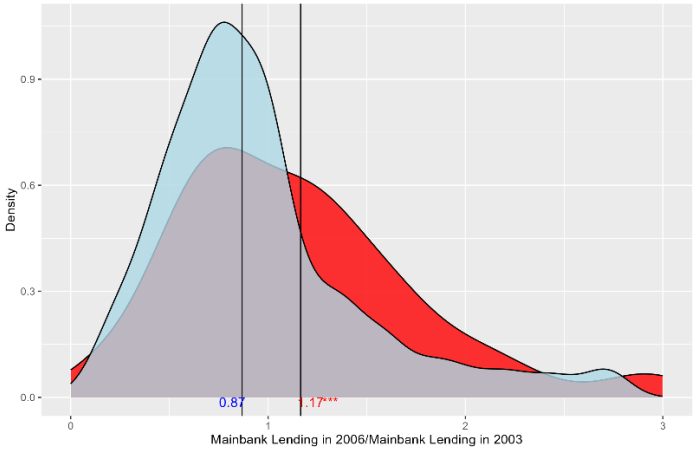


Panel B: Investment



Panel C: Total Borrowing

Panel D: Main bank lending

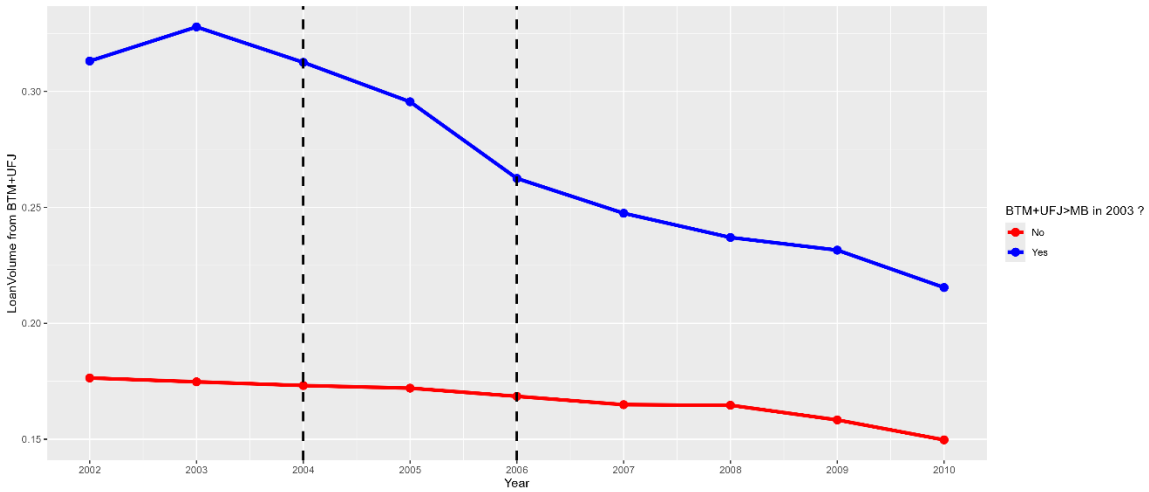


Note:

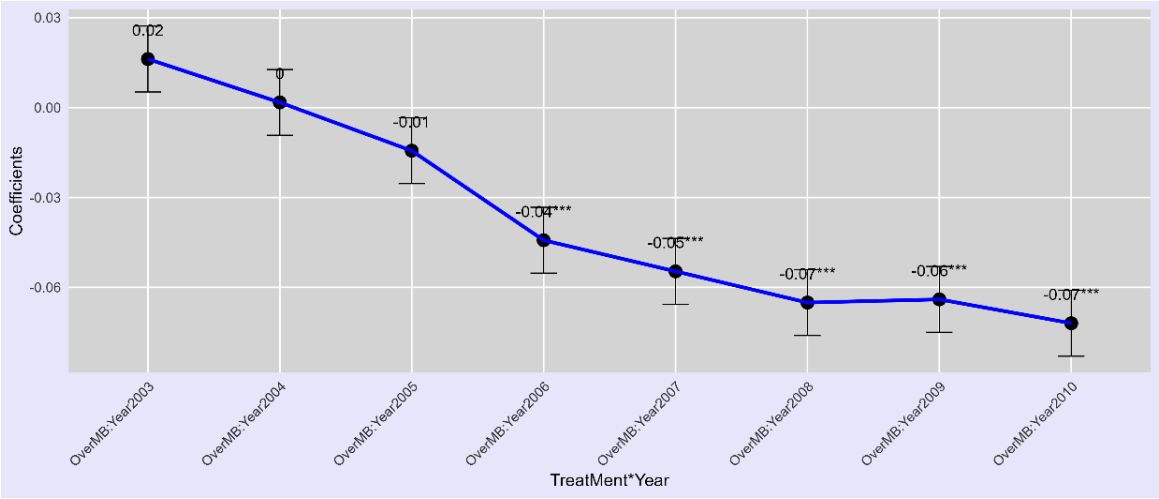
Panel A illustrates the extent to which MUFG (formed from the merger of BTM and UFJ) reduced lending from 2003, prior to the merger, to 2006, after the merger. Panel B presents changes in capital investment during the same period. Panel C shows how total borrowing from banks changed between 2003 and 2006. Panel D highlights changes in borrowing specifically from the main bank over the same period. The red group represents the treatment group (BTM+UFJ ≥ top share lending in 2003), and the blue group represents the control group (BTM+UFJ < top share lending in 2003).

Figure 3

Panel A: Average MUFG Loan share ratio by Treatment × Year



Panel B: Coefficients plot of Treatment × Year on MUFG share

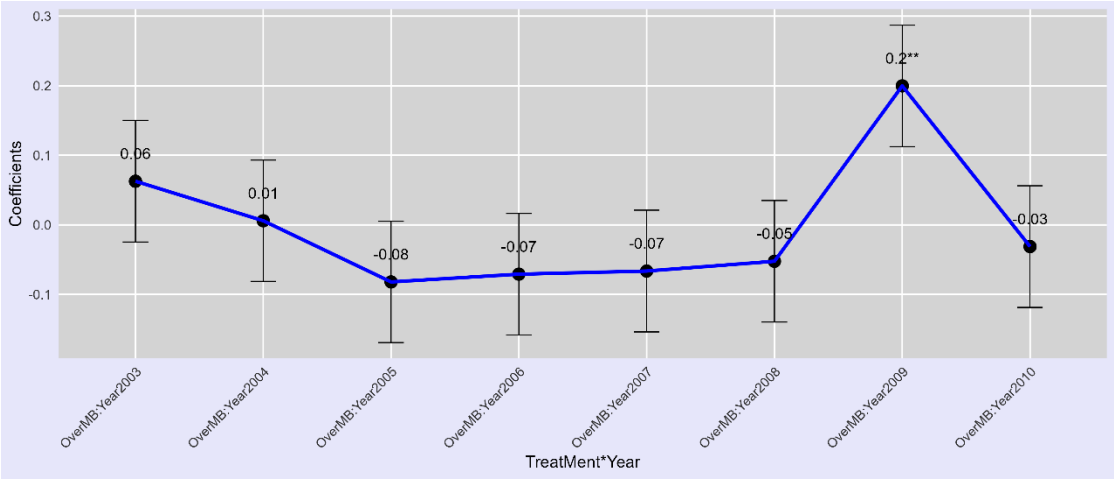


Note:

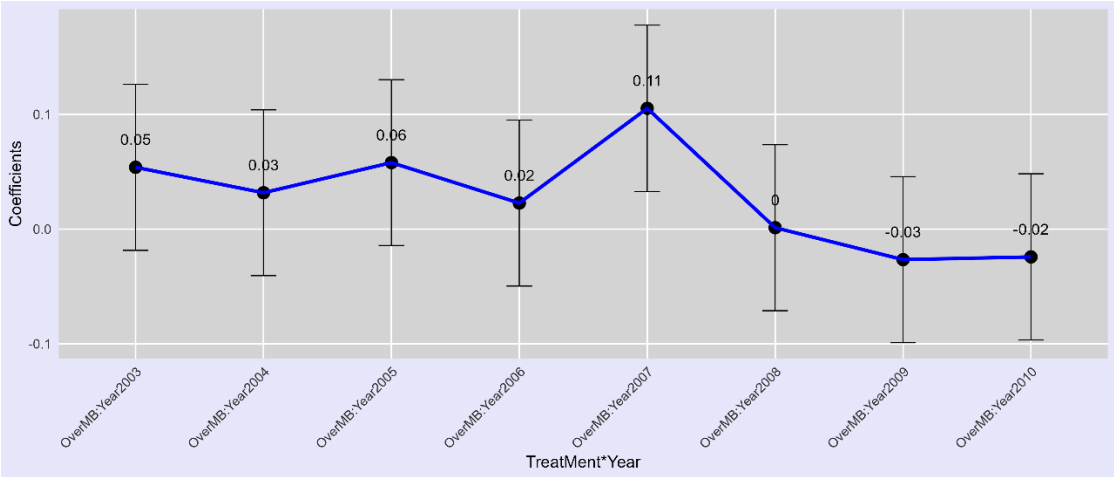
Panel A depicts the loan share ratio of MUFG (or BTM+UFJ prior to the merger). The year 2004 marks the merger announcement, while 2006 represents the merger's completion. The blue line represents the treatment group, and the red line represents the control group. Panel B presents the coefficient plot based on Column (3) of Table X Panel A, the effects of Treatment × Post on the share ratio of MUFG.

Figure 4

Panel A: Coefficients plot of Treatment × Year on investment



Panel B: Coefficients plot of Treatment × Year on total borrowing

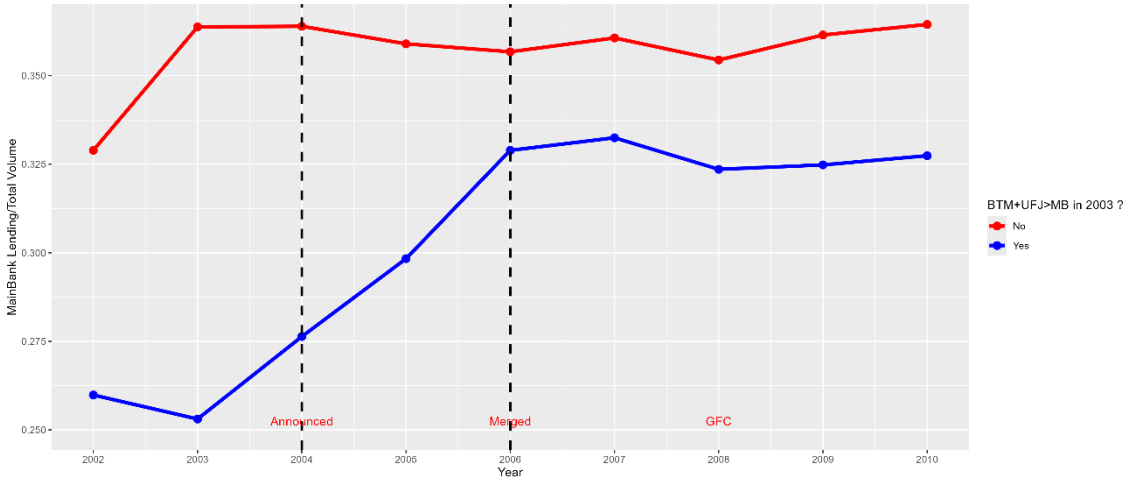


Note:

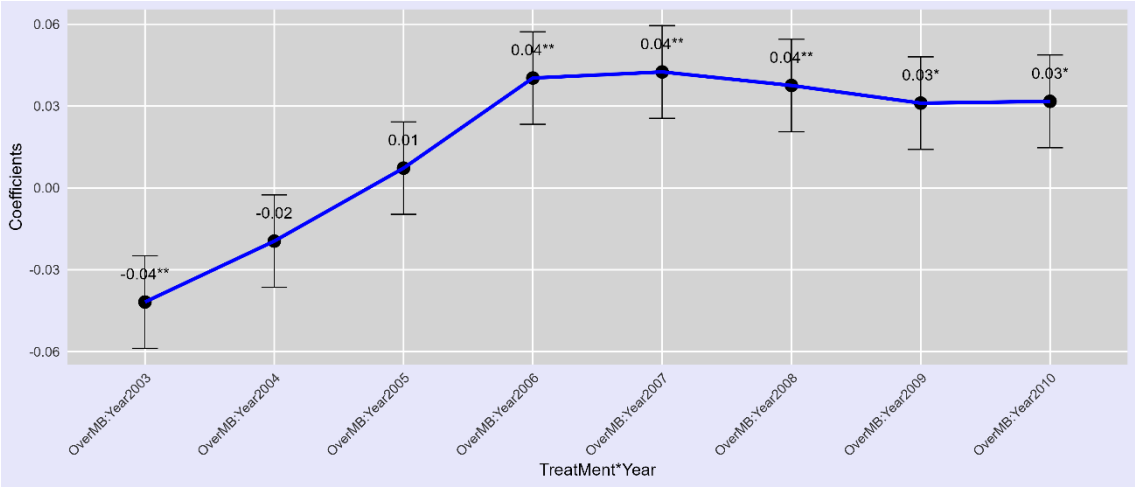
Panel A presents the coefficient plot based on Column (3) of Table X Panel B, the effects of Treatment × Year on investment. Panel B presents the coefficient plot based on Column (3) of Table X Panel C, the effects of Treatment × Year on total borrowing.

Figure 5

Panel A: Panel A: Average main bank (at pre-merger) share ratio by Treatment × Year



Panel B: Panel B: Coefficients plot of Treatment × Year on main bank (at 2003) share

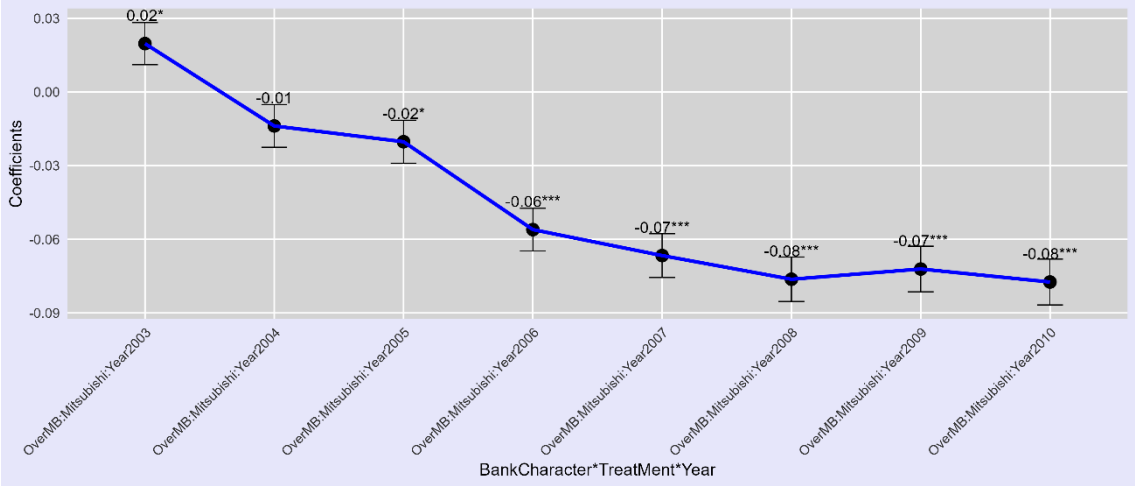


Note:

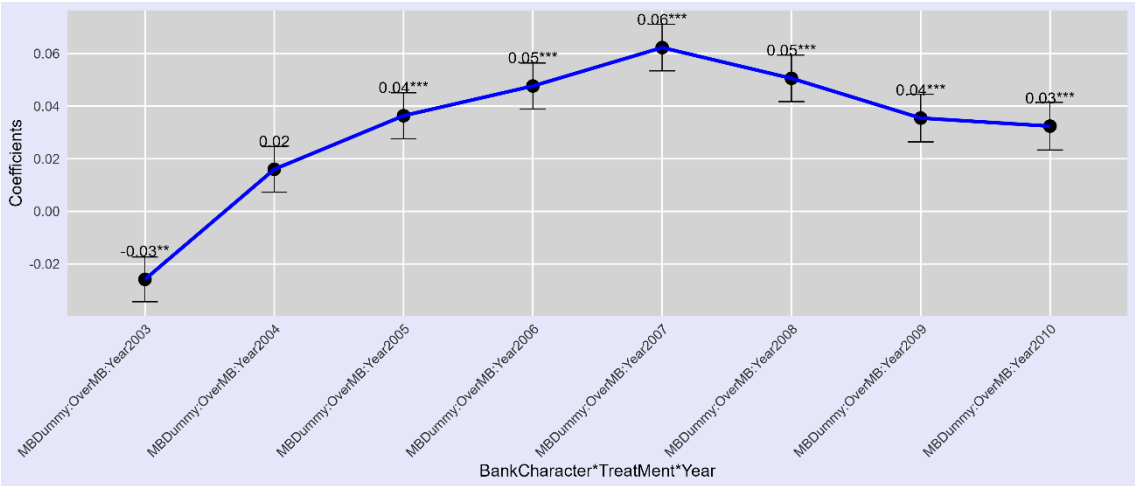
Panel A depicts the loan share ratio of main bank at 2003, pre-merger year. The year 2004 marks the merger announcement, while 2006 represents the merger's completion. The blue line represents the treatment group, and the red line represents the control group. Panel B presents the coefficient plot based on Column (3) of Table X Panel D, the effects of Treatment × Post on the share ratio of main bank.

Figure 6

Panel A: Coefficients plot of Treatment × MUFG × Year on Loan share



Panel B: Coefficients plot of Treatment × MBDummy × Year on Loan share

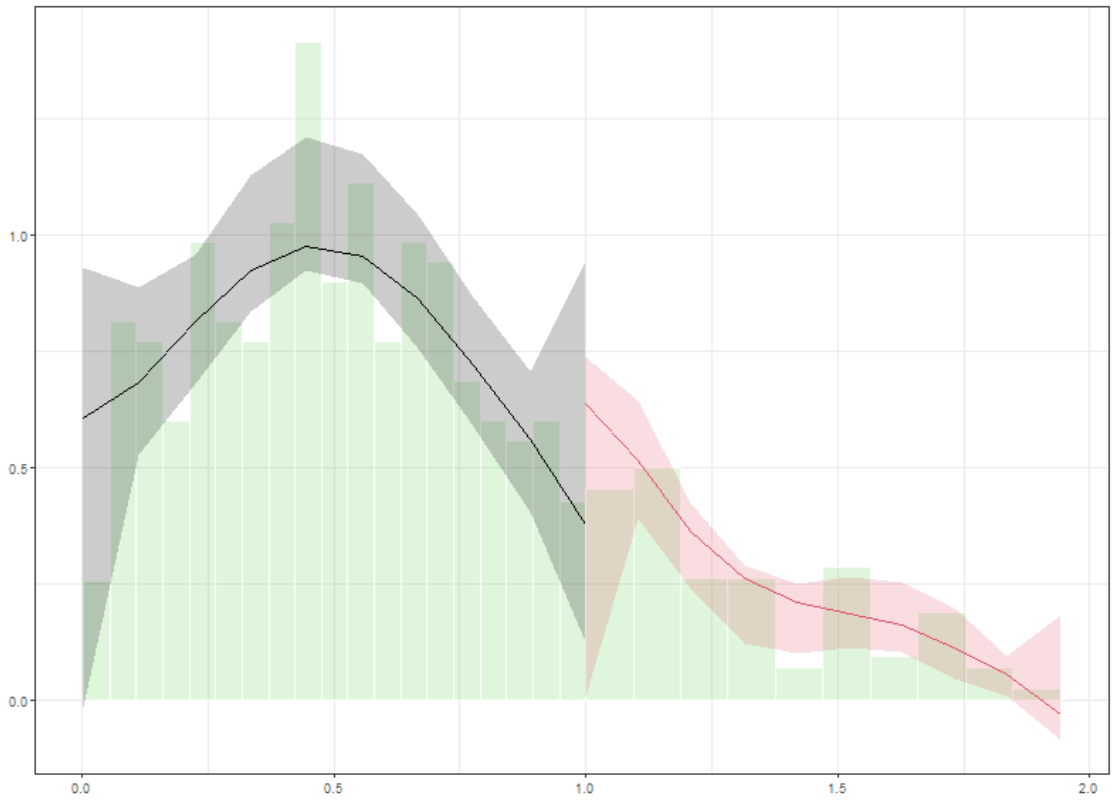


Note:

Panel A presents the coefficient plot based on Column (2) of Table X Panel A, the effects of Treatment × MUFG (takes value 1 if this loan is from MUFG) × Post on the share ratio. Panel B presents the coefficient plot based on Column (2) of Table X Panel B, the effects of Treatment × MBDummy (takes value 1 if this loan is from main bank at 2003) × Post on the share ratio.

Figure 7

Panel A: Density test



Panel B: Covariate balance test

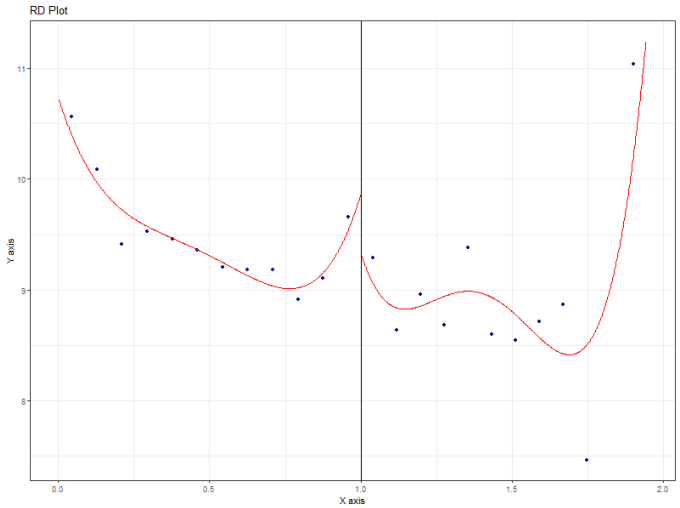


Figure 8 Bin plot

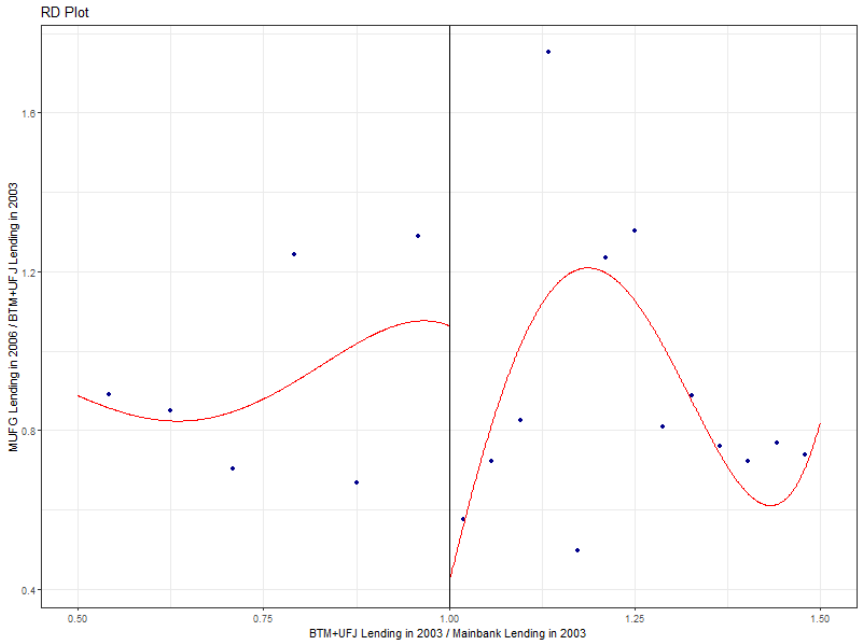
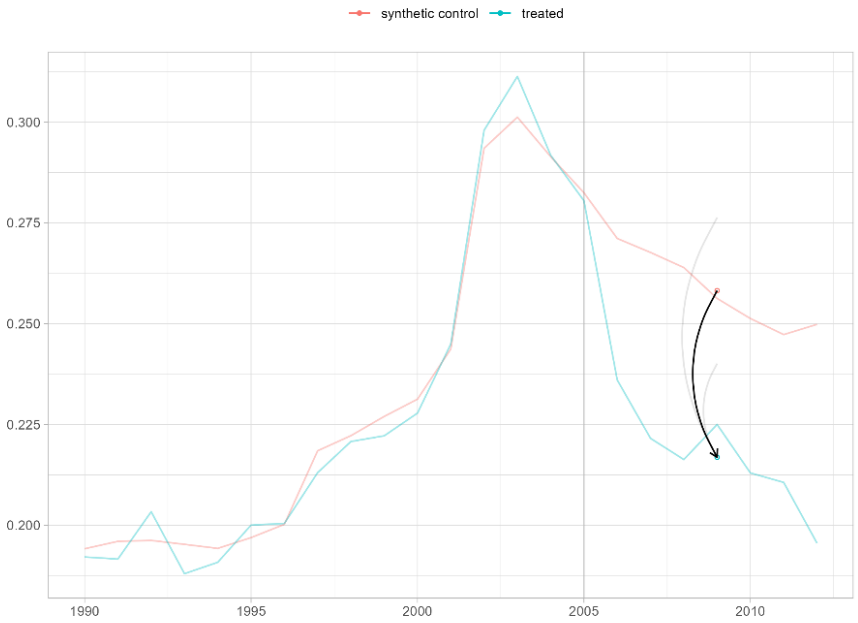


Figure 8 : The results of synthetic DID

Panel A



Panel B

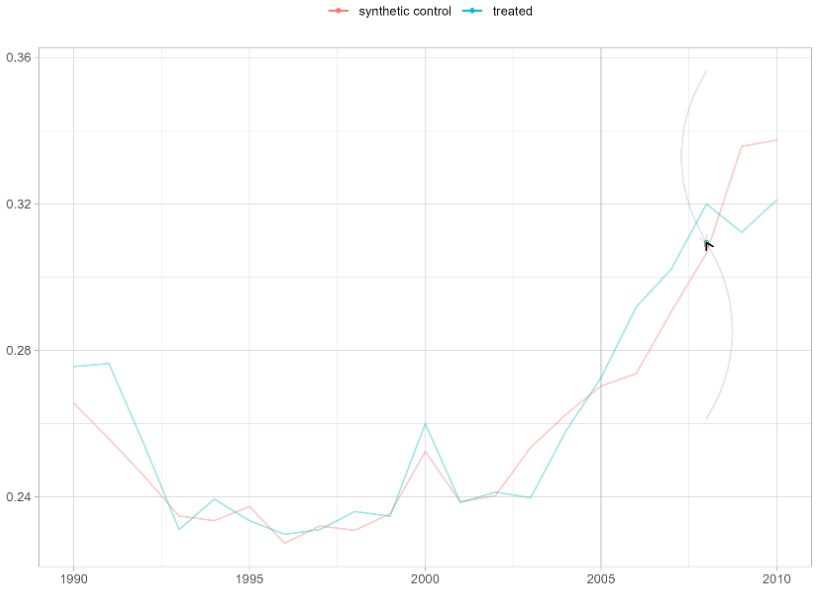
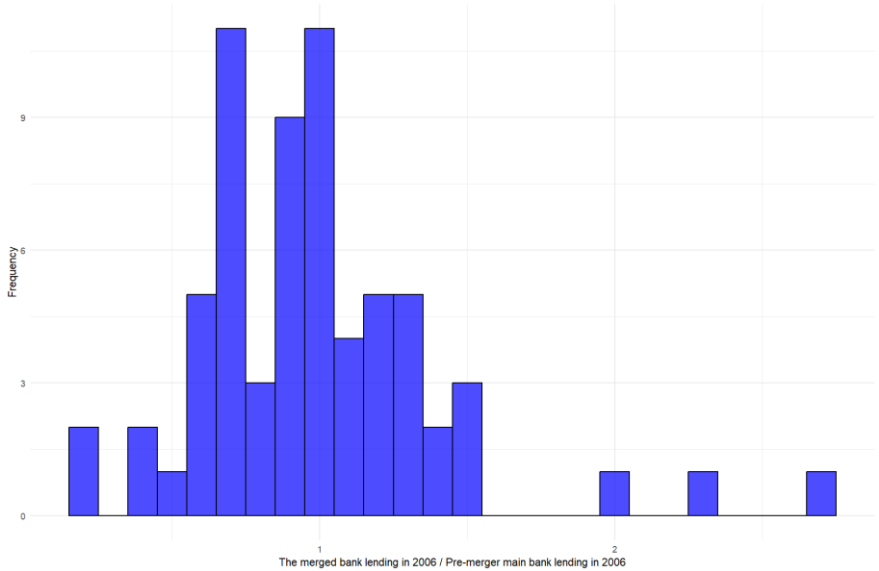


Figure 9: PDF and CDF of the merged bank lending / main bank lending

Panel A



Panel B

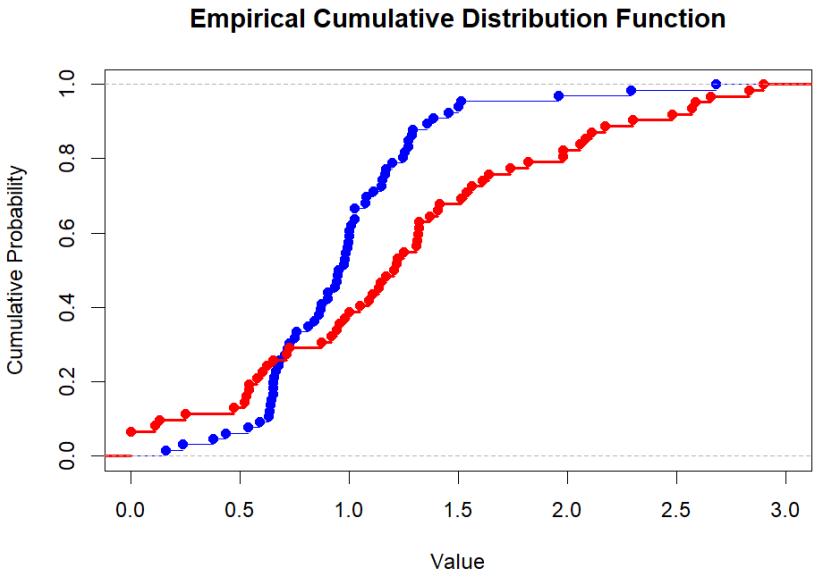


Figure 10: The plot of fuzzy bunching CDF

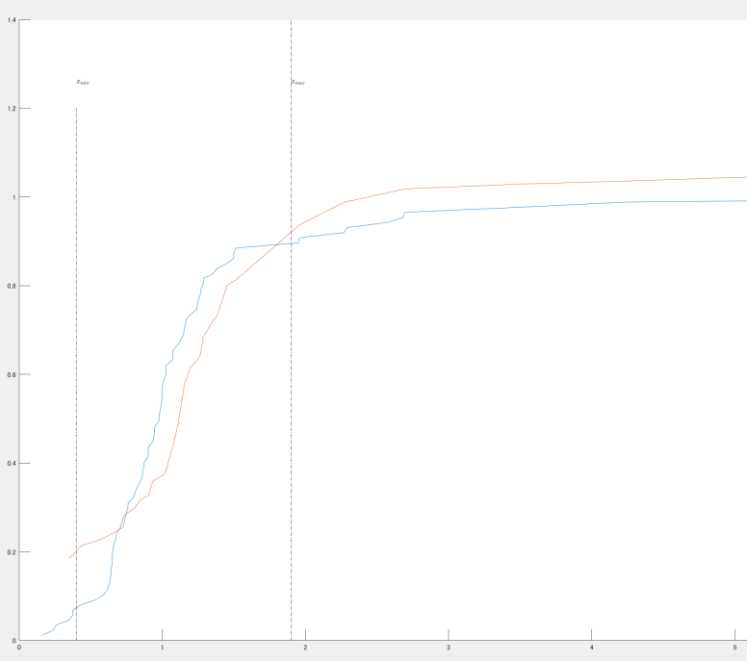


Table 1 Variable definitions

	Definition
Treatment and post variables	
OverMB	Dummy=1 if firm i belongs to the treatment group. The treatment group is defined as "the set of firms for which the combined lending of Bank of Tokyo-Mitsubishi (BTM) and UFJ Bank (UFJ) exceeded the lending provided by their top share bank as of 2003".
Post2004	Dummy=1 from 2004 (merger announcement year)
Post2006	Dummy=1 from 2006 (merger completed year)
Dependent variables	
RatioMUFG	Borrowing volume from MUFG (or BTM+UFJ before 2003) in firm's borrowing portfolio divided by firm's total borrowing from financial institutions
Invest	The change in tangible assets from the previous year plus depreciation and impairment losses deflated by total tangible.
TotalVolume	Firm's total borrowing from financial institutions
MBRatio	borrowing volume from top share bank in firm's borrowing portfolio divided by firm's total borrowing from financial institutions
Interest	Total interest payment divided by firm's total borrowing from financial institutions
Control variables	
DebtRatio	Total debt/Total asset
ROA	Net income/Total asset
CashRatio	Cash/Total asset

Table 2 Summary statistics

	Total sample				Treatment				Control			
	N	Mean	Median	S.D.	N	Mean	Median	S.D.	N	Mean	Median	S.D.
Treatment and post variables												
OverMB	3176	0.18	0	0.38	564	1	1	0	2612	0	0	0
Post2004	3176	0.78	1	0.42	564	0.78	1	0.41	2612	0.78	1	0.42
Post2006	3176	0.55	1	0.5	564	0.56	1	0.5	2612	0.55	1	0.5
Dependent variables												
RatioMUFG	3176	0.19	0.17	0.11	564	0.27	0.26	0.12	2612	0.17	0.15	0.1
Invest	3176	1.14	1.09	0.47	564	1.19	1.09	0.82	2612	1.13	1.08	0.34
TotalVolume	3176	40072.47	9970.5	98474.34	564	16774.23	7287.5	26962.2	2612	45103.17	10568	107203.4
MBRatio	3176	0.35	0.32	0.13	564	0.3	0.3	0.11	2612	0.36	0.33	0.13
Interest	3176	0.03	0.02	0.1	564	0.03	0.02	0.03	2612	0.04	0.02	0.11
Control variables												
DebtRatio	3176	0.63	0.63	0.15	564	0.61	0.62	0.15	2612	0.64	0.64	0.15
ROA	3176	0.01	0.02	0.04	564	0.02	0.02	0.04	2612	0.01	0.02	0.04
CashRatio	3176	0.11	0.1	0.08	564	0.13	0.11	0.08	2612	0.11	0.09	0.08

Table3. Cross-tabulation of Treatment status and main bank switch

Cross-tabulation of MB Switch and OverMB in 2003

MB Switch in 3years	MB>BTM+UFJ	MB<=BTM+UFJ	Total
No	466	61	527
Yes	49	34	83
Total	515	95	610

Note: The second column represents the treatment group ($MB > BTM + UFJ$), which consists of firms where the combined lending amounts of the merging banks, as of 2003 just prior to the merger, exceeded those of the top-ranking lender in their borrowing portfolios. In contrast, the third column represents the control group ($MB \leq BTM + UFJ$), which consists of firms where the combined lending amounts of the merging banks, as of 2003 just prior to the merger, fell below those of the top-ranking lender in their borrowing portfolios.

Table4. Regression results

	Panel A			Panel B		
Dependent variable	*RatioMUFG*	*RatioMUFG*	*RatioMUFG*	*Invest*	*Invest*	*Invest*
	(1)	(2)	(3)	(1)	(2)	(3)
OverMB:Post2004	-0.053***			-0.045		
	(0.014)			(0.050)		
OverMB:Post2006		-0.061***			0.000	
		(0.011)			(0.042)	
OverMB:Year2003			0.016			0.063
			(0.011)			(0.087)
OverMB:Year2004			0.002			0.006
			(0.011)			(0.087)
OverMB:Year2005			-0.014			-0.082
			(0.011)			(0.087)
OverMB:Year2006			-0.044***			-0.071
			(0.011)			(0.087)
OverMB:Year2007			-0.055***			-0.066
			(0.011)			(0.088)
OverMB:Year2008			-0.065***			-0.052
			(0.011)			(0.087)
OverMB:Year2009			-0.064***			0.200**
			(0.011)			(0.087)
OverMB:Year2010			-0.072***			-0.031
			(0.011)			(0.087)
Num.Obs.	3176	3176	3176	3176	3176	3176
R2 Adj.	0.739	0.744	0.745	0.096	0.095	0.099
Control?	Yes	Yes	Yes	Yes	Yes	Yes
FE	Firm+Year	Firm+Year	Firm+Year	Firm+Year	Firm+Year	Firm+Year

Table4 (continued)

	Panel C			Panel D		
Dependent variable	*TotalVolume*	*TotalVolume*	*TotalVolume*	*MBRatio*	*MBRatio*	*MBRatio*
	(1)	(2)	(3)	(1)	(2)	(3)
OverMB:Post2004	-0.003			0.045**		
	(0.041)			(0.019)		
OverMB:Post2006		-0.020			0.050***	
		(0.034)			(0.014)	
OverMB:Year2003			0.054			-0.042**
			(0.072)			(0.017)
OverMB:Year2004			0.032			-0.020
			(0.072)			(0.017)
OverMB:Year2005			0.058			0.007
			(0.072)			(0.017)
OverMB:Year2006			0.023			0.040**
			(0.072)			(0.017)
OverMB:Year2007			0.105			0.043**
			(0.072)			(0.017)
OverMB:Year2008			0.001			0.038**
			(0.072)			(0.017)
OverMB:Year2009			-0.027			0.031*
			(0.072)			(0.017)
OverMB:Year2010			-0.024			0.032*
			(0.072)			(0.017)
Num.Obs.	3176	3176	3176	3176	3176	3176
R2 Adj.	0.943	0.943	0.943	0.571	0.574	0.574
Control?	Yes	Yes	Yes	Yes	Yes	Yes
FE	Firm+Year	Firm+Year	Firm+Year	Firm+Year	Firm+Year	Firm+Year

Note: This table presents the estimates from DID, the effects of Treatment × Year on firm level variables. The treatment variable, $OverMB_{it}$, is defined as a dummy variable that takes a value of 1 if the combined lending of the merging banks exceeded the lending provided by their main bank as of 2003, prior to the merger. In Panels A through D, the dependent variables are the share of combined lending of the merging banks (or lending of the merged bank after the merger) divided by total borrowing for firm i ($RatioMUFG_{it}$), Investment, the logarithmic value of a firm's total borrowings from banks ($Log(TotalVolume)_{it}$) and borrowing volume from top share bank in firm's borrowing portfolio divided by firm's total borrowing from banks ($MBRatio_{it}$) respectively. In each panel, the first column defines the post variable as starting from 2004, while the second column defines it as starting from 2006. The third column decomposes the treatment effects by year. All equations include firm fixed effects and year fixed effects. All equations include total debt/total asset ($DebtRatio_{it}$), net income/total asset (ROA_{it}) and cash/total asset ($CashRatio_{it}$) as control variables.
The standard errors in parentheses are clustered at the firm level and the year level.
***p<0.01, **p<0.05, *p<0.1.

Table 5: Loan level analysis

	Panel A		Panel B	
Bank Variables	*MUFG*	*MUFG*	*MBDummy*	*MBDummy*
	(1)	*(2)*	*(1)*	*(2)*
OverMB:Bank:Post2006	-0.065***		0.039***	
	(0.004)		(0.004)	
OverMB:Bank:Year2003		0.020**		-0.026***
		(0.009)		(0.009)
OverMB:Bank:Year2004		-0.014		0.016*
		(0.009)		(0.009)
OverMB:Bank:Year2005		-0.020**		0.036***
		(0.009)		(0.009)
OverMB:Bank:Year2006		-0.056***		0.048***
		(0.009)		(0.009)
OverMB:Bank:Year2007		-0.067***		0.062***
		(0.009)		(0.009)
OverMB:Bank:Year2008		-0.076***		0.051***
		(0.009)		(0.009)
OverMB:Bank:Year2009		-0.072***		0.036***
		(0.009)		(0.009)
OverMB:Bank:Year2010		-0.077***		0.032***
		(0.009)		(0.009)
Num.Obs.	54990	54990	54990	54990
R2 Adj.	0.857	0.857	0.891	0.891
Firm×Year, Bank×Year, Bank×Firm FEs?	Yes	Yes	Yes	Yes

Note: This table presents the results of loan level data analysis, the effects of Treatment ×Year×Bank variables on bank-firm-year level loan amount. The treatment variable, $OverMB_{it}$, is defined as a dummy variable that takes a value of 1 if the combined lending of the merging banks exceeded the lending provided by their main bank as of 2003, prior

to the merger. The dependent variable is the ratio of loans from bank j to firm i, relative to the total borrowing of firm i. In Panels A, the bank variable is $MUFG_{ijt}$, a dummy variable that takes the value of 1 if the lending bank is MUFG. In Panels B, the bank variable is $MBDummy_{ijt}$, a dummy variable that takes the value of 1 if the lending bank is the main bank of firm i in 2003. In each panel, the first column defines the post variable as starting from 2006. The second column decomposes the treatment effects by year. All equations include Firm × Year, Bank × Year and Firm × Bank fixed effects. The standard errors in parentheses are clustered at the firm level and the year level. ***p<0.01, **p<0.05, *p<0.1.

Table 6: Covariate balance test for regression discontinuity design

Value	Parameter
-0.6680200	Estimate(Conventional)
-2.1082508	95% Confidence Interval Lower
0.7722107	95% Confidence Interval Upper
0.7348251	Standard Error

Note:

This table checks whether the covariates are balanced around the threshold of the running variable. The covariate used is the logarithmic value of the firm's total borrowings from banks as of 2003. The estimation employs the local linear regression from equation (4). The first row displays the estimated results using the optimal bandwidth. Rows 2 and 3 show the results for the 95% confidence intervals. The fourth column presents the standard errors for heteroskedasticity-robust nearest neighbor variance estimator with three neighbors to be used.

Table7 Regression discontinuity design results

Panel A

Value	Parameter
-0.7100354	Estimate(Conventional)
-1.4445030	95% Confidence Interval Lower
0.0244323	95% Confidence Interval Upper
0.3747353	Standard Error

Panel B

Value	Parameter
-0.8027369	Estimate(Bias-Corrected)
-1.5372046	95% Confidence Interval Lower
-0.0682693	95% Confidence Interval Upper
0.3747353	Standard Error

Note:

This table presents the results of regression discontinuity design. Panel A presents the results of conventional estimator, which uses optimal bandwidth, while Panel B presents the results of bias-corrected estimator, modified by estimated bias using pilot bandwidth. The estimation employs the local linear regression from equation (4). The first row displays the estimated results. Rows 2 and 3 show the results for the 95% confidence intervals. The fourth column presents the standard errors for heteroskedasticity-robust nearest neighbor variance estimator with three neighbors to be used.

Table 8: The determinants of main bank switch

Dependent variable: MBSwitch				
	(1)	(2)	(3)	(4)
OverMB: MegaBankDummy	0.037			0.019
	(0.077)			(0.077)
OverMB:ROA		0.590		0.394
		(0.395)		(0.401)
OverMB:DiffMUFG_MB			1.745***	1.619***
			(0.594)	(0.609)
Num.Obs.	609	609	609	609
R2 Adj.	0.062	0.065	0.075	0.073
Other single terms?	Yes	Yes	Yes	Yes

Note: This table presents the results of the analysis on the factors influencing the main bank switch. The treatment variable, $OverMB_{it}$, is defined as a dummy variable that takes a value of 1 if the combined lending of the merging banks exceeded the lending provided by their main bank as of 2003, prior to the merger. The dependent variable, MBSwitch, is defined as a dummy variable that takes a value of 1 if the main bank is the merged bank as of 2006, merger complete year. Column (1) examines whether firms with a mega-bank as their main bank before the merger (MegaBankDummy) switched to the merged bank as their main bank after the merger. Column (2) investigates whether firms with higher profitability tend to switch their main bank to the merged bank. Return on assets (ROA) is used as the profitability measure. Column (3) explores whether a large difference in the merging banks' lending compared to the main bank's lending (DiffMUFG) influences the likelihood of the main bank switching to the merged bank. Column (4) estimates a model that includes all three factors simultaneously. The robust standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1.

Table 9: Fuzzy bunching estimation results

Parameters	$\overline{\frac{Q_i}{M}}$	Std.error	τ_i	Non-optimizing agent rate
Values	1.4	0.01	16%	0.4

Appendix

Appendix A: The variable definitions and statistics for loan level analysis

	Definition
Treatment and post variables	
OverMB	Dummy=1 if firm i belongs to the treatment group. The treatment group is defined as "the set of firms for which the combined lending of Bank of Tokyo-Mitsubishi (BTM) and UFJ Bank (UFJ) exceeded the lending provided by their top share bank as of 2003".
Post2006	Dummy=1 from 2006 (merger completed year)
Dependent variables	
FocalLoanRatio	the ratio of loans from bank j to firm i, relative to the total borrowing of firm i, relative to the total borrowing of firm i.
Interest variables	
MUFG	Dummy variable that takes the value of 1 if the lending bank is MUFG.
MBDummy	Dummy variable that takes the value of 1 if the lending bank is the top share lender of firm i in 2003

	Total sample				Treatment				Control			
	N	Mean	Median	S.D.	N	Mean	Median	S.D.	N	Mean	Median	S.D.
Treatment and post variables												
OverMB	54990	0.13	0	0.33	7063	1	1	0	47927	0	0	0
Post2006	54990	0.51	1	0.5	7063	0.51	1	0.5	47927	0.5	1	0.5
Dependent variables												
FocalLoanRatio	54990	0.1	0.05	0.13	7063	0.12	0.06	0.13	47927	0.09	0.04	0.13
Interest variables												
MUFG	54990	0.09	0	0.29	7063	0.11	0	0.31	47927	0.09	0	0.28
MBDummy	54990	0.1	0	0.3	7063	0.12	0	0.33	47927	0.09	0	0.29

Appendix B: The variable definitions and statistics for cross section level analysis (RDD, the determinants of switching)

	Definition
Dependent variables	
MBSwitch	Dummy variable that takes a value of 1 if the main bank is the merged bank as of 2006, merger complete year.
Interest variables	
MegaBankDummy	Dummy variable that takes the value of 1 if the top share lender is mega bank (Mizuho, SMBC and Risona)
ROA	Net income / Total asset
DiffMUFG	(The merging bank lending / the mainbank lending)/the mergingd bank lending

All variables are meajured in 2003.

	Total sample				Treatment				Control			
	N	Mean	Median	S.D.	N	Mean	Median	S.D.	N	Mean	Median	S.D.
Dependent variables												
MBSwitch	610	0.14	0	0.34	95	0.36	0	0.48	515	0.1	0	0.29
Interest variables												
MegaBankDummy	610	0.65	1	0.48	95	0.73	1	0.45	515	0.64	1	0.48
ROA	609	0.01	0.02	0.12	95	0.01	0.02	0.08	514	0.01	0.02	0.13
DiffMUFG	610	-0.15	-0.14	0.17	95	0.07	0.05	0.05	515	-0.19	-0.16	0.15

Appendix C: DID estimation on average interest payments

Dependent variable	*Interest*	*Interest*	*Interest*
	(1)	(2)	(3)
OverMB:Post2004	0.017		
	(0.010)		
OverMB:Post2006		0.009	
		(0.009)	
OverMB:Year2003			0.004
			(0.018)
OverMB:Year2004			0.018
			(0.018)
OverMB:Year2005			0.017
			(0.018)
OverMB:Year2006			0.021
			(0.018)
OverMB:Year2007			0.016
			(0.018)
OverMB:Year2008			0.020
			(0.018)
OverMB:Year2009			0.021
			(0.018)
OverMB:Year2010			0.017
			(0.018)
Num.Obs.	3176	3176	3176
R2 Adj.	0.222	0.221	0.220
Control?	Yes	Yes	Yes
FE	Firm+Year	Firm+Year	Firm+Year

Appendix D: **Proof of Proposition 1**

From indifferent condition of the marginal firms in equation (6), τ can be rewritten as follows:

$$1-\tau=\frac{\left(R\left(\underline{Q}_i\middle|\overline{z}_i\right)-r\right)\underline{Q}_i}{\left(R(\overline{Q}_i|\overline{z}_i)-r\right)\overline{Q}_i} \tag{A.1}$$

We conduct a Taylor expansion for $R\left(\underline{Q}_i\middle|\overline{z}_i\right)$ at the optimal loan volume $\overline{Q}_i$.

$$R\left(\underline{Q}_i\middle|\overline{z}_i\right)\approx R(\overline{Q}_i|\overline{z}_i)+R_Q(\overline{Q}_i|\overline{z}_i)\left(\overline{Q}_i-\underline{Q}_i\right) \tag{A.2}$$

By substituting this into (A.1), the numerator becomes

$$\begin{aligned}\left(R\left(\underline{Q}_i\middle|\overline{z}_i\right)-r\right)\underline{Q}_i &\approx \left(R(\overline{Q}_i|\overline{z}_i)+R_Q(\overline{Q}_i|\overline{z}_i)\left(\overline{Q}_i-\underline{Q}_i\right)-r\right)\underline{Q}_i\\ &=\left(R(\overline{Q}_i|\overline{z}_i)-r-\frac{1}{\overline{Q}_i}\left(R(\overline{Q}_i|\overline{z}_i)-r\right)\left(\overline{Q}_i-\underline{Q}_i\right)\right)\underline{Q}_i\\ &=\left(R(\overline{Q}_i|\overline{z}_i)-r\right)\left(1-\frac{\overline{Q}_i-\underline{Q}_i}{\overline{Q}_i}\right)\underline{Q}_i\end{aligned} \tag{A.3}$$

where second equation is derived by using the equation (3) which is the first order condition for unbiased loan volume $R_Q(Q_i|z_i)=-\frac{1}{Q_i}(R(Q_i|z_i)-r)$. Rearranging the (A.1), we have

$$\begin{aligned}1-\tau &\approx \frac{\left(R(\overline{Q}_i|\overline{z}_i)-r\right)\left(1-\frac{\overline{Q}_i-\underline{Q}_i}{\overline{Q}_i}\right)\underline{Q}_i}{\left(R(\overline{Q}_i|\overline{z}_i)-r\right)\overline{Q}_i}\\ &=\left(1-\frac{\overline{Q}_i-\underline{Q}_i}{\overline{Q}_i}\right)\left(\frac{\underline{Q}_i}{\overline{Q}_i}\right)\\ \tau &\approx 1-\left(1-\frac{\overline{Q}_i-\underline{Q}_i}{\overline{Q}_i}\right)\left(\frac{\underline{Q}_i}{\overline{Q}_i}\right)\\ &=\left(\frac{\overline{Q}_i-\underline{Q}_i}{\overline{Q}_i}\right)^2\end{aligned} \tag{A.4}$$