Bank Type, Competition and Stability in Japanese Banking

Hong Liu[a] and John O.S. Wilson[b]

March 2011

Abstract:

We investigate whether the relationship between competition and stability varies across different bank types for Japanese banks during the period 2000-2009. In general we find that stability varies across bank types, in that banks with a regional focus (Regional, Tier 2 Regional, Shinkin and Credit Cooperative banks) are found to be more stable on average than nationwide (City and Trust) banks. The relationship between competition and stability varies across bank types with different stability levels. Specifically, competition appears to enhance the stability of banks with lower stability level (City banks), but damage the stability of banks with higher stability levels (Regional, Tier 2 Regional, Shinkin and Credit Cooperative banks).

Keywords: Banking, competition, dynamic panel estimation, Japan, risk, stability

JEL Codes: G21 L1

a Accounting and Finance, Business School, University of Glasgow, West Quadrangle, Main Building, University Avenue, Glasgow, G12 8QQ, Tel: +44 141 330 6124. Fax: +44 141 330 4442.

b School of Management, University of St Andrews, The Gateway, North Haugh, St Andrews, Fife, KY16 9SS, UK. Tel: +44 1334 462803. Fax: +44 1334 462812.

I. Introduction

In the past few years, a theoretical and empirical literature has emerged which explores the links between competition and stability in banking.[1] Two views are posited in the literature. One view (the competition-fragility view) argues that less competitive banking systems are less fragile because the numerous lending opportunities, high profits, capital ratios and charter values of incumbent banks make them better placed to withstand demand or supply-side shocks, and provide dis-incentives for excessive risk taking (Keeley, 1990; Allen and Gale, 2000, 2004; Carletti, 2008). An alternative view (competition-stability view) contends that competition leads to less fragility. This is because the market power of banks results in higher interest rates for customers making it more difficult for them to repay loans. This increases the possibility of loan default and increases the risk of bank portfolios, and subsequently makes the financial system less stable (Boyd and DeNicolo, 2005). Empirical evidence in support of either view in rather mixed.

The empirical research examining the relationship between bank competition and stability discussed above fails to consider the heterogeneity of bank types. In this paper, we posit that differences in terms of ownership structure, bank strategy and regulatory treatment are likely to lead banks to interact with the external environment differently, and consequently have implications for risk and stability. Particularly, different bank types have different levels of stability. On one hand, those banks with low stability might tend to avoid taking on more risks to protect their fragile franchise value when competition increases. While on the other hand when facing increasing competition, those banks with high stability have relatively more room for risk taking

[1] Northcott (2004), Berger et al, (2004), Degryse and Ongena (2008), Claessens (2009) and Dick and Hannan (2010) provide reviews of the theoretical and empirical competition literature. Beck et al (2010a) and Vives (2010) provide overviews of the theoretical and empirical relationship between competition and financial stability.

and hence may tend to take on riskier projects to protect their competitiveness and profitability levels. Hence, the competition and stability relationship may vary across different types of bank due to their different levels of stability. Overall, the results of our analysis not only inform on-going empirical controversies, but are also of direct interest to policy-makers engaged in assessing the merits of competition as a means of reducing risk-taking incentives in the banking industry.

The segmented nature of the Japanese banking system provides an ideal dataset to test these ideas. It comprises nationwide banks such as City and Trust banks, and banks with a regional focus such as Regional, Tier 2 Regional, Shinkin and Credit Cooperative banks. Using data from Japanese banks spanning the period 2000-2009 (when the industry was recovering from a long lasting banking crisis) and a two step methodology, this study provides evidence as to the extent to which competition and stability differs across bank types.[2] To our knowledge, this research is the first to examine the variations of the competition-stability relationship by bank type.[3]

The principal findings are as follows. Banks with a regional focus (Regional, Tier 2 Regional, Shinkin and Credit Cooperatives) are more stable than their nationwide banking counterparts (City and Trust banks). Competition has negative

[2] The latter years on our sample period incorporate the global financial crisis. The direct impact of this financial crisis on Japanese banks has been small compared to counterparts located in many other developed countries (for instance, the US and UK), where many banks failed or were bailed out by their respective governments. In part this reflects lower levels of involvement of Japanese banks in originate-to-distribute type activities than many of their US and European banking counterparts, and the successful implementation of the various financial reforms in the aftermath of the banking crisis in the 1990s (Kashyap, 2002; Hattori, 2007; Jones and Tsutsumi, 2009). These financial reforms include the implementation of the capital adequacy requirement in 1993, the recognition of a large number of non-performing loans in 1997, and the prompt corrective action rules implemented in 1998 (Watanabe, 2010).

[3] Beck et al (2010b) examine how regulation, supervision and other institutional factors impact on bank the link between competition and stability for a sample of German banks with different ownership characteristics. They find that an increase in competition has a larger impact on banks' risk-taking incentives in countries with stricter activity restrictions. Our study differs from this research by examining the potential variations of competition-stability relationship across bank types within one country.

impact on the stability of banks with higher level of stability (Regional Tier 2 Regional, Shinkin and Credit Cooperatives banks), but a positive impact on banks with lower levels of stability (City banks). Furthermore, our results suggest that diversified and inefficient banks with high loan-to-asset ratios are less stable than their focused, efficient more cautious counterparts. Finally, inflation has a significant negative impact on bank stability.

The remainder of the paper is structured as follows. Section II provides a brief discussion of the Japanese banking system. Section III discusses relevant literature. Section IV describes the two-step methodology used to examine whether bank stability differs across types and the extent to which any link between competition and stability varies by bank types. Section V describes the data, and interprets the results. Section VI concludes.

II. The Japanese Banking System

The Japanese banking system comprises various bank types. These include: City, Trust, Regional, Tier 2 Regional, Shinkin and Credit Cooperative banks.[4] City banks are nationwide institutions that provide comprehensive banking services (traditional and non-traditional) mainly to large corporate customers. These banks dominate most segments of the domestic market, and are active internationally. Trust banks are licensed to carry out both banking and trust activities. They focus on activities in the real estate market as well providing asset and wealth management services to customers.

Regional banks are medium-sized institutions whose activities have a regional focus. Accordingly, their ties to local firms and households are strong with the bulk

[4] Casu et al (2006) and Uchida and Udell (2010) provide an extended discussion of the evolution and structure of the Japanese banking system.

of their lending going to small and medium-size enterprises (SMEs). The Second Association of Regional banks (Tier 2 Regional banks) were initially established as mutual (Sogo) banks, but were transformed into regional banks under the 1992 Banking Act. These banks are smaller in scale than Regional banks, and are normally confined to the prefecture in which their respective head offices are located.[5]

Shinkin banks or Credit associations are cooperative financial institutions. These banks are smaller than City and Regional banks and conduct their banking businesses within their respective local area. Due to their mutual form, Shinkin banks provide services to their members, which are normally SMEs. Shinkin banks can also provide loan services to non-members, but this is limited to 20% of total lending. These banks can also accept deposits from non-members (Hosono et al, 2006).

Credit Cooperatives (*shinyou kumiai*) are also deposit-taking cooperative banks that specialize in SME financing. They can accept deposits and instalment savings from members. In some cases, credit cooperatives can also accept deposits from local governments, public firms, and non-profit organizations (Fukuyama et al, 1999). While the Ministry of Finance directly monitors commercial banks, credit associations (Shinkin banks) and other financial institutions, the prefectural governments monitor Credit Cooperatives. Credit Cooperatives conduct all their activities within their given prefecture.

Evidence of the performance of the Japanese banking system after the long lasting economic recession during 1990s is surprisingly scant. A recent study by Loukoianova (2008) finds that the performance of Japanese banking system as a

[5] Japan is subdivided into 47 administrative areas, known as prefectures.

whole has been improving gradually since 2001, but there are significant differences within the banking sector. Regional banks appear to be more inefficient both in terms of cost and revenue compared to their commercial banking counterparts. These differences reflect their underlying characteristics such as size and business mix (Loukoianova, 2008). Deelchand and Padgett (2009) find that over the period 2003-2006 that inefficient Japanese cooperative banks operate with relatively more capital and take on more risk than their more efficient counterparts. Furthermore, large cooperative banks holding less capital take on more risk and are less efficient than their smaller counterparts. Most recently, Liu and Wilson (2010) observe improvements in the profitability of Japanese banks following the banking crisis which affected the banking system in the 1990s.

The boundaries between banks with different institutional characteristics remains even after the financial liberalization in the 1980s and 1990s, and the fundamental changes following the major banking crisis that commenced in the mid 1990s (Casu et al, 2006, chapter 16; Uchida and Udell, 2010). Given the segmented structure of the banking system, we would anticipate: differences in stability, and between competition and stability for different bank types. [6]

III. Literature Review

There is a rich theoretical and empirical literature exploring the relationship between competition and stability in the banking system. Starting from Marcus (1984) and Keeley (1990), researchers contend that increased competition leads to fragility. This is because increased competition drives down loan rates and net interest margins.

[6] Empirical evidence appears to support the view that the Japanese banking market is segmented, where City and Trust banks compete nationwide, Regional banks weakly segmented geographically by prefecture while Shinkin banks compete only within the same type of banks and in the same prefecture (Kano and Tsutsui, 2003).

As the franchise value erodes, bank owners have incentives to take on more risks, resulting in higher fragility. Boyd and De Nicolo (2005) offer a contrary view that asserts that competition enhances stability. They show that low lending rates (arising from increased competition) reduces borrowing costs and leads to an increase in entrepreneurial investments in the economy. The resultant reduction in loan default rates assures bank stability.

Empirical evidence with respect to whether competition enhances or reduces bank stability is somewhat mixed and inconclusive. For example, Boyd et al. (2006) and DeNicolo and Loukoianova (2007) find that the risk of bank failure increases in less competitive markets, while Jiménez et al. (2010) find that risks decrease with a rise in the market power of incumbent banks. Turk-Ariss (2010) assesses how different degrees of market power affect bank efficiency and stability in developing banking systems. The results suggest that an increase in market power leads to both greater bank stability and enhanced profit efficiency, albeit at the expense of significant cost efficiency losses. In a related contribution Casu and Girardone (2009) assess the relationship between competition and efficiency in the banking sectors of five EU countries. Utilising Granger causality tests, they find a positive causation between market power and efficiency, but find little evidence of causality running from efficiency to market power.

Berger et al. (2009) use a variety of risk and competition measures derived from a dataset of banks from 23 countries. The results are rather mixed and provide limited support to both the competition-fragility view and competition-stability views. Specifically, market power increases credit risk, but banks with more market power face less risk overall. Zhao et al. (2009, 2010) assess the extent to which deregulatory measures aimed at promoting competition lead to increased risk taking across Indian

banks. The results suggest competition encourages banks to increase risk. Beck et al (2010b) use a large cross country dataset of banks to show that an increase in bank competition has a larger impact on risk-taking incentives in countries with strict activity restrictions and low levels of concentration.

Most recently, Martinez-Miera and Repullo (2010) suggest a non-linear relationship between bank competition and stability. They argue that heightened competition may reduce borrower's probability of default (referred to as a risk-shifting effect), but it may also reduce the interest payments from performing loans, which serves as a buffer to cover loan losses (referred to as a margin effect). They find evidence of a U-shaped relationship between competition (measured by the number of banks) and bank stability. In highly concentrated markets the risk-shifting effect dominates and more competition reduces bank risk, while in very competitive markets the margin effect dominates, and the increased competition erodes bank's franchise value and hence increases risk.

The research reviewed above fails for the most part to account for the possibility that the relationship between competition and stability is likely to vary across different types of bank. Such differences may arise from: differences in ownership structure and bank-customer relationships; exposure to capital market discipline; geographic areas served (regional versus national); access to external finance (i.e. mutual banks can only build up capital via retained earnings); and differential regulatory treatment. Consequently, stability is likely to vary across different types of bank. Furthermore, the relationship between competition and stability may differ depending on the initial stability of banks. On one hand, for those banks with low stability, they might tend to avoid taking on more risks when competition increased to protect their fragile level of stability. While on the other

hand when facing increasing competition, those banks with high stability have relatively more room for risk taking and may tend to take on riskier projects to maintain their competitiveness and profitability levels. However, the exact nature of how such differences affect bank stability and any observed competition and stability relationship is unclear.[7] Consequently, further investigation is required in order to resolve on-going theoretical and empirical controversies.

IV. Empirical Methods

To test empirically whether the bank competition-stability relationship varies across bank types, we adopt a two-step strategy. In *Step One*, we utilise a model that controls for the effects of various bank-specific and macroeconomic factors in order to identify the direct impact of competition on bank stability and the differences in bank stability across bank types. In *Step Two*, we test whether the impact of competition on bank stability depends on the bank's original level of stability, and whether the competition-stability relationship varies across bank type.

[7] Mutual banks are likely to have different risk taking incentives to commercial banks, since they pursue social and economic development objectives, rather than shareholder value maximization. Mutual banks may be less fragile than their commercial banking counterparts because: they have a stable deposit base and pursue business strategies that aim to build up capital for future generations of members (Beck et al, 2009). However, mutual banks are less diversified and have an inability to raise capital at short notice. Consequently, these banks are less able to absorb demand-or supply-side shocks to their balance sheets (Fonteyne, 2007; Goddard et al., 2010). Furthermore, mutual bank borrowers may have incentives to free ride in taking risky loans, since the losses will be shared among all the members of the bank (Delgado et al, 2007). Rey and Tirole (2007) utilise an overlapping generations framework to show that inter-generational conflicts between established and new members can make the cooperative an unstable organizational form. Hower (2009) notes that firms that have a main banking relationship with a cooperative or savings bank are less likely to exit upon the onset of financial distress than counterparts whose main bank relationship is with a commercial bank. This implies that lending officers within commercial banks are *harder nosed* than their opposite numbers in mutual banks. Such *hard-nosed* behaviour may lead to commercial banks exhibiting more stability than their mutual banking counterparts.

Step One

In Step One, we utilise the following model:

$$\delta_{it} = \beta_0 + \lambda\delta_{i,t-1} + \beta_1 Lerner_{it} + \beta_2 Lerner_{it}^2 + \beta_3 D_j + \beta_4 X_{it} + \beta_5 M_t + \mu_i + \nu_{it} \qquad (1)$$

In Equation (1), $\delta_{i,t}$ is a stability measure for bank i (i = 1...N) at time t (t = 1...T) and $\delta_{i,t-1}$ is one-period lagged stability measure. Bank stability is measured as the Z-index, computed as the bank's return on assets plus the capital-to-assets ratio, all divided by the standard deviation of asset returns. A higher Z-index implies a lower probability of insolvency and higher bank stability. Following Cihak et al (2009), a three-year rolling window is used to calculate the standard deviation of return on assets to arrive at rolling Z-index in order to capture the dynamics of bank stability.[8]

We use a Lerner index ($Lerner_{it}$) as our bank competition measure (Lerner, 1934).[9] The Lerner index is a proxy indicator of the degree of market power and is measured by the mark-up of price over marginal cost.[10] We also include the square of the Lerner index ($Lerner_{it}^2$) to address the potential non-linearity of the relationship between competition and stability (as argued by Martinez-Miera and Repullo, 2010). D_j are dummy variables for each bank type (City, Regional, tier 2 Regional, Shinkin and Credit Cooperative banks) in order to test whether bank stability differs across bank types. X_{it} is a vector of exogenous bank-specific covariates and M_t is the

[8] We use accounting-based rather than market-based risk measures, because most Japanese regional and cooperative banks are not listed.

[9] Given the segmented nature of Japanese banking, conventional proxies for competition based on market structure (such as the concentration ratio or Herfindahl Index) are likely to be unsuitable.

[10] See Appendix for the more information of the estimation of Lerner index.

Macroeconomic variable (inflation). μ_i is a fixed effect, and ν_{it} is a random disturbance.

The two-step system GMM estimator with Windmeijer correction is used to estimate Equation 1 (Arellano and Bover, 1995; Blundell and Bond, 1998). For robust statistical inferences, we also report the statistics for the Hansen test of over-identifying restrictions and the second-order autocorrelation test of no second-order autocorrelation in the error term (Hansen, 1982)**.**

Lagged values are used for the covariates of Equation 1, to avoid possible endogeneity issues. Cost inefficiency (CI), measured by the cost to income ratio (overheads as a proportion of operating profits before provisions) is expected to be negatively related to bank stability. More inefficient banks are likely to take on greater risk to generate returns to improve performance (Boyd et al, 2006; Agoraki et al, 2009).

The ratio of loans to total assets (LA) is naturally expected to be negatively related to bank stability, since the greater is the bank's loans exposure, the higher is the potential of default risk (Liu et al, 2010).

Size (lnTA), measured by the logarithm of total assets, is expected to be negatively related to risk. The benefits of economies of scale and market power allow large banks to remain more stable than their smaller counterparts (Berger, 1995). However, managers of larger banks might be prepared to accept more risk, in anticipation of government safety-net measures for the bail-out of large distressed banks (O'Hara and Shaw, 1981).

Diversification (DIV), measured by the ratio of non-interest income to total operating income, is expected to be negatively related to risk. However, recent empirical evidence (for the US, Europe and Japan suggests that diversification into

non-core banking activities is associated with increased risk and lower returns (Stiroh, 2004; Lepetit et al., 2008; Mercieca et al., 2007; Laeven and Levine, 2007; Demirguc-Kunt and Huizinga, 2010; Liu and Wilson, 2010).

To capture the effects of macroeconomic shocks on banks' balance sheets, we use Inflation (INF), calculated as the percentage change in the relevant GDP deflator. INF has been used in previous studies of banking to proxy for macroeconomic mismanagement, which has been found to adversely affect the financial system and real economy (Demirguc-Kunt and Detragiache, 1998; Lown and Morgan, 2006; Buch et al, 2010). Furthermore, higher inflation can distort decision-making, exacerbate information asymmetry and introduce price volatility. Consequently, a negative relationship between INF and bank stability is expected.

Step Two

To test whether the impact of competition on bank stability depends on the bank's original stability level, and consequently whether the competition-stability relationship differs across bank types, we conduct an additional regression analysis. [11] In the first regression, we create the interaction term between bank stability (using lagged one year Z-index) and competition (using the lagged one year Lerner index). We expect the coefficient of this interaction term to be positive given that banks with higher initial stability tend to take on more risks when competition increases, which leads to reduced overall stability (and vice-versa). To provide further evidence of the impact of the bank stability level on the competition-stability relationship, in the second regression we create five stability quintile dummies (according to the lagged one year Z-index) that equal one if the value of Z-index falls within that quintile and

[11] We exclude the square of the Lerner index in Step Two because we find linear relationship between the competition and stability in the Japanese banking system from Equation (1). See Table 3 for empirical results.

zero otherwise. We then multiply the competition variable (the lagged one year Lerner index) by each of the stability quintile dummy variables, so that we have five interaction terms[12]. Following the same logic as the first regression, we expect that the signs of the interaction terms for the larger quintiles to be positive, while the signs of the interaction terms for the smaller quintiles to be negative.

Finally, in the third specification we create the interaction of the competition measure (the lagged one year Lerner index) with bank type dummies. We expect that the signs of the interaction coefficients are different across the bank types. Specifically, for those bank types with lower stability the interaction term may have negative signs (indicating a positive relationship between competition and stability) while for those bank types with higher stability the interaction term may have positive signs (indicating negative impact of competition on bank stability).

V. Data and Results

This section presents the data used in the present study. It also discusses the results of empirical analyses of: whether bank stability differs across bank types and whether the competition-stability relationship differs across different types of bank.

Data

Accounts data for all banks operating in Japan for the period 2000 to 2009 were obtained from the Bankscope database compiled by Bureau Van Dijk.[13] This represents the period after the banking crisis and long lasting economic recession in the 1990s. The final sample is an unbalanced panel with 4,806 bank-year observations on 732 banks.

[12] Hence for each of the observation four of the interaction terms equal to zero.
[13] Banks reporting extreme values of bank-specific variables (smaller than the 1st percentile or larger than the 99th percentile) are winsorized.

Figure 1 traces the evolution of bank stability (measured by the Z-index). The stability of the Japanese banking system improved over the period from 2000 to 2006. This was reversed in 2007 to 2008, before starting to improve again in 2009. This pattern reflects the financial conditions over the sample period. By bank type, Shinkin and Regional banks exhibit the highest stability, while City banks show the least stability over the entire sample period.

Table 1 presents variable definitions and descriptive statistics for the sample of banks. Table 2 presents the descriptive statistics for each type of bank in the sample. [14]As illustrated previously (in Figure 1 above), Shinkin and Regional banks show the highest stability, with Z-indices of 112.15 and 92.94, respectively. Tier 2 Regional banks and Credit Cooperatives report similar levels of soundness (with Z-index values of 73.56 and 75.04 respectively)**.** The Z-index of Trust banks is 69.40, which is higher than City banks (20.35). Of the other covariates, City banks are the largest, while Credit Cooperatives are the smallest in size. On average, both Regional banks and Tier 2 Regional Banks are larger in size than Shinkin and Credit Cooperative Banks.

Both Trust and City banks are well diversified (measured by the proportion of non-interest income to total operating income). As previously noted, banks with a regional focus are limited in carrying out non-traditional banking businesses. Both Regional and Tier 2 Regional banks are heavily involved with lending (with loans-to-assets ratios of 65.33% and 69.84%, respectively). For the overall banking system, loans account on average for less than 54% of bank assets

The average cost to income ratio for the Japanese banking system is 68.54% (with City banks being the most cost efficient). With regard to market power

[14] Please note that the reported average values are slightly different in the two tables, This is because the values reported in Table 1 is the mean value across the whole sample, while in Table 2, we average values for each bank type first and then calculate the mean value of the average values for different groups.

(measured by the Lerner index), trust banks have the highest market power, followed by city banks. Banks with a regional focus report comparatively lower market power, indicative of the comparatively higher levels of competition in their respective markets.

Differences of Stability across Bank Types

Table 3 reports estimation results of Equation (1). We estimate seven regressions in order to assess the stability across different bank types. In the first specification (or base line estimation), we include bank-specific indicators only. In the second specification, we add competition measures (which include the Lerner index and the squared Lerner index), and the inflation ratio to control for changes in the competition and macroeconomic environment. The third specification includes a set of bank-type dummy variables to assess the extent to which other bank types are safer or not than City banks. In the fourth specification, we exclude City banks from the sample to test whether the other bank types are safer than Trust banks. Sequentially, in the fifth to seventh specifications, we further exclude Trust, Regional and Tier 2 Regional banks from the sample to test whether the rest bank types are safer than Regional, Tier 2 Regional and Shinkin banks, respectively.

The relationship between Lerner index and the Z-index is positive and significant across all regressions, while the squared Lerner index enters the regression significantly and negatively. This result indicates a U-shaped relationship between competition and bank stability. However, we find that most inflection points[15] are above the maximum value of the Lerner index (43.28), indicating an effective linear

[15] The inflection point is calculated for every specification by setting the first-order derivative to zero and comparing its value to the empirical distribution of the Lerner index data.

relationship between Lerner index and stability.[16] This pattern is consistent with 'competition-fragility' hypothesis, indicating that higher competition (or lower Lerner Index) induce intensive risk taking behaviour, which leads to lower bank stability.

In column (4), the coefficients on all the bank dummies (with the exception of Trust banks) are positive and significant, indicating that Regional, Tier 2 Regional, Shinkin and Credit Cooperative banks are more stable than City banks. These findings is further strengthened in column (5) when comparing all other banks with Trust banks. Again, there is strong evidence to suggest that Regional, Tier 2 Regional, Shinkin are more stable than Trust banks. From column (6) to (8), we find no significant differences in stability between Regional banks, Tier 2 Regional and Shinkin banks. However, Credit Cooperatives are found to be less stable than Shinkin banks (with significant and negative signs on the dummy coefficients). These banks have a very narrow geographic and customer focus and so are more exposed to changes in supply and demand conditions in deposit and loan markets.

We now briefly discuss the other covariates. Larger banks appear to be more stable than their smaller counterparts. Diversified banks tend to be less stable than their focused counterparts. The loan-to-assets ratio is negatively related to the Z-index, indicating that a high proportion of loans to total assets may reduce bank stability. The cost-income ratio is negatively related to the Z-index, implying that inefficient banks tend to be less stable. Inflation is has a negative impact on bank stability. This indicates that inefficient macroeconomic management may adversely impact on bank stability.

We also run a number of additional tests to check the extent to which our empirical findings are robust.[17] First, we use the Herfindahl Index (the sum of the

[16] The exception is in column (2) in which the reflection point is 41.37.

square of the share of each bank's assets over the total assets of the banking system) as an alternative competition measure, to investigate the impact of possible differences in the sources of market power. The principal results are unaffected. Second, the results are also unaffected when using a 4-year rather than a 3-year rolling window to calculate the Z-index. Finally, we exclude Shinkin and Credit Cooperative banks from the sample to test whether the results are biased or not by the dominant presence of these banks in our sample (4,404 observations out of 5,740 from the whole sample). The main results hold in that there is a positive relationship between Lerner index and bank stability, and Trust, Regional and Tier 2 Regional banks appear more stable than City banks.

Competition and stability relationship by bank types

In this section, we augment the analysis presented above by examining whether the relation between competition and stability varies across bank types and whether this variation, if any, can be explained by the levels of bank stability.

Table 4 presents the results of three regressions that test the direct and interactive associations among bank stability and competition. In the first specification, we test the hypothesis that banks with different stability respond differently to the changes in competition. The results show that when including this interaction term between stability and competition (L.lnZ*L.Lerner), the direct impact of competition on bank stability turns significantly positive (negative sign for L.Lerner).[18] Hence, increased competition drives down bank average loan rates and make the borrowers less prone to default, and consequently help to stabilize banks. The results, however, also suggest that the stabilizing effects of the intensified

[17] These results are not reported but available from the authors upon request.
[18] Recall in Table 3, we find negative relationship between bank competition and stability without considering the impact of the variations of bank stability level on the competition-stability relationship.

competition diminish when the bank has a higher level of stability (the interaction term enters positively and significantly in Regression 1). When facing increasing competition, banks' risk taking behavior will depend on their initial level of stability. Banks with higher stability have more room for risky investments and tend to feel confident to their stability levels. Hence, they concern their competitiveness and profitability more than their stability. Consequently, they are more likely to take more risks to a competition increase. For those banks that reach sufficiently high stability levels in the previous year, the increased competition may reduce overall bank stability in the following year. Hence, ignoring the interactions between bank stability level and competition leads to an incorrect inference about the competition-stability relationship.

In the second regression, the coefficients for the interaction of stability quintile dummy and Lerner index have opposite signs for different stability quintiles. For the lowest stability quintiles, we find that Lerner index has significant negative impact on bank stability, which indicates a positive relationship between competition and stability. For the highest three stability quintiles, the opposite is true that significant negative relationship between competition and stability is found. These results again support our findings in the first regression that banks with high stability tend to have negative competition-stability relationship, while banks with low stability are more likely to have positive competition-stability relationship. Banks in the second lowest quintile appear to take on a moderate level of risks to balance the tradeoff between return enhancement and stability when facing increased competition, hence the competition is found to have insignificant impact on bank stability.

Finally, we consider whether the competition-stability relationship differs across bank types and whether these differences, if any, can be explained by their

different stability levels. As reported in the third regression, the coefficients of the City bank-Lerner interaction is negative, while the coefficients of the interactions for Regional, Tier 2 Regional, Shinkin and Credit Cooperative banks are all positive and significant (indicating a negative relationship between bank competition and stability). These results strongly support our hypothesis that competition impacts on stability differently across bank types. As we find in Step One of our analysis, Regional, tier 2 Regional, Shinkin and Credit Cooperative banks exhibit higher stability than City banks and tend to respond to the increasing competition by taking on more risks (to enhance returns). City banks exhibit the least stability, tend to concern their fragile position and to protect their franchise value more than profitability enhancement, and hence are more likely to avoid increasing in risky projects investments when facing an increasing competition condition. The stability of Trust banks lies between City banks and the other bank types and their moderate risk taking behavior leads to no significant impact of bank competition on stability.

While we also accept that such a differential impact of competition on stability across different bank types may arise from differences other than the stability level itself, (for example, ownership structure, business strategy and regulatory treatment across bank types),[19] we believe the results of our empirical analysis suggests bank stability levels can largely explain the variations of competition-stability relationship across bank types.

[19] In an analysis of US banking, DeYoung et al (2004) argue that small and large banks pursue different business strategies within the broader banking industry. Small banks operate in local or regional markets and develop close relationships with their customers to make relationship loans (to small and medium sized businesses). From such activities, these banks can charge high interest margins, which lead to high profitability. By contrast, large banks utilise advantages afforded by economies of scale in loan production, marketing and servicing to offer transaction loans (such as credit cards and mortgages). The low production, marketing and servicing costs of such activities feed through to high profitability.

VI. Summary

The extent to which competition enhances or reduces the stability of banks is of crucial importance in ensuring intermediation is undertaken in an efficient manner, benefiting the both the financial system as well as the real economy. Previous research has provided extensive evidence of a link between competition and stability, but for most part fails to account for possible differences in such a relationship across different types of bank. The segmented nature of the Japanese banking system provides us an ideal testing ground to examine two interrelated questions: whether bank stability differs across bank types (City, Trust, Regional, Tier 2 Regional, Shinkin and Credit Cooperatives) and whether the competition-stability relationship varies across the aforementioned types of bank.

The empirical analysis (using data from the Japanese banking industry for the period 2000-2009) provides results which suggest that Regional, Tier 2 Regional, Shinkin and Credit Cooperative banks (which tend to have a narrow geographic focus) are more stable than City and Trust banks (which have a nationwide coverage). Furthermore, we find that the relationship between competition and stability varies by bank type and these variations can largely be explained by the impact of bank stability itself. Banks with higher levels of stability (i.e., Regional, Tier 2 Regional, Shinkin and Credit Cooperative banks) tend to take on more risks when facing an increasing competition (which leads to an overall negative relationship between bank competition and stability). Those banks with lower stability (i.e., City banks) are more likely to avoid increasing risk so as to protect their franchise value when competition increases (which leads to an overall positive relationship between competition and stability). Trust banks exhibit a moderate level of stability and take on moderate risks when competition intensifies and hence results in no clear relationship between

competition and stability. Overall, the results provide evidence of variation in the competition-stability relation across different bank types.

Our results have implications for policy makers charged with maintaining the safety and soundness of the banking system in the aftermath of the banking crisis in Japan of the 1990s, since they suggest that banks with a regional focus are more stable than their nationwide banks. Our results on the varying relationships between competition and stability for different bank types also suggests that policy makers should encourage competition between nationwide banks, while limiting the extent to which other banks compete.

References

Allen, F., and Gale, D., (2000). *Comparing Financial Systems*. Cambridge, MA: MIT Press.

Allen, F., and Gale, D., (2004). Competition and financial stability. *Journal of Money, Credit, and Banking* 36, 433-80.

Agoraki, M.E., Delis, M.D. and Pasiouas, F., (2009). Regulations, competition and bank risk-taking in transition countries', *MPRA Paper* 16495.

Arellano, M. and Bover, O., (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics* 68, 29-51.

Beck, T., Hesse, H., Kick, T. and Von Westernhagen, N., (2009). Bank ownership and stability: evidence from Germany. *Bundesbank Working Paper Series*.

Beck, T., Coyle, D, Dewatripont,M, Freixas, X and Seabright P., (2010a) *Bailing Out the Banks: Reconciling Stability and Competition*. London: CEPR.

Beck, T., DeJonghe, O. and Schepens, G., (2010b) Bank competition and stability: reconciling conflicting empirical evidence, mimeo.

Berger, A.N., (1995) The profit-structure relationship in banking – tests of market-power and efficient-structure hypotheses. *Journal of Money, Credit, and Banking, 27*, 404-415.

Berger, A.N., Klapper, L.F., Turk-Ariss, R. (2009). Bank competition and financial stability. *Journal of Financial Services Research* 35, 99-118.

Berger, A.N., Demerguc-Kunt, A., Levine, R., Haubrich, J.C., (2004). Bank concentration and competition. *Journal of Money, Credit and Banking* 36, 433-451.

Blundell, R and Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics* 87, 115-143.

Boyd, J.H., and DeNicoló, G. (2005). The theory of bank risk-taking and

competition revisited. *Journal of Finance*, 60, 1329-343.

Boyd, J., DeNicolo, G., Jalal, A.M., (2006). Bank risk taking and competition revisited: new theory and evidence. *IMF Working paper* 06/29.

Buch, C.M., Eickmeier, S. and Prieto, E. (2010) Macroeconomic factors and micro-level bank risk, *Deutsche Bundesbank Discussion Paper*, Number 20/2010.

Carletti, E. (2008). Competition and regulation in banking, in: Boot, A., Thakor, A. (eds.) *Handbook of Financial Intermediation and Banking*. Amsterdam: Elsevier.

Casu B., Girardone, C., (2009). Testing the relationship between competition and efficiency in banking: a panel data analysis. *Economics Letters* 105, 134-137.

Casu, B., Girardone, C. and Molyneux, P. (2006). *Introduction to Banking*. Harlow: FT Prentice Hall.

Claessens, S. (2009) Competition in the financial sector: overview of competition policies, *IMF Working Paper*, 09/45.

Deelchand, T. and Padgett, C. (2009) The Relationship between Risk, Capital and Efficiency: Evidence from Japanese Cooperative Banks, *ICMA Centre Discussion Paper*, DP 2009-12.

Degryse, H. and Ongena, S. (2008) Competition and regulation in the banking sector: a review of the empirical evidence on the sources of bank rents, in A. Boot and A. Thakor (eds.), *Handbook of Financial Intermediation and Banking*. Amsterdam: Elsevier.

Delgado, J., Salas, V., Saurina, J., (2007). Joint size and ownership specialization in bank lending. *Journal of Banking & Finance* 31, 3563-3583

De Nicolò, G., and Loukoianova, E. (2007). Bank ownership, market structure and risk *IMF Working Paper* 07/215

Demirguc-Kunt, A., and Detragiache, E. (1998). The determinants of banking crises in developing and developed countries. *IMF Staff Papers,* 45, 81-109.

Demirguc-Kunt, A. and Huizinga, H., (2010). Bank activity and funding strategies: the impact on risk and returns. *Journal of Financial Economics*, 98, 626-650.

DeYoung, R., Hunter, W.C. and Udell, G.F. (2004) The past, present, and probable future for community banks, *Journal of Financial Services Research*, 25, 85–133.

Dick, A.A. and Hannan, T.H. (2010) Competition and antitrust in banking, in Berger, A.N., Molyneux, P. and Wilson, J.O.S. (eds.) *Oxford Handbook of Banking.* (Oxford: Oxford University Press), 405-429.

Fonteyne, W. (2007). Cooperative banks in Europe: policy issues. *IMF Working Paper* Number 159.

Goddard, J., McKillop, D. and Wilson, J.O.S. (2010). Prompt corrective action and the capitalization of US Credit Unions, available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1531570.

Fukuyama, H., Guerra, R., and Weber, W.L., (1999). Efficiency and ownership: evidence from Japanese Credit Cooperatives. *Journal of Economics and Business*, 51, 473-487.

Hansen, L.P., (1982), Large sample properties of generalized method of moments estimators, *Econometrica* 50, 1029-1054

Hosono, K., Sakai, K. and Tsuru, K. (2006). Consolidation of cooperative banks (Shinkin) in Japan: motives and consequences, Discussion papers, Research Institute of Economy, Trade and Industry (RIETI).

Hower, D. (2009) From soft and hard nosed bankers: bank lending strategies and the survival of financially distressed firms, *ZEW Centre for European Economic Research Discussion Paper*, Number 09-059.

Hattori, M., Ide, J., and Miyake, Y. (2007). Bank profits in Japan from the perspective of ROE analysis. *Bank of Japan Review*, March 1-7.

Jiménez, G., Lopez, J. and Saurina, J. (2010). How does competition impact on bank risk taking? *Banco De Espana Working Paper* 1005.

Jones, R.S., and Tsutsumi, M. (2009). Financial stability: overcoming the crisis and improving the efficiency of the banking sector. *OECD Economics Department Working Papers*, No.738.

Kano, M. and Tsutsui, Y. (2003) Geographical segmentation in Japanese bank loan markets. *Regional Science and Urban Economics* 33, 157-174.

Kashyap, A. (2002). Sorting out Japan's financial crisis. *Federal Reserve Bank of Chicago Economic Perspectives* 26, 42-55.

Keeley, M.C., (1990). Deposit insurance, risk, and market power in banking, *American Economic Review* 80, 1183-1200

Laeven, L., Levine, R., (2007). Is there a diversification discount in financial conglomerates? *Journal of Financial Economics* 85, 331-367.

Lepetit, L., Nys, E., Rous, P., Tarazi, A., (2008). Bank income structure and risk: an empirical analysis of European banks. *Journal of Banking and Finance* 32, 1452-1467.

Lerner, A. P. (1934) The concept of monopoly and the measurement of monopoly power, *Review of Economic Studies*, 1, 157—175

Liu, H., and Wilson, J.O.S. (2010). The profitability of banks in Japan: the road to recovery? *Applied Financial Economics*, 20, 1851-1866.

Liu, H., Molyneux, P., and Wilson, J.O.S. (2010). Competition and stability in European banking: A regional analysis, *Istituto Luigi Einaudi per gli Studi Bancari Finanziari e Assicurativi (IstEin), Working Paper* Number 9.

Loukoianova, E. (2008). Analysis of the efficiency and profitability of the Japanese banking. *IMF Working Paper* 08/63.

Lown, C. and Morgan, D.P. (2006). The credit cycle and the business cycle: new findings using the loan officer opinion survey, *Journal of Money, Credit and Banking*, 38, 1575-1597.

Martinez-Miera, D., and Repullo, R. (2010). Does competition reduce the risk of bank failure? *Review of Financial Studies* 23 (10), 3638-3664

Mercieca, S., Schaeck, K., and Wolfe, S., (2007). Small European banks: benefits from diversification? *Journal of Banking and Finance* 31, 1975-1998.

Northcott, C.A., (2004), Competition in banking: A review of the literature, *Bank of Canada, Working Pape*r, No 2004-24

O'Hara, M., and Shaw, W. (1990). Deposit insurance and wealth effects: The benefit of being too big to fail. *Journal of Finance* 45, 1587-1600.

Rey, P. and Tirole, J. (2007) Financing and access in cooperatives, *International Journal of Industrial Organization*, 25, 1061-1088.

Stiroh, K.J. (2004). Diversification in banking: Is noninterest income the answer? *Journal of Money, Credit, and Banking* 36, 853-882.

Turk-Ariss, R., (2010). On the implications of market power in banking: evidence from developing countries. *Journal of Banking & Finance*, 34, 765-775.

Uchida, H. and Udell, G. (2010). Banking in Japan. Berger, A.N., Molyneux, P. and Wilson, J.O.S. (eds.) *Oxford Handbook of Banking*. Oxford: Oxford University Press.

Watanabe, W., (2010). Does a large loss of bank capital cause Evergreening? Evidence from Japan. *Journal of the Japanese and International Economies* 24, 116-136.

Vives, X (2010) Competition and stability in banking. *IESE Business School Working Paper* Number 852.

Zhao, T., Casu, B., Ferrari, A., (2009). Competition and risk taking incentives in the lending market: an application to Indian banking. *Centre for Banking Research Working Papers*, WP-CBR-02-2009, Cass Business School, City University London.

Zhao, T., Casu B., Ferrari, A., (2010). The impact of regulatory reforms on cost structure, ownership and competition in Indian banking. *Journal of Banking & Finance*, 34, 246-254.

Table 1 Variable Definitions and Summary Statistics

Variable	Definitions	N. Obs.	Mean	St.dev
Z	A measure of how many standard deviations a bank is away from exhausting its capital base. A higher value indicates a higher overall bank stability. It is calculated at the 3-year rolling time window.	4806	94.42	177.55
lnTA	The logarithm of bank's total assets.	5740	11.73	2.36
DIV	The ratio of non-interest income over total operating income.	5707	17.88	16.62
LA	The ratio of total loans over total assets.	5702	53.80	13.97
CI	the cost to income ratio (overheads as a proportion of operating profits before provisions)	5660	74.54	15.29
Lerner	Lerner index, as a measure of bank competition. The Lerner index measures the mark-up of price over marginal costs and is therefore an indicator of the degree of market power. The higher the value, the lower the bank competition the bank faces.	856	17.14	8.50
INF	Inflation ratio, calculated as the percentage change of GDP deflator	10	-1.23	0.34
Trust	Dummy variable for Trust bank	153		
Regional	Dummy variable for Regional bank	645		
Tier 2 Regional	Dummy variable for tier 2 Regional bank	521		
Shinkin	Dummy variable for Shinkin bank	2979		
Credit cooperative	Dummy variable for credit cooperative bank	1854		

Source: Bank-level data is from Bankscope, while Inflation is from World Bank Development Indicators.

Table 2 Descriptive statistics (by bank type)

Institution	Obs.	Z	lnTA	DIV	LA	CI	Lerner
City	62	20.35	16.69	46.29	54.06	50.66	22.40
Trust	138	69.40	12.38	78.25	33.08	68.17	32.59
Regional	641	92.94	13.44	23.06	65.33	68.82	20.49
Tier 2 Regional	495	73.56	12.51	18.12	69.84	71.34	15.65
Shinkin	2755	112.15	11.62	15.67	51.85	76.72	15.20
Credit cooperative	1649	75.04	10.76	13.37	49.04	75.53	18.60
Total	5740	73.91	12.90	32.46	53.87	68.54	20.82

Notes: The classification of banks follows that used by Japanese Bankers' Association. City denotes City banks. Trust denotes Trust banks. Regional denotes Regional banks. Tier 2 Regional denotes Member Banks of the Second Association of Regional Banks. Shinkin denotes Shinkin banks. Credit cooperative denotes Credit cooperative banks.

Table 3 Differences of bank stabilities across bank types

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L.lnZ	0.099	0.083	0.261	0.214	0.097	0.208**	0.269**
	(0.270)	(0.353)	(0.225)	(0.308)	(0.271)	(0.029)	(0.013)
L.lnTA	0.138***	0.125***	0.061*	0.062*	0.081**	0.091**	0.088**
	(0.000)	(0.000)	(0.051)	(0.064)	(0.049)	(0.025)	(0.023)
L.DIV	-0.012***	-0.015***	-0.007**	-0.008**	-0.008**	-0.011***	-0.012***
	(0.000)	(0.000)	(0.017)	(0.012)	(0.017)	(0.007)	(0.003)
L.LA	-0.028***	-0.024***	-0.017***	-0.017***	-0.019***	-0.016***	-0.015***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
L.CI	-0.014***	-0.008***	-0.004	-0.005	-0.007***	-0.006**	-0.005*
	(0.000)	(0.003)	(0.185)	(0.158)	(0.005)	(0.024)	(0.082)
L.Lerner		0.085***	0.061***	0.066***	0.074***	0.067***	0.062***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L.Lerner2		-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.000***
		(0.000)	(0.006)	(0.008)	(0.003)	(0.006)	(0.007)
L.INF		-10.042***	-10.028***	-9.185***	-9.282***	-9.943***	-3.031***
		(0.000)	(0.001)	(0.003)	(0.005)	(0.003)	(0.000)
Trust			0.211				
			(0.654)				
Regional			1.103**	0.961**			
			(0.015)	(0.035)			
Tier 2 Regional			1.029**	0.885*	-0.048		
			(0.023)	(0.054)	(0.766)		
Shinkin			1.213**	1.084**	0.218	0.246*	
			(0.013)	(0.034)	(0.156)	(0.095)	
Credit Cooperative			0.775*	0.604	-0.316	-0.204	-0.409***
			(0.077)	(0.129)	(0.107)	(0.218)	(0.000)
Const.	4.874***	-5.200**	-6.745**	-5.809*	-4.588	-5.694*	-0.558
	(0.000)	(0.011)	(0.031)	(0.053)	(0.135)	(0.051)	(0.457)
N	3986	3932	3932	3918	3871	3385	3025
hansenp	0.15	0.07	0.28	0.22	0.06	0.17	0.16
ar2	0.85	0.86	0.21	0.36	0.86	0.19	0.11
reflection	0.00	41.37	61.20	61.89	61.17	63.60	68.62

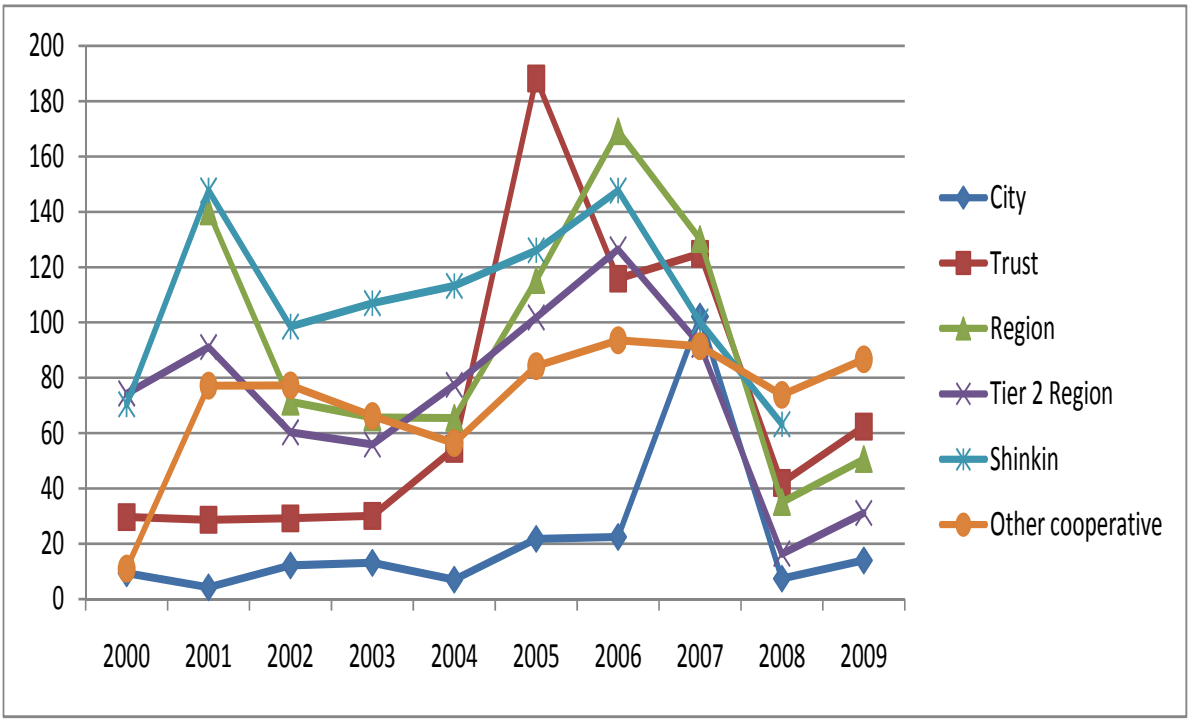
Note: The table presents regression results of bank stability on competition, including bank type dummy variables. The sample consists of 732 banks from Japan over the period 2000-2009. The dependent variable is the logarithm of 3-year rolling Z-index. All explanatory variables except the dummy variables are lagged with one year period to address the potential endogeneity problem. System GMM estimator with Windmeijer correction is used for all regressions. 'Hansenp' is the p-value of the Hansen test statistic of over-identifying restrictions, while AR(2) is the p-value of the second order autocorrelation test statistic. "Reflection' represents the reflection point where the U-shaped competition-stability relationship starts to reverse. P-values of the estimated coefficients are reported in brackets. Year dummies from 2001 through 2009 are included in the model but not reported in the table. *, **, and *** represent 10, 5 and 1 percent significance level, respectively. For more detailed variable definitions, please see Table 1 and 2.

Table 4 The competition-stability relationships across bank types

	(1)		(2)		(3)	
L.lnZrolling	-0.417*	(0.097)	-0.311	(0.337)	0.104	(0.238)
L.lnTA	0.153***	(0.000)	0.131***	(0.000)	0.060	(0.115)
L.DIV	-0.008**	(0.044)	-0.006*	(0.099)	-0.006*	(0.054)
L.LA	-0.019***	(0.000)	-0.015***	(0.000)	-0.018***	(0.000)
L.CI	-0.001	(0.756)	-0.002	(0.313)	-0.006***	(0.010)
L.INF	-14.588***	(0.000)	-15.034***	(0.000)	-8.477***	(0.004)
L.Lerner	-0.122***	(0.003)				
L.lnZ * L.Lerner	0.033***	(0.002)				
Quint1*L.Lerner			-0.082*	(0.079)		
Quint2*L.Lerner			-0.013	(0.522)		
Quint3*L.Lerner			0.036***	(0.000)		
Quint4*L.Lerner			0.062***	(0.000)		
Quint5*L.Lerner			0.082***	(0.002)		
City * L.Lerner					-0.017**	(0.015)
Trust * L.Lerner					0.017	(0.112)
Regional * L.Lerner					0.056***	(0.000)
Tier 2 regional * L.Lerner					0.056***	(0.000)
Shinkin * L.Lerner					0.070***	(0.000)
Credit cooperative * L.Lerner					0.034***	(0.000)
Const.	-6.960***	(0.007)	-8.159***	(0.000)	-3.801	(0.164)
N	3932		3932		3932	
hansenp	0.13		0.1		0.06	
ar2	0.18		0.96		0.92	

Note: The table presents regression results of how bank competition-stability relationship varies according to bank's stability levels, including interactions between bank stability level and competition variables. The sample consists of 732 banks from Japan over the period 2000-2009. The dependent variable is the logarithm of 3-year rolling Z-index. All explanatory variables are lagged with one year period to address the potential endogenity problem. "Quint 1 to 5 " indicates five quintile dummy variables for the bank's previous year's stability level. System GMM estimator with Windmeijer correction is used for all regressions. 'Hansenp' is the p-value of the Hansen test statistic of over-identifying restrictions, while AR(2) is the p-value of the second order autocorrelation test statistic. "Reflection' represents the reflection point where the U-shaped competition-stability relationship starts to reverse. P-values of the estimated coefficients are reported in brackets. Year dummies from 2001 through 2009 are included in the model but not reported in the table. *, **, and *** represent 10, 5 and 1 percent significance level, respectively. For more detailed variable definitions, please see Table 1 and 2.

Figure 1 Evolution of bank stability in Japan, 2000-2009: by bank type



Note: Authors' calculations.

Appendix: Estimation of Lerner index.

We use the Lerner index as our measure for market competition (Lerner, 1934). The Lerner index measures the mark-up of price over marginal costs and is therefore an indicator of the degree of market power. It is calculated as:

$$Lerner_{it} = (P_{it} - MC_{it}) / P_{it} \tag{A1}$$

Where P_{it} is the price of total assets (proxied by the ratio of total revenues to total assets for bank i at time t), MC_{it} is the marginal cost of bank i at time t. This is derived from a translog cost function as follows:

$$\ln Cost_{it} = \beta_0 + \beta_1 \ln Q + \frac{\beta_2}{2} \ln^2 Q + \sum_{k=1}^{2} \gamma_k \ln W_k + \sum_{k=1}^{2} \phi_k \ln Q \ln W_k + \sum_{k=1}^{2} \sum_{j=1}^{2} \ln W_k \ln W_j + \delta_1 Trend + \delta_2 Trend^2 + \delta_3 Trend \times \ln Q + \sum_{k=1}^{2} \lambda_k Trend \times \ln W_k + \varepsilon \tag{A2}$$

Where Cost represents total bank cost, calculated as total expenses over total assets; Q represents a proxy for bank output or total assets. W_1, W_2 and W_3 represent three input prices of funding, fixed capital and labour, respectively, and are calculated as the ratios of interest expenses to total deposits, other operating and administrative expenses to total assets and personnel expenses to total assets, respectively. $Trend$ represents yearly fixed effects to capture technical changes in the cost function over time.

Following Turk-Ariss (2010), we scale cost and input prices by W_3 to correct for heteroscedasticity and scale biases. Equation (A2) is estimated separately for each country. Finally marginal costs (MC) are then computed as:

$$MC = \frac{Cost}{Q} [\beta_1 + \beta_2 \ln Q + \sum_{k=1}^{2} \phi_k \ln W_k + \delta_3 Trend] \tag{A3}$$