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JEL Classification: D22, G21, L13

Keywords: bank capital, Credit market competition, Risk Taking, fragility, stability

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Credit Market Competition and Bank Capitalization*

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September 20, 2021

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We document that within regional U.S. mortgage markets an increase in competition exerts differential effects on banks with large and small market shares. Large market share banks reduce capitalization and increase risk taking as a response to an increase in the intensity of competition, while small market share banks enhance capitalization and reduce risk taking. These results are tied to market shares and not driven by bank size or the level of concentration within local regional markets.

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1 Introduction

The nature and riskiness of lending decisively depend on the intensity of competition in credit markets. While lending relationships thrive in imperfectly competitive markets that allow to generate positive rents, intense competition reduces lending to arm's-length transactional lending with reduced monitoring (see, e.g., Petersen and Rajan, 1995; Boot and Thakor, 2002). Relationships can effectively exploit soft information while transactional lending focuses on hard information only. Typically, the overall effect of increased competition on the riskiness of lending is ambiguous and depends on the relative importance of different sources of information. Moreover, empirical evidence reveals that banks with larger market shares behave differently from small market share banks. For example, large market share banks are more willing to provide liquidity support to their customers in periods of distress (see, e.g., Giannetti and Saidi, 2019). But how does this heterogeneity in business models affect the impact of increased competition on bank stability?

In this paper, we aim to provide empirical answers to this question for the U.S. banking system. We study how the impact of competition on stability changes across banks with different levels of market shares. The main challenge of this exercise is to define an exogenous change in the credit market competition that is not correlated to the bank characteristics in these markets in order to define the causality from changes in market competition to changes in bank stability, e.g., bank capitalization. To address this challenge, following Garmaise and Moskowitz (2006) and Nguyen (2019), we implement an instrumental variable (IV) analysis and use exposure to mergers of large banks as an instrument to measure changes to the intensity of competition at the metropolitan level (MSA-level) that are uncorrelated to local economic trends or the bank characteristics. We find that MSAs where the two merging banks had branches one year before the merger experience a significant decrease in the credit market competition: Exposure to a merger decreases the credit market competition of an MSA by about 0.3 percentage point, which is equivalent to 1% of the standard deviation.[1]

[1]The instrument passes the Kleibergen-Paap weak instruments test with an F statistic of 377.276 which

We then analyse how such changes in competition affect bank stability by studying the impact of increased competition on bank capitalization and risk taking. In our analysis, we differentiate between banks with large and small market shares in order to implicitly control for different business models. We find a surprisingly strong asymmetric reaction to an increase in the intensity of competition: Large market share banks tend to reduce their capitalization after an increase in competition while small market share banks tend to increase their capitalization. According to our results, 1 percentage point increase in the competition decreases the capital ratios of large market share banks by 1.12 percentage points, whereas it increases the capital ratios of small market share banks significantly by about a third of a percentage point. At the same time, large market share banks increase the riskiness of their lending while small market share banks reduce it. We find that a 1 percentage point increase in the credit market competition leads to a significant increase in banks' risk density by 3.2 percentage points for large market share banks and a significant decrease of 1 percentage point for small market share banks. In contrast to earlier work (see, e.g., Petersen and Rajan, 1995), who find asymmetric aggregate behaviour across MSAs, we find these asymmetric reactions across banks within the same MSA (even before aggregation).

Several checks confirm the robustness of our results. First, we repeat our analysis for different thresholds in the definition of large market share banks as top 15 and top 25 in addition to top 20 (our baseline setting). We find similar results for all thresholds where the impact is strongest for top 15 and least strong for top 25 as expected. Second, we show that it is not the size of banks that drive our results by repeating our analysis for large and small banks separately. Third, we divide our sample into high and low concentration markets to show that the difference in the response of large and small market share banks is not driven by the credit market concentration.

Our evidence suggests that large market share banks and small market share banks apply

is much larger than the recommended minimum of 10 to have a strong instrument (Staiger and Stock, 1997). This implies that the mergers of large banks are strong instruments for decreases in the credit market competition.

different technologies for screening and information production. Moreover, large market share banks react to increased competition by slashing margins while small market share banks react by increasing capitalization. We contribute to the large empirical literature that examines the effect of market competition on banks' risk taking. There is so far no consensus whether increased competition would increase or decrease stability in the banking system (see, e.g., Beck et al., 2013). We provide empirical evidence that the impact of increased competition on stability varies across banks with different market shares. We find that an increase in competition leads to less stability for large market share banks by increasing their risk taking and decreasing their capital ratios ("competition-fragility" view). On the other hand, increased competition leads to more stability for small market share banks by decreasing their risk taking and increasing their capitalization ("competition-stability" view).

This paper proceeds as follows. In Section 2, we review the relevant theoretical and empirical literature, and develop our hypotheses. Section 3 introduces the data. Section 4 presents the methodology and main results. In Section 5, we show additional robustness checks. Section 6 concludes.

2 Hypotheses Development and Literature Review

The literature on market competition and banks' risk taking starts with the "charter value" hypothesis of Keeley (1990) (see also, e.g., Allen et al., 2000; Hellmann et al., 2000; Repullo, 2004; Allen and Gale, 2004). This is also known as the "competition-fragility" view that an increase in competition increases banks' risk taking. Keeley (1990) provides both a theoretical framework and an empirical evidence that the deregulation of US banking system, which increased the competition in the banking industry, led to a reduction in banks' market power. This, in turn, increased banks' incentives to take on additional risk by increasing the risk on their assets and decreasing their capital.

Several papers document empirical evidence for the "competition-fragility" view. Dem-

setz et al. (1996) show that banks with high franchise value hold more capital and take on less risk by diversifying their loan portfolios. Gehrig (1996) documents a deterioration of loan monitoring in Switzerland as competition started to heat up in the 1990s. Similarly, Galloway et al. (1997) find that high charter value imposes self discipline on banks and, as a result, high-charter-value banks take on lower risk relative to banks with low charter value. Using the Texas real estate collapse in the 1980s as a natural experiment, Gan (2004) documents that competition reduces franchise value of thrifts and the reduced franchise value increases risk taking. In a cross-country analysis, Beck et al. (2006) show that crises are less likely to occur in countries with more concentrated banking systems. Using data from 23 countries, Berger et al. (2009) find that banks with more market power have less overall risk.

Following the literature, we expect that the "charter value" hypothesis is more likely to hold for banks that enjoy large market shares since they exert more market power. This suggests our first hypothesis.

H1. An increase in competition incentivizes banks with large market shares to decrease their capital and increase their risk taking.

An opposing hypothesis is developed by Boyd and De Nicolo (2005), which is known as the "competition-stability" view that an increase in competition leads to a decrease in banks' risk taking. Boyd and De Nicolo (2005) show that an increase in competition decreases the interest rates charged on loans and this alleviates moral hazard problem of borrowers to move into riskier projects. In addition, it also decreases the adverse selection problem since higher rates might attract high risk borrowers. As a result, banks' risk taking decreases with an increase in competition.[2]

The "competition-stability" view is documented in several empirical papers. Nicoló et al.

[2]In addition, Martinez-Miera and Repullo (2010) show that the relationship between competition and risk taking depends on the level of market competition and demonstrate a U-shape relationship between competition and the risk of bank failure in their model. Jiménez et al. (2013) provide empirical evidence on the U-shape relationship for the Spanish banking system.

(2004) find evidence that highly concentrated financial systems exhibit higher systemic risk than less concentrated systems. Barth et al. (2009) show that banking competition decreases lending corruption. Schaeck et al. (2009) document that more competitive banking systems are less prone to systemic crises. Focusing on the US real estate market, Akins et al. (2016) present that greater competition mitigates the boom and bust cycle in house prices and, thus, leads to financial stability.[3]

In a following theoretical paper, Allen et al. (2011) study the relationship between credit market competition and bank capitalization. In their model, loan rates and bank capital can be used as substitutes to incentivize a bank to monitor its borrowers. In line with the "competition-stability" view, they find that an increase in credit market competition decreases loan rates and this leads to an increase in banks' capital ratios so that banks can commit to continue their monitoring activities. Using data from 10 European countries, Schaeck and Cihak (2012) find empirical evidence supporting this theory that competition increases banks' capital holdings. Similarly, Berger et al. (2009) show that banks in competitive markets hold more capital.

Banks with large market shares charge higher loan rates on their borrowers (see, e.g., De Jonghe et al., 2020). This already incentivizes them to efficiently monitor their borrowers. In addition, as banks with large market shares are more exposed to their markets, they have incentives to protect these markets (see, e.g., Giannetti and Saidi, 2019; De Jonghe et al., 2020). As a result, they are more likely to engage in stringent monitoring which would increase the performance of their borrowers in these markets. We thus expect that only small market share banks would use capital as a commitment device to signal that they continue monitoring their borrowers and this would decrease their risk taking as they have more skin in the game, which is consistent with the "competition-stability" view. This implies our second hypothesis.

[3]Akins et al. (2016) additionally show that greater competition decreases banks' capital holdings which supports the "competition-fragility" view.

H2. Banks with small market shares increase their capital ratios and decrease their risk taking with an increase in competition.

Following the first two hypotheses, banks with larger market shares are expected to have lower capital ratios and higher risk in competitive markets. On the other hand, we expect that larger market share banks would have higher capital ratios and take lower risk in concentrated markets. This leads us to our third hypothesis.

H3. Banks with larger market shares have lower (higher) capital ratios and take higher (lower) risk in competitive (concentrated) markets.

3 Data

The data on mortgage loan applications and originations come from a comprehensive sample of U.S. mortgage data submitted by regulated financial institutions under the provisions of the Home Mortgage Disclosure Act (HMDA). HMDA is the largest source of U.S. mortgage originations and covers most of the mortgage activity of commercial banks, thrifts, credit unions and mortgage companies with a branch in a Core Based Statistical Area (Metropolitan or Micropolitan Statistical Area) (see, e.g., Mian and Sufi, 2009; Loutskina and Strahan, 2011; Avery et al., 2012; Favara and Imbs, 2015; Gilje et al., 2016; Favara and Giannetti, 2017; Dursun-de Neef, 2020).[4] We focus on the mortgages issued by commercial banks in the Metropolitan Statistical Areas (MSAs) for ten years starting from 2001 until 2010.

The loan-level HMDA data are aggregated at the MSA level for each commercial bank in each year and collected through SNL Financial, part of S&P Global Market Intelligence.

[4]Each Metropolitan Statistical Area must have at least one urbanized area with at least 50,000 inhabitants and Micropolitan Statistical Area must have at least one urban cluster with a population between 10,000 and 50,000.

Following Garmaise and Moskowitz (2006), the credit market concentration in an MSA is calculated as the Herfindahl index by taking the sum of squared market shares of all banks in that MSA:

$$Concentration_{jt} = \sum_{i=1}^{N} MarketShare_{ijt} \times MarketShare_{ijt} \tag{1}$$

for MSA j in year t. $MarketShare_{ijt}$ is the market share of bank i in MSA j and calculated as

$$MarketShare_{ijt} = Loans_{ijt}/Loans_{jt}, \tag{2}$$

where $Loans_{ijt}$ is the volume of loans issued by bank i in MSA j in year t and $Loans_{jt}$ is the total volume of loans issued in MSA j in that year. MSAs with lower (higher) Herfindahl measures are more competitive (concentrated) credit markets (see, e.g., Berger et al., 1998; Garmaise and Moskowitz, 2006). Following Akins et al. (2016), credit market competition, *Competition*, is then obtained by multiplying *Concentration*, as defined in equation 1, by -1. This makes sure that higher values of *Competition* indicate higher credit market competition.

We merge the HMDA data with the data on commercial banks' balance sheets and income statements, which come from year-end Call Reports (Reports of Condition and Income) and are collected through SNL Financial, part of S&P Global Market Intelligence. To exclude outliers, we exclude banks with negative values of total equity, banks that are not active in the loan market with total loans ratio below 5% and the deposit market with deposits ratio below 5%, and very small banks with total assets smaller than $75 million. We then merge the data with the data on MSA level house price indices (HPI), income per capita and population. The HPI data come from the Federal Housing Finance Agency (FHFA), the data on income per capita and population are collected from the Bureau of Economic Analysis. The final unbalanced sample consists of 312,759 bank-MSA-year observations.

Panel (A) of Table 1 reports the summary statistics for mortgage loans. The volume of mortgage loans issued by each bank in each MSA is on average $11.24 million and the volume

of applications is $20.26 million. Danville (IL) has the smallest volume of granted loans with $93.57 million and Riverside-San Bernardino-Ontario (CA) has the largest volume at $93.7 billion. The average market share of banks in each MSA is 0.4%.

As reported in Panel (B) of Table 1, our sample of banks have an average size of $2.6 billion. On average, 68.6% of their assets are loans and 7.3% of their assets are liquid assets as cash and equivalents. Their assets are mostly financed with deposits where the average deposits ratio is 81.8%. They are on average well-capitalized with an average equity ratio of almost 10%. The remaining 8.4% of their assets are financed by non-depository debt. Their return on assets is 0.7% and the interest income ratio for these banks is on average 3.6%. In addition, they have on average 1.2% non-performing loans ratio.

Panel (C) of Table 1 presents the summary statistics at the MSA level. There is significant variation in the market concentration across MSAs. Worcester (MA-CT) is the most competitive MSA with the lowest Herfindahl index of 0.01 whereas Altoona (PA) has the largest concentration with the highest Herfindahl index of 0.65. The average population of MSAs is 463.51 thousand. The smallest population belongs to Carson City (NV) at 53.47 thousand and Houston-The Woodlands-Sugar Land (TX) has the largest population at 5.95 million. On average, MSAs have an average income per capita of $32.47 thousand. Households with lowest average income per capita of $14.82 thousand live in McAllen-Edinburg-Mission (TX) whereas the ones with the highest average income per capita of $103.97 thousand live in Bridgeport-Stamford-Norwalk (CT).

4 Empirical Methods and Results

In this paper, we study the effect of credit market competition on banks' capital ratios. It is challenging to define a causal relationship between credit market competition and bank capitalization since banks choose their credit markets and their capital ratios simultaneously in equilibrium. Their capital ratios might have an impact on the competition they face in the

credit markets, i.e., reverse causality. To address this issue, we implement an instrumental variable (IV) analysis and use exposure to mergers of large banks as an instrument to measure changes in credit market competition that are uncorrelated with local economic trends or the existing banks' financial characteristics. Following Garmaise and Moskowitz (2006) and Nguyen (2019), we focus on only the mergers between large banks, where both buyer and target banks have pre-merger total assets of above $1 billion, to avoid the possibility that local economic conditions might motivate the mergers.[5]

During the time period from 2001 until 2010, there are in total 1910 bank mergers.[6] We can match 1456 of these merging banks to the balance sheet data to calculate the size of these banks. 65 of these mergers are dropped since the merging banks belong to the same parent company. We then keep the mergers where both the buyer and the target banks have pre-merger total assets of above $1 billion. This leaves us with the final sample of 116 mergers.

One merger example in our final sample is the acquisition of Charter One Financial by Royal Bank of Scotland that took place on May 4, 2004. The pre-merger size of the target bank, Charter One Financial, was $42.63 billion and Royal Bank of Scotland had a size of $62.35 billion. Another example is the acquisition of Hudson United Bancorp, with a total size of $9.1 billion, by TD Banknorth that had a size of $28.69 billion, which was agreed on July 11, 2005.

We finally exclude all banks that were either the acquirer or the target in one of the mergers during our sample period so that we can focus on the effect of the change in credit market competition on bank capitalization. This leaves us with an unbalanced final sample of 312,759 bank-MSA-year observations.

[5]The mergers between large banks might be motivated by e.g. expansion into new markets, an increase in market power or cost savings (Nguyen, 2019). They are unlikely to be motivated by changes in the local economic trends (Garmaise and Moskowitz, 2006).

[6]We download the information on the mergers and acquisitions from SNL Financial, part of S&P Global Market Intelligence.

4.1 Bank mergers and credit market competition

We first establish that exposure to bank mergers is a valid instrument for the change in credit market competition in the MSAs where the merging banks have branches before the mergers take place. In order to do that, we estimate the following first-stage regression:

$$Competition_{i,j,t} = \alpha + \beta Merger_{j,t} + \gamma \cdot X_{i,t-1} + \theta \cdot Y_{j,t-1} + \delta_i + \delta_j + \delta_t + \epsilon_{i,j,t}. \quad (3)$$

The dependent variable, $Competition_{i,j,t}$, is the credit market competition that bank i is experiencing in MSA j in year t. Our time period is from 2001 until 2010. $Merger_{j,t}$ is equal to one if two banks that merge in year t have both branches located in MSA j one year before the merger, in year $t-1$, and zero otherwise. The main coefficient of interest is β which captures the effect of a merger on the credit market competition in an MSA where both of the merging banks have branches one year before the merger.

In the regression, we control for bank and MSA characteristics. In the bank controls, $X_{i,t-1}$,we include a set of bank characteristics that proxy the confidential CAMELS supervisory rating, which provides a comprehensive assessment of a bank's overall condition (Lopez, 1999). The acronym CAMELS refers to the six components of a bank's condition: capital adequacy, asset quality, management, earnings, liquidity, and sensitivity to market risk. The following bank characteristics are chosen as proxies for each component: total equity for capital adequacy, loan loss reserves for asset quality, net interest income for management quality, return on assets for earnings, cash for liquidity, and loans divided by deposits for market risk. We additionally include the size of each bank, defined as the logarithm of total assets, as part of the bank controls. In the MSA controls ,$Y_{j,t-1}$, we include MSA characteristics that might be related to the credit market competition: house price index (HPI), income per capita, and population. We further include bank fixed effects, δ_i, MSA fixed effects, δ_j, and year fixed effects, δ_t, to control for unobserved heterogeneity. Finally, all standard errors are clustered at the bank and the MSA level.

Table 2 shows the results. Column (1) includes only the main variable $Merger_{j,t}$. We find a negative and significant effect. This confirms that MSAs where the two merging banks had branches one year before the merger experience a significant decrease in the credit market competition. This implies that mergers increase the credit market concentration which decreases competition in these MSAs. This is consistent with findings of Garmaise and Moskowitz (2006) and Nguyen (2019). Column (2) adds MSA control variables and Column (3) adds further bank control variables. These additional control variables do not change the size or the significance of $Merger_{j,t}$. According to the full specification in Column (3), exposure to a merger decreases the credit market competition of an MSA by about 0.3 percentage point, which is equivalent to 1% of the standard deviation.

4.2 Credit market competition and bank capital

In this section, we analyze whether changing competition in the credit markets would have an impact on banks' capital ratios. As already discussed in section 2, there are two opposing hypotheses on this relationship. The first one is based on the "charter value" hypothesis of Keeley (1990), which is also known as the "competition-fragility" hypothesis. According to the results of Keeley (1990), an increase in competition decreases banks' charter value, which, in turn, incentivizes them to take on additional risk and to decrease their capital. The second one is developed by Boyd and De Nicolo (2005) and called "competition-stability" view. Boyd and De Nicolo (2005) show that an increase in competition decreases the loan rates and this decreases the incentives for borrowers to take on additional risk, and, as a result, the risk taking decreases with an increase in competition. In line with this hypothesis, Allen et al. (2011) show that an increase in credit market competition increases bank capitalization. In their model, loan rates and bank capital are used as substitutes to incentivize banks to monitor their borrowers.

We argue that the first hypothesis, the "competition-fragility" view, applies to banks that have a high charter value with a large market power. This suggests that banks with

large market shares would react to an increase in credit market competition by decreasing their capital ratios. On the other hand, the second hypothesis, "competition-stability" view, is not suitable for banks with large market shares since these banks already charge high loan rates which incentivizes them to monitor their borrowers and they do not need to use capital as a substitute to signal that they would monitor their borrowers. As a result, we expect that banks with small market shares would respond to an increase in competition by increasing their capital ratios.

To analyse these hypotheses empirically, we examine the effect of a change in the credit market concentration on banks' capital ratios by estimating the following second-stage regression equation:

$$Capital\ \ ratio_{i,t} = \alpha + \beta \widehat{Competition}_{i,j,t} + \gamma \cdot X_{i,t-1} + \theta \cdot Y_{j,t-1} + \delta_i + \delta_j + \delta_t + \epsilon_{i,j,t}. \quad (4)$$

The independent variable, $\widehat{Competition}_{i,j,t}$, is the credit market competition that is instrumented by the mergers of large banks as described in Section 4.1. In the second-stage regression, we include the same control variables and fixed effects as in equation 3 and, similarly, all standard errors are clustered at the bank and the MSA level.

The results are reported in Table 3. Column (2) shows the coefficient estimates for all banks. According to our results, an increase in the credit market competition does not have a significant effect on banks' capital ratios. In addition, the reported Kleibergen-Paap test (for weak instruments) F statistic of the first stage regression is 377.276, which is much larger than the recommended minimum of 10 to have a strong instrument (Staiger and Stock, 1997). This implies that bank mergers are strong instruments for changes in the credit market competition of MSAs.

To investigate the two opposing hypotheses, we divide our sample into two with respect to banks' market shares in each MSA. According to the coefficients reported in columns

(3) to (6), we find that the impact becomes significant where the direction of the effect is different for two types of banks. Large market share banks are the banks that have market shares in the top 20% of the distribution and the remaining are defined as the small market share banks (the bottom 80 %). Columns (3) and (5) report the coefficients from the first stage regressions for large and small market share banks respectively. For both types of banks, an increase in mergers significantly decreases the credit market competition where the coefficient is similar to the full sample. In addition, the Kleibergen-Paap test F statistic is large for both subsamples which supports the validity of the instrument. According to our results reported in column (4), large market share banks have a significant decrease in their capital ratios when they experience an increase in the credit market competition: A 1 percentage point increase in the competition decreases their capital ratios by 1.12 percentage points, which is highly significant. On the other hand, as shown in column (6), small market share banks increase their capital ratios significantly by about a third of a percentage point (0.39) when they face a 1 percentage point increase in the credit market competition.

Overall, our results imply that the impact of an increase in the credit market competition on banks' capital ratios depends on their market shares in that market. An increase in the credit market competition leads to lower bank capital ratios for banks with large market shares and to higher capital ratios for banks with small market shares. The findings support our expectations that the "competition-fragility" view would apply to banks with large market shares whereas the "competition-stability" view would apply to small market share banks.

4.3 Credit market competition and bank risk taking

We next analyze whether banks change their risk taking when they experience an increase in the credit market competition. As mentioned in the previous section, we expect that the banks with large market shares would increase their risk taking with an increase in credit market competition since their charter value would decrease supporting the "competition-

fragility" view. On the other hand, banks with small market shares would experience a decrease in their risk taking since the increase in competition would decrease the loan rates and the risk taking by borrowers supporting the "competition-stability" view.

To analyze these hypotheses, we repeat the same regression specification in equation 4 and change the dependent variable to risk density which is defined as the risk-weighted assets divided by total assets following Gambacorta and Shin (2018). The results are reported in Table 4. According to the coefficient reported in column (1), a change in credit market competition does not have a significant effect on banks' risk taking when we do the analysis for all banks. However, when we again divide our sample as large and small market share banks, the picture changes. For banks with large market shares (top 20%), we find that a 1 percentage point increase in the credit market competition leads to a significant increase in banks' risk density by 3.2 percentage points. This suggests that large market share banks increase their risk-weighted assets by 3.2 percentage points of their total assets with a 1 percentage point increase in competition. On the other hand, banks with small market shares (bottom 80%) experience a significant decrease in their risk density by almost 1 percentage point when they face a 1 percentage point increase in the credit market competition. This implies that they decrease their risk-weighted assets by almost 1 percentage point of their total assets.

Overall, combining the results from the last section, we find that, with an increase in credit market competition, banks with large market shares increase their risk density and decrease their capital ratios, which supports the "competition-fragility" hypothesis. Small market share banks, on the other hand, decrease their risk density and increase their capital ratios supporting the "competition-stability" hypothesis.

To sum up, our findings indicate that both hypotheses hold for different types of banks: The "competition-fragility" hypothesis holds for large market share banks whereas the "competition-stability" hypothesis applies to small market share banks.

4.4 Market shares, bank capital and risk taking

Our results imply that large market share banks would hold lower capital ratios if they operate in a competitive market and higher capital ratios in a concentrated market. We next study whether the relationship between market shares and banks' capitalization change with the credit market competition accordingly. We regress banks' capital ratios on their market shares for different levels of credit market competition where we define markets that are in the top 15%, 20% and 25% as competitive markets and concentrated markets are markets with competition levels in the bottom 80% of the distribution. We expect that larger market shares would be associated with lower capital ratios in the competitive markets and with higher capital ratios in the concentrated markets.

Table 5 presents the results. In highly competitive markets (top 15%), a 1 percentage point higher market share is associated with a 0.04 percentage point lower capital ratios, which is highly significant. When we decrease the competition slightly by choosing the top 20%, the relationship is still significant: banks with a 1 percentage point larger market shares hold a 0.02 percentage point lower capital ratios. The relationship stays negative but insignificant when we study markets in the top 25%. This suggests that there is a negative relationship between banks' market shares and their capital ratios if they are located in competitive markets - the stronger the relationship the higher the competition in the market. On the other hand, when we study the same relationship for banks in concentrated markets (bottom 80 %), we find a positive association between banks' market shares and their capital ratios: a 1 percentage point larger market share is related to a 0.01 percentage point increase in banks' capital ratios.

We next study the relationship between market shares and banks' risk taking behavior. In highly competitive markets, banks with large market shares have significantly more risk-weighted assets: A 1 percentage point larger market share is associated with a 0.13 (0.08) percentage point higher risk density in markets with the top 15% (25%) of the competition distribution, where the relationship is highly significant. On the other hand, in concentrated

markets, a 1 percentage point larger market share is linked to lower risk-weighted assets by a 0.01 percentage point of total assets.

Overall, the results suggest that banks with larger market shares choose lower capital ratios and higher risk density in highly competitive markets. In concentrated markets, we have the opposite relationship: larger market share banks select higher capital ratios and lower risk density.

5 Robustness

5.1 Different thresholds

In the main analysis, we divide the sample into two as banks with large market shares (top 20%) and banks with small market shares (bottom 80%). As a robustness check, we next analyze how the results would change if we modify the threshold market shares to the top 25% or the top 15%. We expect that the impact of an increase in market competition on banks' capital ratios would be stronger for banks with a market share in the top 15% and less strong for banks in the top 25% relative to our main findings with the top 20%.

Table 6 presents the results. We find that the impact is largest for the top 15%: A 1 percentage point increase in the credit market competition leads to a significant decrease in bank capital by 2.39 percentage points of their total assets as shown in column (2). On the other hand, as reported in column (8), banks with a market share in the 25% of the distribution decrease their capital by a 0.76 percentage point of their total assets. These findings suggest that the negative impact of credit competition on banks' capital ratios becomes stronger as their market share increases.

In addition, we repeat the same analysis for banks' risk taking by studying their risk density. Columns (3) and (9) show that banks in the top 15% increase their risk-weighted assets significantly by 6.53 percentage points of their total assets whereas the increase is only 1.51 percentage points and insignificant for banks in the top 25%. Similar to the impact

on their capital ratios, the larger the threshold the stronger the positive effect on their risk density.

Overall, we show that if we choose a threshold of 15% instead of 20%, we find that the results are stronger and a threshold of 25% makes the results less strong. This suggests that the impact of competition on banks' capitalization and risk taking is stronger for banks with larger market shares.

5.2 Large versus small banks

One might argue that banks with large market shares are also the larger banks and the size of the banks might be driving our results. To control for this, we have the size of the banks as an additional bank control in our regressions. To study this further, we next investigate whether we find similar results if we repeat our analysis for large versus small banks. To do so, we divide our sample into two as large and small banks where large banks are defined as banks with total assets in the top 20% of the distribution and the rest (bottom 80%) are small banks.

Table 7 show the results. According to the coefficients reported in columns (2) and (3), we find that an increase in the credit market competition does not have a significant effect on large banks' capital ratios or their risk density. This implies that the size of large market share banks does not drive the results.

5.3 High versus low credit market concentration

One might think that large market share banks are located in highly concentrated markets and the level of the credit market concentration might be the driver of our main findings. To investigate this, we divide our sample into two as high versus low market concentration where high market concentration is defined as markets with concentrations in the top 20% of the distribution and the rest is defined as low market concentration.

The results are reported in Table 8. We show that banks located in markets with high

market concentration do not significantly adjust their capital ratios or their risk density as a response to increased credit market competition. This observation suggests that our results are not driven by the behaviour of banks in highly concentrated market.

6 Conclusion

There is a large empirical literature on the effect of competition on bank stability that provides evidence for either one of the two opposing hypotheses: "competition-fragility" and "competition-stability". We contribute to this literature by showing that both hypotheses hold, but for different types of banks. Our analysis provides robust evidence for asymmetric responses to increased competition by banks with large market shares relative to banks with small market shares in regional U.S. mortgage markets. We find that banks with large market shares (top quintile) observe a reduction in their incentives to pledge costly capital as a response to increased competition as higher competition reduces their charter values. For the same reason large market share banks respond to increased competition by tolerating larger risks. This is in line with the "competition-fragility" hypothesis of Keeley (1990). On the other hand, the competitive response of small market share banks (bottom quintiles) is just moving into the opposite direction; they need to commit to client monitoring by pledging larger amounts of costly bank capital and, for that reason, reduce portfolio risk. This response is consistent with the "competition-stability" hypothesis of Boyd and De Nicolo (2005).

These findings have implications for modeling competition in local credit markets. The evidence suggests that local banking markets are highly differentiated and, typically, do not correspond well to industrial structures implied by standard symmetric competition models a la Cournot or Salop.[7] In order to understand competition in local banking markets, the sources and drivers of asymmetry in market shares need to be identified, which is beyond the scope of our analysis.

[7]See also Dick (2007) for evidence on asymmetric market structures in U.S. regional banking markets.

Our findings also have implications for regulatory policy. Not only do we show that the effect of competition on bank stability is ambiguous, but we establish that the destabilizing effect occurs particularly for the top quintile of large market share banks, while the stabilizing effect is concentrated on the lower quintiles of smaller market share banks. A challenging question for supervision is to what extent the high market share banks belong to the group of systemic banks, or at least to the group of banks applying internal credit risk models.[8] We leave this question for future research since it would also affect other credit and funding markets well beyond mortgage markets.

[8]In this sense Gehrig and Iannino (2021) identify banks employing internal credit risk models as the main drivers of systemic risk to society.

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Table 1. Definitions and summary statistics for variables

Variable	Definition	Mean	St. deviation
Panel A: Loan-market characteristics (Bank-MSA-Year Variation)			
Volume of mortgage loans originated ($1,000)	Volume of mortgage loans made by each bank in each MSA	11240.26	88558.17
Volume of mortgage loans applied ($1,000)	Volume of mortgage loan applications to each bank in each MSA	20259.87	163128.8
Market share	Volume of mortgage loans made by each bank in each MSA divided by total mortgage loans made in that MSA	0.004	0.016
Merger	Dummy equal to one if two banks that merge in year t have both branches located in MSA j one year before the merger, in year $t-1$, and zero otherwise	0.010	0.101
Bank-MSA-year observations		312,759	
Panel B: Bank characteristics (Bank-Year Variation)			
Total assets (billions)	Total assets	2.598	36.500
Equity ratio	Total equity divided by total assets to proxy Capital adequacy (C)	0.098	0.030
Loan loss reserves (%)	Loan loss reserves divided by total loans to proxy Asset quality (A)	0.994	0.596
Interest income	Net interest income divided by total assets to proxy Management quality (M)	0.036	0.009
Return on assets (ROA)	Net income divided by total assets to proxy Earnings (E)	0.007	0.013
Cash ratio	Cash and non-interest-bearing deposits divided by total assets to proxy Liquidity (L)	0.073	0.062
Deposits	Total deposits divided by total assets to proxy Sensitivity to market risk	0.818	0.081
Loans/Deposits	Total loans divided by total deposits (S)	0.850	0.227
Risk density	Risk weighted assets divided by total assets	0.729	0.122
Bank-year observations		31,055	
Panel C: MSA characteristics (MSA-Year Variation)			
House price index (HPI)	HPI at the MSA level	169.047	37.067
Population (thousand)	Population at the MSA level	463.510	671.402
Income per capita (thousand)	Income divided by population at the MSA level	32.465	6.829
Market concentration	Sum of squared market shares	0.049	0.031
MSA-year observations		3,700	

Table 2. First stage regression: Credit market competition
The regressions in this table examine the effect of mergers on credit market competition. The dependent variable is the credit market competition measured as credit market concentration, defined in equation 1, multiplied by -1. The instrument, $Merger_{j,t}$, is equal to one if two banks that merge in year t have both branches located in MSA j one year before the merger, in year $t-1$, and zero otherwise. All variables are defined in Table 1. Robust standard errors are clustered at the bank and MSA level.

	Competition	Competition	Competition
Merger	-0.003***	-0.003***	-0.003***
	(0.000)	(0.000)	(0.000)
log(HPI)		0.008***	0.008***
		(0.001)	(0.001)
log(Income per capita)		0.003	0.003
		(0.002)	(0.002)
log(Population)		-0.026***	-0.026***
		(0.004)	(0.004)
Equity ratio			0.008*
			(0.004)
Loan loss reserves			-0.000***
			(0.000)
Interest income			-0.015
			(0.012)
ROA			0.004
			(0.006)
Cash ratio			-0.002
			(0.002)
Loans/Deposits			-0.000
			(0.001)
log(Assets)			0.000
			(0.000)
Bank fixed effects	Yes	Yes	Yes
MSA fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	181348	181348	181118
Adjusted R^2	0.506	0.507	0.507

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3. Second stage regression: Capital ratio

The regressions in this table examine the effect of credit market competition on banks' capital ratios. The dependent variable is the capital ratio of banks, defined as the equity ratio. The independent variable, $\widehat{Competition}$, is the instrumented credit market competition. The instrument, $Merger_{j,t}$, is equal to one if two banks that merge in year t have both branches located in MSA j one year before the merger, in year $t-1$, and zero otherwise. All variables are defined in Table 1. Columns (1), (3), and (5) report the first stage regressions. Top 20 (bottom 80) refers to the banks that are in the top quintile (bottom quintiles) of the market share distribution. Robust standard errors are clustered at the bank and MSA level.

	All banks		Top 20		Bottom 80	
$\widehat{Competition}$		0.116		-1.123**		0.390**
		(0.174)		(0.548)		(0.197)
Merger	-0.003***		-0.002***		-0.003***	
	(0.000)		(0.000)		(0.000)	
log(HPI)	0.008***	-0.002	0.006***	0.002	0.009***	-0.003*
	(0.001)	(0.001)	(0.002)	(0.004)	(0.001)	(0.002)
log(Income per capita)	0.003	0.013***	0.009*	0.023***	0.002	0.011***
	(0.002)	(0.002)	(0.005)	(0.008)	(0.003)	(0.002)
log(Population)	-0.026***	-0.001	-0.014	-0.012	-0.029***	0.007
	(0.004)	(0.005)	(0.009)	(0.013)	(0.004)	(0.006)
Equity ratio	0.008*	0.492***	0.016*	0.553***	0.005	0.483***
	(0.004)	(0.005)	(0.009)	(0.015)	(0.004)	(0.006)
Loan loss reserves	-0.000***	0.004***	0.000	0.006***	-0.001***	0.002***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Interest income	-0.015	-0.206***	-0.064**	-0.615***	-0.002	-0.038
	(0.012)	(0.019)	(0.031)	(0.059)	(0.013)	(0.026)
ROA	0.004	0.222***	0.013	0.390***	0.002	0.166***
	(0.006)	(0.009)	(0.013)	(0.023)	(0.006)	(0.010)
Cash ratio	-0.002	0.031***	-0.007*	0.053***	-0.001	0.020***
	(0.002)	(0.002)	(0.004)	(0.007)	(0.002)	(0.002)
Loans/Deposits	-0.000	0.007***	-0.000	0.013***	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
log(Assets)	0.000	-0.000	-0.000	0.000	0.000	-0.001***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
MSA fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	181118	181118	50933	50933	129699	129699
Adjusted R^2	0.507		0.506		0.501	
Kleibergen-Paap test for weak instruments		377.276		44.533		265.358

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4. Second stage regression: Risk density
The regressions in this table examine the effect of credit market competition on banks' risk taking. The dependent variable is the risk density of banks, defined as the risk weighted assets divided by total assets. The independent variable, $\widehat{Competition}$, is the instrumented credit market competition. The instrument, $Merger_{j,t}$, is equal to one if two banks that merge in year t have both branches located in MSA j one year before the merger, in year $t-1$, and zero otherwise. All variables are defined in Table 1. Top 20 (bottom 80) refers to the banks that are in the top quintile (bottom quintiles) of the market share distribution. Robust standard errors are clustered at the bank and MSA level.

	All banks	Top 20	Bottom 80
$\widehat{Competition}$	-0.524	3.202*	-0.972*
	(0.486)	(1.767)	(0.517)
log(HPI)	0.020***	0.014	0.022***
	(0.005)	(0.014)	(0.005)
log(Income per capita)	-0.009	-0.057**	-0.009
	(0.006)	(0.025)	(0.008)
log(Population)	-0.029*	0.029	-0.041**
	(0.015)	(0.042)	(0.018)
Equity ratio	-0.502***	-0.666***	-0.440***
	(0.018)	(0.054)	(0.019)
Loan loss reserves	0.010***	0.026***	0.004***
	(0.001)	(0.003)	(0.001)
Interest income	1.649***	0.583***	2.039***
	(0.138)	(0.215)	(0.176)
ROA	1.255***	2.544***	0.819***
	(0.038)	(0.107)	(0.038)
Cash ratio	-0.029***	0.019	-0.042***
	(0.009)	(0.026)	(0.010)
Loans/Deposits	0.117***	0.106***	0.113***
	(0.003)	(0.006)	(0.005)
log(Assets)	0.005***	-0.008**	0.010***
	(0.002)	(0.004)	(0.002)
Bank fixed effects	Yes	Yes	Yes
MSA fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	181118	50933	129699
Kleibergen-Paap test for weak instruments	377.276	44.533	265.358

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5. Market share, bank capital and risk taking

The regressions in this table examine the relationship between market shares with bank capital and risk taking for competitive versus concentrated markets. The dependent variables are capital ratio of banks, defined as the equity ratio, and the risk density of banks, defined as the risk weighted assets divided by total assets. The independent variable is the market share of banks in each MSA. All variables are defined in Table 1. Top 20 (bottom 80) refers to the banks that are in the top quintile (bottom quintiles) of the market share distribution. Top 15 and Top 25 are defined similarly. Robust standard errors are clustered at the bank and MSA level.

	Highly Competitive Markets						Concentrated Markets	
	Top 15		Top 20		Top 25		Bottom 80	
	Capital ratio	Risk density	Capital ratio	Risk density	Capital ratio	Risk density	Capital ratio	Risk density
Market share	-0.039***	0.130***	-0.021*	0.108***	-0.014	0.083***	0.011***	-0.011*
	(0.014)	(0.043)	(0.012)	(0.033)	(0.010)	(0.028)	(0.002)	(0.006)
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MSA controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MSA fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	27936	27936	37508	37508	46096	46096	143075	143075
Adjusted R^2	0.829	0.891	0.819	0.880	0.809	0.872	0.766	0.823

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6. Robustness: Different thresholds

The regressions in this table examine the effect of credit market competition on banks' capital ratios and their risk density for different thresholds for large market share banks. The dependent variables are the capital ratio of banks, defined as the equity ratio, and the risk density of banks, defined as the risk weighted assets divided by total assets. The independent variable, $\widehat{Competition}$, is the instrumented credit market competition. The instrument, $Merger_{j,t}$, is equal to one if two banks that merge in year t have both branches located in MSA j one year before the merger, in year $t-1$, and zero otherwise. All variables are defined in Table 1. Columns (1), (4), and (7) report the first stage regressions. Top 20 refers to the banks that are in the top quintile of the market share distribution. Top 15 and Top 25 are defined similarly. Robust standard errors are clustered at the bank and MSA level.

	Top 15			Top 20			Top 25		
	First stage	Capital ratio	Risk density	First stage	Capital ratio	Risk density	First stage	Capital ratio	Risk density
$\widehat{Competition}$		-2.387**	6.527**		-1.123**	3.202*		-0.755*	1.512
		(1.022)	(3.017)		(0.548)	(1.767)		(0.430)	(1.457)
Merger	-0.002***			-0.002***			-0.003***		
	(0.000)			(0.000)			(0.000)		
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MSA controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MSA fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	38462	38462	38462	50933	50933	50933	62601	62601	62601
Adjusted R^2	0.522			0.506			0.498		
Kleibergen-Paap test for weak instruments		19.742	19.742		44.533	44.533		55.654	55.654

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7. Robustness: Large versus small banks
The regressions in this table examine the effect of credit market competition on banks' capital ratios and their risk taking for small versus large banks. The dependent variables are the capital ratio of banks, defined as the equity ratio, and the risk density of banks, defined as the risk weighted assets divided by total assets. The independent variable, $\widehat{Competition}$, is the instrumented credit market competition. The instrument, $Merger_{j,t}$, is equal to one if two banks that merge in year t have both branches located in MSA j one year before the merger, in year $t-1$, and zero otherwise. All variables are defined in Table 1. Columns (1) and (4) report the first stage regressions. Large banks are the banks with total assets in the top 20% of the distribution and the rest (bottom 80%) are small banks. Robust standard errors are clustered at the bank and MSA level.

	Large banks (Top 20)			Small banks (Bottom 80)		
	First stage	Capital ratio	Risk density	First stage	Capital ratio	Risk density
$\widehat{Competition}$		-0.458	-1.505		0.193	-0.042
		(0.496)	(1.087)		(0.170)	(0.547)
Merger	-0.003***			-0.003***		
	(0.000)			(0.000)		
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
MSA controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
MSA fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	46756	46756	46756	134361	134361	134361
Adjusted R^2	0.502			0.510		
Kleibergen-Paap test for weak instruments		59.334	59.334		292.489	292.489

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8. Robustness: High vs low market concentration
The regressions in this table examine the effect of credit market competition on banks' capital ratios and their risk density for high versus low concentration markets. The dependent variables are the capital ratio of banks, defined as the equity ratio, and the risk density of banks, defined as the risk weighted assets divided by total assets. The independent variable, $\widehat{Competition}$, is the instrumented credit market competition. The instrument, $Merger_{j,t}$, is equal to one if two banks that merge in year t have both branches located in MSA j one year before the merger, in year $t-1$, and zero otherwise. All variables are defined in Table 1. Columns (1) and (4) report the first stage regressions. High concentration (low concentration) is defined as MSAs in the top 20 (bottom 80) of the market concentration distribution. Robust standard errors are clustered at the bank and MSA level.

	High market concentration (Top 20)			Low market concentration (Bottom 80)		
	First stage	Capital ratio	Risk density	First stage	Capital ratio	Risk density
$\widehat{Competition}$		-0.062	-0.536		0.243	-1.034
		(0.139)	(1.254)		(0.371)	(0.993)
Merger	-0.009***			-0.001***		
	(0.001)			(0.000)		
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
MSA controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
MSA fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	30921	30921	30921	149541	149541	149541
Adjusted R^2	0.565			0.365		
Kleibergen-Paap test for weak instruments		110.171	110.171		96.058	96.058

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$