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Bank Competition and Financial Stability: Evidence from the Financial Crisis

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Abstract

We examine the link between bank competition and financial stability using the recent financial crisis as the setting. We utilize variation in banking competition at the state level and find that banks facing less competition are more likely to engage in risky activities, more likely to face regulatory intervention, and more likely to fail. Focusing on the real estate market, we find that states with less competition had higher rates of mortgage approval, experienced greater inflation in housing prices before the crisis, and experienced a steeper decline in housing prices during the crisis. Overall, our study is consistent with greater competition increasing financial stability.

I. Introduction

In recent decades, the banking sector in the United States has steadily consolidated. During the recent financial crisis, politicians and regulators expressed concern about the lack of competition in the banking industry and the role it may have played in the crisis and recovery. In a speech on banking reform on Jan. 21, 2010, President Barack Obama argued that the "American people will not be served by a financial system that comprises just a few massive firms. That's not good for consumers; it's not good for the economy."[1] On Mar. 20, 2010, Federal Reserve Chairman Ben Bernanke made a similar argument that the existence of large, systemically risky firms skews competition in the financial services industry, suggesting that the current marketplace "falls substantially short" when it comes to open competition.[2] In Feb. 2012, Dallas Federal Reserve President

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[1] http://www.whitehouse.gov/the-press-office/remarks-president-financial-reform

[2] http://www.federalreserve.gov/newsevents/speech/bernanke20100320a.htm

Richard Fisher articulated that "after the crisis, the five largest banks had a higher concentration of deposits than they did before the crisis. I am of the belief personally that the power of the five largest banks is too concentrated."[3]

The issue of bank competition and stability has also attracted significant academic attention. The conventional theory, known as the "charter value hypothesis," argues that banks balance the gains from increased risk taking with the loss of charter value if such risk taking fails. Banks with more market power have higher charter values because they are able to charge higher rents. The increased charter value deters risk-taking behavior because it increases the opportunity cost of bankruptcy. An increase in competition will reduce the value of bank charters, which in turn is associated with an increase in risk taking (Keeley (1990), Allen and Gale (2000), Hellmann, Murdock, and Stiglitz (2000), and Repullo (2004)). In contrast, Boyd and De Nicoló (2005) argue that this theory ignores the effect of bank competition on borrowers' behavior. Their model of borrowers' behavior shows that, in equilibrium, a lack of competition *may* lead to lower bank stability. As the lending market becomes more concentrated, banks use their market power to charge higher loan rates, leading to an increase in their interest margins. Higher loan rates increase the probability of bankruptcy for borrowers, who respond by undertaking riskier projects (Stiglitz and Weiss (1981)). This response by borrowers is ignored by the charter value hypothesis. The increased likelihood of borrower default reduces bank stability.[4]

Apart from the formal models of banking competition, competition can have beneficial effects on financial stability by stimulating innovation and encouraging efficiency. This can enhance banks' responsiveness in times of crisis, which increases financial stability. In addition, strong market power can induce excessive risk taking if there is an implicit government guarantee for banks considered "too big to fail." Given the theoretical debate, mixed empirical evidence, consolidation in the banking sector, and direction taken in banking reforms, it is important to reexamine the link between competition and risk taking and how this link fits in the broader framework of competition and financial stability.

The objective of this study is to conduct a comprehensive empirical examination of the relation between competition within the banking industry and financial stability in the United States. In particular, we utilize variation in banking competition across states to examine the impact on i) individual bank actions and outcomes and ii) the housing and mortgage market within states. Ideally, we would use only exogenous variation in competition. Some prior research has used banking deregulation as a natural experiment (e.g., Jayaratne and Strahan (1996), Galloway, Lee, and Roden (1997), and Zarutskie (2006)). However, the restrictions on interstate banking were lifted well before our sample period and no longer have significant explanatory power for competition in our sample, thereby making deregulation unsuitable as an instrument. In addition, although the theoretical

[3]http://www.reuters.com/article/2012/02/29/us-banks-fisher-idUSTRE81S1WY20120229

[4]Martinez-Miera and Repullo (2010) show that, depending on the degree of correlation in the default rates across loans, the relation could become U-shaped as well. Increasing competition initially reduces bank failure (as noted by Boyd and De Nicoló (2005)), but beyond a certain point, competition increases bank failure.

models investigate equilibrium actions for a given *level* of competition, deregulation leads to a *change* in competition. The disruption to established banks and the entry of new, untested banks following deregulation may temporarily lead to greater instability, even if a higher degree of competition in steady state would be beneficial. Therefore, rather than using a shock to the level of competition, we use a shock to the financial system, and we examine the resilience of banks to this shock as a function of the degree of competition they face.

We examine the effects of bank competition both before and after the financial crisis on i) individual bank actions and failures and ii) mortgage lending and housing prices. Our first set of analyses of bank competition and individual bank actions is comprised of two parts. For the year prior to the crisis, we examine how the degree of competition a bank faces is associated with its actions by examining five dimensions of bank risk taking that could link competition and bank stability: the interest margin, Tier 1 capital, the fraction of risky assets, profitability, and liquidity. For the years during the crisis, we study how competition is associated with the likelihood of regulatory enforcement actions and bank failure. Our second set of analyses of bank competition and housing prices is also conducted in two parts. First, because changes in the real estate market were a significant factor in the financial crisis, we examine the relationship between competition and changes in the house price indices (HPIs) in different states before and during the crisis. To gain more insight on how banking competition may have affected real estate prices, we examine the relation between banking competition and individual mortgage-lending decisions.

In our first set of analyses, we document that just before the crisis, more competition is associated with banks charging a lower interest margin, maintaining a lower Tier 1 capital ratio, holding a less risky portfolio of assets, having lower profitability, and maintaining lower liquidity. During the crisis, more competition is associated with a lower likelihood of enforcement actions and bank closure. We find results consistent with the theory advocated by Boyd and De Nicoló (2005): More competition is associated with less risk taking. In our second set of analyses, we find that more competition is associated with a smaller increase in the HPI before the financial crisis and a smaller decrease in the HPI during the financial crisis. This result suggests that more competition had a disciplinary effect that mitigated the inflation in housing prices before the crisis and the deflation afterward. We also find that greater competition is associated with higher mortgage rejection rates. This effect is strongest for the highest-risk mortgages (i.e., those for borrowers with the lowest income-to-loan ratios). Overall, the results are consistent with a lack of competition contributing to the inflation of housing prices and the subsequent reversal.

Our study contributes to the empirical literature on the relationship between competition and risk taking. The findings in this literature are mixed. Early empirical evidence from the United States is generally motivated by the banking crises of the 1980s. With banking deregulation reforms and increased competition, banks across the United States suffered unprecedented failure. According to the Federal Deposit Insurance Corporation (FDIC), 1,143 banks failed from 1983–1990, whereas only 228 failed from 1945–1982. In general, empirical evidence within the United States has supported the competition-fragility view.

Keeley (1990) finds that more competition, as measured by a lower Tobin's q, is associated with greater risk taking, measured as the default risk using either the market-value capital-to-asset ratio or the interest cost on large certificates of deposit. However, as noted by both Keeley and subsequent researchers, q is an indirect measure of competition that is itself affected by risk taking. Demsetz, Saidenberg, and Strahan (1996) and Galloway et al. (1997) also test the charter value hypothesis and find that, consistent with Keeley's theory, banks with a higher franchise value take less risk than do banks with a low franchise value.

Using the Texas real estate crisis as an exogenous shock, Gan (2004) documents that competition reduces franchise value, which induces risk taking among thrifts. Gan employs two measures of risk: direct investment in real estate as a percentage of assets and brokered deposits as a percentage of assets. She uses the logarithmic transformation of the number of thrifts in a town and the number of bank branches as two measures of competition. In an international setting, Beck, Demirgüç-Kunt, and Levine (2006) find that crises are less likely to occur in countries with more concentrated banking systems (measured using the market share of the three largest banks). Berger, Klapper, and Turk-Ariss (2009) find results generally consistent with this theory (banks with higher market power generally have less overall risk exposure).

The competition-stability view advocated by Boyd and De Nicoló (2005) suggests that more competition decreases risk taking, which is supported by several international studies. Investigating the relation between the concentration ratio and bank risk, De Nicoló, Bartholomew, Zaman, and Zephirin (2004) find that countries with more concentrated banking systems show higher levels of risk taking. Using the Herfindahl index, this is confirmed by Houston, Lin, Lin, and Ma (2010). Barth, Lin, Lin, and Song (2009) also find that bank competition reduces corruption in bank lending, which can improve bank stability. Using the ability of banks to pass on cost increases as a measure of competition, Schaeck, Cihak, and Wolfe (2009) also find that more competition reduces risk taking. They find that countries with more competitive banking systems are less likely to experience a financial crisis. Consistent with the lending rate channel in Boyd and De Nicoló (2005), Garmaise and Moskowitz (2006) find that after banks merge, they charge higher interest rates. In contrast, using the Lerner index as a measure of market power, Beck, De Jonghe, and Schepens (2013) find on average a negative relation between market power and risk taking, but show that the strength of the relation varies across countries based on country-level institutions. Boyd, De Nicoló, and Jalal (2010) find that when bank competition is higher, the bankruptcy risk of the bank is lower, borrower risk is lower, and the loan-to-asset ratio is higher, consistent with the predictions about the impact of bank competition on bank risk and asset allocations in the model by Boyd, De Nicoló, and Jalal (2009).

A related literature focuses on the effect of competition on the types of loans banks make. Petersen and Rajan (1995) find that banks in a less competitive environment are more likely to finance credit-constrained firms. Their results are corroborated by Zarutskie (2006), who shows that firms with the largest information asymmetries have less debt when banking markets are more competitive. Both Petersen and Rajan (1995) and Zarutskie (2006) show that competition among banks discourages them from lending to firms whose credit qualities are unknown;

hence, competition mitigates risk taking. In addition, Bergstresser (2010) finds that households report being less credit constrained if they live in an area where banks enjoy more market power.

What separates our study from the recent empirical work is that it employs only U.S. data, using variation in competition across the different states. This allows us to use a large sample of public and private commercial banks and to achieve greater homogeneity in the legal and regulatory framework. Furthermore, our study also benefits from the fact that it examines the precrisis and crisis periods and thus uses the crisis as a quasi-natural experiment that allows us to study actual bank failures rather than only indirect proxies. In addition, we show that the level of bank competition affects mortgage-lending decisions and housing prices.

The remainder of the paper is organized as follows: We describe the construction of our competition measures in Section II. We show the results of competition on banks' actions precrisis in Section III and competition and regulatory actions during the crisis in Section IV. We provide the results of competition on real estate prices and mortgage-lending decisions in Section V. Finally, we conclude in Section VI.

II. Measuring Competition among Banks

Researchers have used various measures of competition to test the relationship between competition and risk taking. Keeley (1990) uses Tobin's q as an indirect measure of competition. Subsequent work has focused on more direct measures, including the number of banks (e.g., Gan (2004)), concentration ratios (e.g., De Nicoló et al. (2004), Beck et al. (2006)), the Herfindahl index (e.g., Boyd et al. (2010)), bank mergers (e.g., Garmaise and Moskowitz (2006)), and the Panzar–Rosse (1987) H-statistic[5] (e.g., Claessens and Laeven (2004), Schaeck et al. (2009)).

In their review of the empirical literature on the relation between competition in banking markets and bank risk exposure, Boyd and De Nicoló (2005) propose that studies should use competition measures such as the Herfindahl index and the concentration ratio. This is also consistent with the horizontal merger guidelines that the Federal Reserve Board (FED) and the Office of the Comptroller of the Currency (OCC) rely on when they analyze the likely competitive effects of a bank merger (U.S. Department of Justice (1995)). Specifically, the guidelines state that the initial screening of whether a planned merger transaction is anticompetitive should be based on the Herfindahl index. Given these precedents, we use the Herfindahl index and the concentration ratio as the primary competition measures in our tests. However, we find similar results in robustness analyses using the Panzar–Rosse (1987) H-statistic as adapted by Claessens and Laeven (2004).

We calculate the competition measures using the distribution of deposits reported in the FDIC's Summary of Deposits (SOD).[6] We use deposits rather than

[5]"The H-statistic is calculated by estimating the sum of the elasticities of reduced-form revenue equations with respect to factor input prices. . . . In other words, the H-statistic measures the ability of a bank to pass on increases in factor input prices to customers" (Schaeck et al. (2009), p. 714).

[6]These data can be accessed at http://www2.fdic.gov/sod/index.asp.

loans because detailed data about the distribution of bank operations are available only for deposits. The SOD contains midyear branch-level deposits for all institutions insured by the FDIC. Using these data, we measure the extent of competition among all banks within each of the 50 states and in Washington, DC, in each year. For brevity, we use the term *states* to refer to the 50 states and Washington, DC.

The Herfindahl index and the concentration ratio are *market-level* measures of competition. Ideally, we would like *bank-level* measures of competition so that we can perform the analysis at the bank level and control for bank-level characteristics. To do this, we first calculate the competition at the market level and then at the bank level as the weighted-average competition of each market the bank operates in. We choose states as the geographic region to measure market-level competition because banks are typically licensed and supervised by state banking regulators; as a result, these regulators play a role in determining the level of competition within the state. Moreover, the state-level analysis allows us to control for state-level regulations regarding recourse and nonrecourse mortgages in the analysis of the mortgage market.

In contrast, metropolitan statistical areas (MSAs) can cross state lines and do not cover all the banks' branches, leading to incomplete measures of competition for any bank with branches outside of MSAs. Measuring competition at the county level is also problematic. First, competition among banks is likely to extend beyond county lines, especially in states with many small counties or with certain counties that provide significant banking services to people in other counties. Second, there is discretion in the assignment of deposits across branches, and this is more likely to average out in larger geographic units such as states rather than counties because the vast majority of banks operate in a single state.[7] Finally, as a result of these issues, almost half of the counties in the sample have five or fewer branches, thus making the county-level competition measures less useful.

The unit of analysis is the commercial bank (rather than the bank holding company (BHC)) because our data on bank failures and bank regulatory actions are at the commercial-bank level. However, two commercial banks, both owned by the same parent BHC, are not independent competitors. Therefore, when calculating the market-level measures of competition, we first aggregate up to the BHC level within each state.[8] Similarly, although we do not include thrifts in our analyses, we do include them in calculating the extent of competition in each market because they directly compete with commercial banks. Thus the market-level

[7] According to the FDIC, the county represents the physical location of the branch or main office. For the purpose of the SOD data, deposits are allocated to each office in a manner consistent with each office's existing internal record-keeping practices. Examples of assignments are office in closest proximity to the account holder's address, office where the deposit account is most active, and office of origination of the account. Other methods that logically reflect the deposit-gathering activity of the bank's branch offices may be used. It is recognized that certain classes of deposits and deposits of certain types of customers may be assigned to a single office for reasons of convenience or efficiency. The deposit assignment (e.g., consolidation of the accounting for deposits at the main office) is likely to have resulted in fewer recorded branches in each county.

[8] The competition measures based on BHCs and those based purely on commercial banks are highly correlated, and our results are very similar if we instead aggregate throughout at the commercial-bank level.

measure of competition takes into account the effect of both BHC relations and thrifts on overall banking competition, even though our tests examine the effects of competition on commercial banks only.

Our first measure is the Herfindahl index based on deposits in banks and thrifts. Because banks compete with thrifts in attracting deposits and making loans, we include thrifts in the calculation of our competition measures. First, for each institution j, we aggregate within each state the amount of deposits for all branches of that bank or thrift (taking into account any BHC affiliations). Then for each state s, we measure the Herfindahl index, HERFINDAHL$_s$, as follows:

$$\text{HERFINDAHL}_s = \sum_{j=1}^{J} \left(\frac{\text{DEPOSITS}_{s,j}}{\text{DEPOSITS}_s} \right)^2, \tag{1}$$

where DEPOSITS$_{s,j}$ is the amount of deposits held by institution j in state s, DEPOSITS$_s$ is the total amount of deposits held by all institutions in state s, and J is the total number of banks and thrifts in state s.

The concentration ratio is the percentage of bank deposits within a state held by the five largest institutions operating within that state. For each state s, we measure the concentration ratio in each year, CONCENTRATION$_s$, as follows:

$$\text{CONCENTRATION}_s = \sum_{j=1}^{j=5} \frac{\text{DEPOSITS}_{s,j}}{\text{DEPOSITS}_s}, \tag{2}$$

where DEPOSITS$_{s,j}$ is the amount of deposits held by each of the top five institutions in state s, and DEPOSITS$_s$ is the total amount of deposits held by all institutions in state s.

These measures are calculated at the state level. Because we also examine the effects of competition at the bank level, we need to determine the extent of competition faced by each bank, including banks that operate in multiple states. To do so, we take the competition the bank faces in each state in which it operates and weight it by the fraction of the bank's deposits that are in that state. The resulting weighted-average competition measure is our bank-specific measure of competition:

$$\text{COMPETITION}_j = \sum_{s=1}^{S} \frac{\text{DEPOSITS}_{s,j}}{\text{DEPOSITS}_j} \times \text{COMPETITION}_s, \tag{3}$$

where DEPOSITS$_{s,j}$ is the amount of deposits held by bank j in state s, DEPOSITS$_j$ is the total amount of deposits held by bank j, and COMPETITION$_s$ is the competition measure for state s (either the Herfindahl index or the concentration ratio).

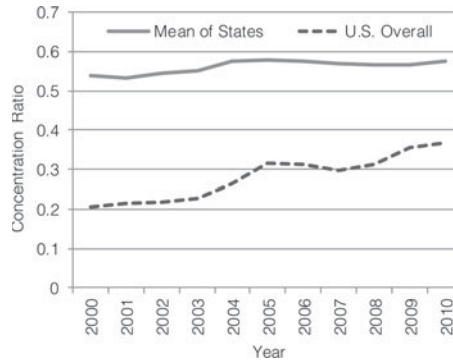
Thus the power of our measure of competition comes from having a comprehensive sample of commercial banks whose measured exposure in competition arises from two sources: i) the variation in bank competition across the different states and ii) the spread of each bank's activities across each of these states.

Figure 1 presents the concentration ratio, the deposit market share of the top five BHCs, over the last decade. Continuing the trend of the previous decades, the

FIGURE 1

Deposit Market Share of the Top Five BHCs

Figure 1 presents the concentration ratio, the deposit market share, of the top five BHCs over time. The dashed line shows the concentration ratio for the United States as a whole. The solid line shows the average concentration ratio across the states based on the top five banks in each state. The deposit data are obtained from the FDIC SOD and include the total deposits for all banks and savings institutions that are insured by the FDIC. Deposits are measured as of June 30 of each year.



market share of the top five banks increases over this time period. This increase is most pronounced for the concentration ratio for the United States as a whole (the dashed line). The average concentration ratio across the states (the solid line) increases less in comparison. This suggests that over the last decade the primary consolidation in the banking sector has been nationwide rather than within state.

Table 1 presents descriptive information about the banks in each of the 50 states and Washington, DC. There is significant variation in terms of the amount of deposits, the measures of competition, the number of banks, the number of regulatory enforcements, and the number of bank failures across states. In 2006, New York had the highest bank deposits, at $731 billion, and Alaska and Vermont had the lowest bank deposits, at $7 billion. Kansas had both the lowest Herfindahl index and the lowest concentration ratio at 0.021 and 0.260, respectively. South Dakota had the highest Herfindahl index, 0.756, and Hawaii, which has one of the lowest number of banks, had the highest concentration ratio at 0.978.

During this time period, the U.S. Department of Justice and Federal Trade Commission's Horizontal Merger Guidelines (2010) classified the degree of competition based on the Herfindahl index into three regions that can be broadly characterized as unconcentrated (Herfindahl below 0.1), moderately concentrated (Herfindahl between 0.1 and 0.18), and highly concentrated (Herfindahl above 0.18). Based on this standard, almost half of the states (49%) exhibit moderate to high concentration. This would suggest that despite the large number of banks in the United States, the commercial banking sector is not fully competitive in all states.

Based on the distribution of our sample of 7,351 banks filing call reports at the end of 2007, Illinois and Alaska have the highest and lowest number of banks, respectively.[9] We examine the distribution of enforcement orders and bank

[9]Note that we arrive at this sample after the data requirements discussed in the next section.

TABLE 1

Distribution of Competition and Bank Outcomes across the United States

Table 1 presents the sum of deposits (in billions of dollars) of all banks, the Herfindahl index, and the concentration ratio of banks operating within each of the 50 states and Washington, DC, in 2006. The Herfindahl index and the concentration ratio are computed using the distribution of the branch deposits within a state. The Herfindahl index is the Herfindahl index of deposits held by banks within the state. The concentration ratio is the percentage of deposits held by the five largest banks within the state. The table also presents, for our sample, the number of banks at the end of 2007, the number of regulatory enforcement orders from 2008 to 2010, and the number of bank failures from 2008 to 2010.

State	Deposits (2006)	Herfindahl (2006)	Concentration (2006)	Banks (2007)	Enforcements (2008–2010)	Failures (2008–2010)
AK	7	0.276	0.933	5	0	0
AL	63	0.091	0.640	141	8	3
AR	37	0.043	0.393	142	8	2
AZ	64	0.212	0.875	41	10	6
CA	498	0.144	0.646	243	61	26
CO	53	0.092	0.540	139	23	3
CT	69	0.112	0.670	45	1	0
DC	21	0.192	0.850	6	0	0
DE	25	0.370	0.905	23	3	0
FL	283	0.130	0.663	242	53	33
GA	144	0.115	0.630	310	56	48
HI	14	0.349	0.978	7	1	0
IA	42	0.028	0.288	370	5	0
ID	14	0.126	0.628	13	2	0
IL	254	0.054	0.416	610	55	36
IN	67	0.050	0.403	121	4	1
KS	38	0.021	0.260	337	24	6
KY	50	0.034	0.356	184	13	0
LA	65	0.107	0.631	138	6	1
MA	122	0.098	0.529	156	3	1
MD	62	0.128	0.702	54	7	2
ME	17	0.073	0.513	26	0	0
MI	107	0.093	0.600	146	20	8
MN	85	0.148	0.604	416	32	15
MO	78	0.051	0.415	326	18	9
MS	37	0.058	0.501	92	3	1
MT	11	0.078	0.529	73	7	0
NC	190	0.226	0.797	88	8	2
ND	11	0.046	0.407	93	1	0
NE	26	0.038	0.374	234	12	1
NH	19	0.186	0.763	15	0	0
NJ	169	0.084	0.581	86	8	3
NM	17	0.123	0.651	46	6	1
NV	31	0.181	0.761	27	7	8
NY	731	0.151	0.693	129	7	3
OH	180	0.092	0.620	185	13	2
OK	47	0.036	0.357	252	9	2
OR	38	0.117	0.688	35	10	6
PA	189	0.067	0.467	196	8	2
RI	14	0.186	0.870	8	1	0
SC	49	0.099	0.619	67	7	3
SD	69	0.756	0.906	83	5	1
TN	95	0.087	0.588	178	11	0
TX	339	0.083	0.573	604	24	7
UT	122	0.216	0.749	59	15	5
VA	113	0.107	0.678	98	9	0
VT	7	0.125	0.712	13	0	0
WA	81	0.114	0.618	83	22	14
WI	90	0.077	0.519	266	22	2
WV	24	0.071	0.521	62	0	0
WY	9	0.065	0.481	38	4	1
Total	4,986			7,351	632	264
Mean	98	0.130	0.610	144	12	5

failures that occurred between 2008 and 2010. There are similarities in the distribution of the incidence of enforcement orders and bank failures across the states, which is not surprising because both enforcement orders and bank failures are indicators of bank instability. For example, states with more regulatory enforcement actions, such as California (61), Georgia (56), Illinois (55), and Florida (53), also

experience more bank failures, with 26 failed banks in California, 48 in Georgia, 36 in Illinois, and 33 in Florida. In comparison, Texas, another large state, had only 24 enforcement actions and 7 bank failures.

III. Competition and Specific Dimensions of Bank Precrisis Risk Taking

Before moving to the analysis of regulatory enforcement and bank failures, we first examine the relation between competition and specific dimensions of bank precrisis risk taking. We consider this issue for several reasons. First, it allows us to directly test some of the intermediate steps predicted by theory, particularly whether this relation affects the interest charged. Second, it enables us to examine whether there are any competing effects among risk dimensions. For example, if competition affects lending to riskier borrowers, do banks adjust their capital holdings to exacerbate or partially offset the higher risk? Third, these types of measures are often used in prior research due to an insufficient number of bank failures. Fourth, it allows us to examine in the bank failure analysis the extent to which these ex ante risk proxies are a sufficient statistic for the effect of competition on the overall risk of bank failure.

The specific dimensions of bank risk taking are the interest margin (INTEREST_MARGIN), capitalization (TIER_1), riskiness of the asset portfolio (ASSET_RISK), earnings performance (ROA), and liquidity level (LIQUIDITY). Our first bank action is INTEREST_MARGIN, which is defined as the interest rate for loans (interest revenue divided by total loans) minus the interest rate for deposits (interest expense divided by total deposits), expressed as a percentage. We examine this for two reasons. First, examining the interest margin provides a validity check for our competition proxies. Economic theory suggests that banks facing greater competition should have lower interest margins. Second, the theory of Boyd and De Nicoló (2005) depends on this link between competition and interest rates.

Our other measures are motivated by some of the key components of the CAMELS (capital adequacy, asset quality, management capability, earnings, liquidity, and sensitivity to market risk) rating system, which regulators use to assess bank risk in their periodic examinations. To capture capital adequacy, we use Tier 1 capital as a percentage of total assets, TIER_1. We use this to measure the amount of risk the bank is taking on the equity and liability side of the balance sheet.[10] To capture asset quality, we use ASSET_RISK, which is the percentage of total assets, including derivatives and off-balance-sheet items, with a risk weight of 100%. We use this as a direct measure of the amount of risk the bank is taking on the asset side of the balance sheet. To capture earnings, we use bank performance, ROA, which is the net income before taxes and extraordinary items as a percentage of total assets. We use this to measure the bank's overall profitability. Finally, to capture liquidity, LIQUIDITY, we use cash as a percentage of total

[10]We do not scale by the risk-weighted assets because we want to separately analyze the level of asset risk and equity capital that the bank chooses to hold.

deposits. We have no direct proxies for the management and sensitivity components of the CAMELS ratings. All five variables are constructed using data from the Dec. 2007 call reports.

Using data from the precrisis period, we examine these predictions using the following regression specification:

$$\text{(4)}\quad \text{BANK\_ACTION} = \alpha + \beta_1\,\text{COMPETITION} + \Sigma\beta_j\,\text{CONTROLS}_j + \varepsilon.$$

The key independent variables of interest are the proxies for bank competition in 2006. Our measures of competition are COMPETITION-H and COMPETITION-C. We construct these variables in two steps. First, as discussed in Section II, we assign to each bank the deposits-weighted state-level Herfindahl index and concentration ratio. COMPETITION-H and COMPETITION-C are then obtained by multiplying these numbers by -1, so that higher values of COMPETITION-H and COMPETITION-C indicate greater competition.

We control for several bank characteristics in our analysis (CONTROLS). We control for bank portfolio characteristics such as total assets (TOTAL_ASSET), total loans as a percentage of total assets (LOAN_TO_ASSET), real estate loans as a percentage of total loans (LOAN_REAL_ESTATE), and the percentage of total deposits that are uninsured by the FDIC (UNINSURED_DEPOSIT). We also control for the primary federal regulator (FED, OCC), because prior literature suggests that there are differences in the levels of enforcement across regulators (e.g., Hill (2011)). FED and OCC are indicator variables equal to 1 if the respective federal agency is responsible for that bank's oversight. The FDIC oversees all banks not regulated by the FED or the OCC.

Table 2 provides descriptive statistics for the variables used in the analyses. The average interest margin is 4.83%. Approximately 56.88% of the total assets have a risk weight of 100%. Banks are well capitalized: The ratio of Tier 1 capital to total assets is 10.42%. Banks are profitable on average, with an average ROA of 1.11%. On average, banks hold 5.28% of their total deposits in the form of cash.

The means for COMPETITION-H and COMPETITION-C, our measures of competition, are -0.082 and -0.491, respectively. The average size of the banks, in terms of total assets, is \$0.472 billion. Loans constitute 66.58% of the total assets. Of the loans, 68.63% are real estate loans. Of the deposits, 40.26% are uninsured. The FED oversees 12.4% of the banks in our sample, the OCC 20.8%, and the FDIC 66.8%. Finally, 8.6% of the banks received enforcement orders, and 3.6% of the banks failed between 2008 and 2010.

In Table 3, we present the regression analysis of the relation between the competition a bank faces and specific dimensions of bank risk taking. The first two columns present the results for the interest margin. The coefficient for COMPETITION-H (COMPETITION-C) is -1.370 (-1.763) and is statistically significant at the 1% level, indicating that more competition is negatively associated with the interest margin. Specifically, a 1-standard-deviation change in COMPETITION-H (COMPETITION-C) is associated with a difference of 11.34 basis points (bps) (23.22 bps) in the interest margin. Although we use the net interest margin in our main test, we also separately analyze the interest paid on deposits and the interest charged on loans. We find that greater competition is associated with higher deposit interest and lower interest charged on loans; both of

TABLE 2

Descriptive Statistics

Table 2 provides the descriptive statistics of the variables used to examine the relation between bank competition, bank actions, and regulatory actions. The sample consists of 7,351 banks. COMPETITION-H (COMPETITION-C) is the deposits-weighted Herfindahl index (concentration ratio), which is multiplied by −1 so that higher values indicate more competition. The steps involved in computing the measure for each bank are as follows: i) the Herfindahl index and the concentration ratio for each state in 2006 are first computed (see Table 1), and ii) a bank is then assigned a weighted measure based on the amount of its deposits in each state in 2006. INTEREST_MARGIN is the interest rate for loans (interest revenue divided by total loans) minus the interest rate for deposits (interest expense divided by total deposits), expressed as a percentage. TIER_1 is Tier 1 capital as a percentage of total assets. ASSET_RISK is the percentage of total assets, including derivatives and off-balance-sheet items, with a risk weight of 100%. ROA is defined as net income before taxes and extraordinary items as a percentage of total assets. LIQUIDITY is cash as a percentage of total deposits. TOTAL_ASSET is the total assets of the firm (in billions of dollars). LOAN_TO_ASSET is the total loans as a percentage of total assets. LOAN_REAL_ESTATE is real estate loans as a percentage of total loans. UNINSURED_DEPOSIT is the percentage of the total deposits that are uninsured by the FDIC. FED, OCC, and FDIC are indicator variables equaling 1 if a bank is supervised by the FED, OCC, or FDIC, respectively. All of the previously described bank characteristics (beginning from INTEREST_MARGIN) are based on the call reports filed in Dec. 2007. ENFORCE is an indicator variable equaling 1 if the bank experienced a regulatory enforcement order between 2008 and 2010, and 0 otherwise. FAILED is an indicator variable equaling 1 if the bank was shut down by its regulator between 2008 and 2010, and 0 otherwise.

Variable	Mean	Std. Dev.	P25	Median	P75
COMPETITION-H	−0.082	0.083	−0.094	−0.068	−0.046
COMPETITION-C	−0.491	0.132	−0.582	−0.517	−0.381
INTEREST_MARGIN	4.831	1.209	4.089	4.722	5.504
TIER_1	10.420	3.549	8.120	9.374	11.541
ASSET_RISK	56.875	17.170	45.159	58.077	69.392
ROA	1.111	0.984	0.677	1.198	1.655
LIQUIDITY	5.281	4.704	2.815	3.933	5.884
TOTAL_ASSET	0.472	1.431	0.064	0.136	0.310
LOAN_TO_ASSET	66.575	15.372	57.735	69.033	77.816
LOAN_REAL_ESTATE	68.627	19.594	57.616	72.231	82.999
UNINSURED_DEPOSIT	40.262	15.426	29.425	37.943	48.644
FED	0.124	0.330	0.000	0.000	0.000
OCC	0.208	0.406	0.000	0.000	0.000
FDIC	0.668	0.471	0.000	1.000	1.000
ENFORCE	0.086	0.280	0.000	0.000	0.000
FAILED	0.036	0.186	0.000	0.000	0.000

these findings are statistically significant. This is consistent with the argument that banks exploit their market power by charging higher interest rates for loans and offering lower interest rates for deposits. In contrast, differences in concentration across countries are less reliably related to interest spreads (e.g., Hao, Nandy, and Roberts (2012)).

In these tests, and in all of our regressions, we find a negative coefficient on real estate as a percentage of total loans. This is likely due to the belief held prior to the crisis that real estate loans were safer because they provided greater collateral.

Next, the results in columns 3 and 4 of Table 3 show that banks in more competitive environments have lower Tier 1 capital ratios. The coefficients for COMPETITION-H and COMPETITION-C are −3.340 and −3.062, respectively. A 1-standard-deviation change in COMPETITION-H (COMPETITION-C) is associated with a 0.27% (0.04%) difference in Tier 1 capital ratios. This suggests that any effect of competition on risk taking in asset allocation is partially offset by the amount of equity capital the banks choose to hold. One potential explanation is that banks in less competitive markets accumulate greater equity because of greater profitability.

Columns 5 and 6 of Table 3 show the results for asset risk. We find that more competition is associated with less asset risk, as the coefficients for COMPETITION-H and COMPETITION-C are statistically significant: −12.099

TABLE 3

Bank Actions and Competition

Table 3 presents the regression analysis of the relation between bank actions and competition. The dependent variable for each regression is indicated in the first row. All of the variables are as defined in Table 2. The *t*-statistic of each coefficient is provided in parentheses below the coefficient. Significance levels are based on 2-tailed tests. ** and * indicate significance at the 1% and 5% levels, respectively.

	INTEREST_MARGIN		TIER_1		ASSET_RISK		ROA		LIQUIDITY	
	1	2	3	4	5	6	7	8	9	10
Constant	6.385**	5.904**	14.601**	13.826**	5.134**	3.825**	1.396**	1.381**	11.745**	11.034**
	(86.68)	(74.44)	(65.42)	(56.89)	(7.14)	(4.86)	(21.95)	(19.86)	(39.92)	(34.40)
COMPETITION-H	−1.370**		−3.340**		−12.099**		−0.513**		−2.014**	
	(−8.53)		(−6.87)		(−7.72)		(−3.70)		(−3.14)	
COMPETITION-C		−1.763**		−3.062**		−6.436**		−0.147		−2.603**
		(−16.99)		(−9.63)		(−6.25)		(−1.62)		(−6.20)
TOTAL_ASSET	−0.100**	−0.111**	−0.354**	−0.370**	0.116	0.102	0.036**	0.036**	−0.014	−0.030
	(−10.56)	(−11.87)	(−12.40)	(−12.95)	(1.26)	(1.11)	(4.38)	(4.44)	(−0.36)	(−0.80)
LOAN_TO_ASSET	−0.014**	−0.014**	−0.043**	−0.042**	0.839**	0.842**	0.002**	0.002**	−0.068**	−0.068**
	(−15.19)	(−15.52)	(−15.58)	(−15.57)	(95.08)	(95.33)	(2.71)	(2.89)	(−18.75)	(−18.85)
LOAN_REAL_ESTATE	−0.014**	−0.016**	−0.017**	−0.021**	−0.207**	−0.217**	−0.008**	−0.008**	−0.035**	−0.039**
	(−20.03)	(−23.29)	(−7.77)	(−9.68)	(−30.03)	(−31.36)	(−12.41)	(−12.89)	(−12.61)	(−13.69)
UNINSURED_DEPOSIT	0.005**	0.002*	−0.004	−0.009**	0.225**	0.218**	0.000	−0.000	0.007*	0.003
	(5.79)	(2.42)	(−1.62)	(−3.26)	(26.24)	(24.77)	(0.01)	(−0.03)	(1.95)	(0.70)
FED	0.083*	0.111**	−0.422**	−0.382**	0.517	0.548	0.054	0.052	0.122	0.164
	(2.04)	(2.78)	(−3.42)	(−3.11)	(1.30)	(1.38)	(1.53)	(1.48)	(0.75)	(1.01)
OCC	0.235**	0.234**	−0.393**	−0.400**	−0.529	−0.577	0.129**	0.126**	0.141	0.140
	(7.03)	(7.12)	(−3.88)	(−3.97)	(−1.62)	(−1.77)	(4.47)	(4.38)	(1.06)	(1.05)
No. of obs.	7,351	7,351	7,351	7,351	7,351	7,351	7,351	7,351	7,351	7,351
Adj. R^2	0.137	0.161	0.081	0.087	0.592	0.591	0.030	0.028	0.091	0.095

and −6.436, respectively. The economic interpretation of these effects is that a 1-standard-deviation change in COMPETITION-H (COMPETITION-C) is associated with a 1.00% (0.85%) difference in the percentage of total assets with a risk weight of 100%. These results suggest that more competition is associated with a reduction in the riskiness of the banks' asset portfolios.

We examine the relation between the profitability of banks and competition, using ROA. The results are presented in columns 7 and 8 of Table 3. We find that banks operating in more competitive markets have lower ROAs, as shown by the coefficient for COMPETITION-H, which is −0.513 and statistically significant at the 1% level. However, our results when using our COMPETITION-C proxy, although qualitatively similar, are not statistically significant.

Finally, columns 9 and 10 of Table 3 present the results of the relation of liquidity and competition. We find that banks operating in more competitive markets have lower liquidity: The coefficient for COMPETITION-H (COMPETITION-C) is −2.014 (−2.603) and statistically significant at the 1% level. The economic interpretation of these effects is that a 1-standard-deviation change in COMPETITION-H (COMPETITION-C) is associated with a 0.17% (0.34%) decrease in liquidity.

The results in these tests suggest that banks facing greater competition charge lower interest rates and invest in less risky loans, both of which reduce the risk of bank failure. However, these banks also have lower profitability, and at least partially offset their lower risk by holding fewer liquid assets and less equity capital. It is therefore important to examine actual bank failures to determine the overall effect of competition on risk taking and the risk of bank failure.

IV. Competition and Regulatory Actions against Banks during the Crisis

The prior tests focused on specific ex ante dimensions of bank financial stability through proxies for the components of the CAMELS ratings system used by bank regulators. We now turn toward overall ex post measures of financial stability. In particular, we examine the effect of bank competition on regulatory actions taken against banks during the crisis. Specifically, we examine two regulatory actions: regulatory enforcement orders and bank closure. Banks are subjected to periodic examinations by their regulators. The regulators' examinations consist of a comprehensive review of six components of a bank's financial conditions, the CAMELS ratings. If the examination reveals serious weaknesses, regulators can take formal administrative actions to ensure that the bank remedies them. Although ratings are confidential, formal regulatory orders are publicly disclosed on the relevant regulator's Web site (the FDIC, OCC, or FED). These enforcement actions contain an identification of the weaknesses, as well as specific instructions on how and when to address them. The instructions can contain both governance provisions, which require changes in board and management personnel and practices, and provisions regarding the bank's operations and risk management. At the FDIC and the OCC, these actions take the form of cease-and-desist orders; at the FED, the primary conduit is comprised of written agreements.

Prior research shows that these regulatory interventions have important effects. Peek and Rosengren (1995) find that lending at banks subject to formal actions shrinks at a significantly faster rate than at those with similar capital ratios. In addition, Jordan, Peek, and Rosengren (2000) investigate the stock market response to the announcement of cease-and-desist orders and find a negative stock market reaction that is statistically significant and economically meaningful. Hill (2011) provides a detailed examination of the contents of the enforcement actions and shows that regulators use them to mandate higher bank-specific capital requirements. Consistent with the data in our study, she finds a sharp rise in the rate of formal enforcement actions during the crisis period.

A bank failure is the closing of a bank by its chartering authority, which could be the state regulator, the Office of the Comptroller of the Currency, or the Office of Thrift Supervision. Generally, a bank is closed when it is unable to meet its obligations to depositors and others. When a bank fails, the FDIC, which is appointed as the receiver, is responsible for protecting the insured depositors. Details about the bank failure are published in a press release by the FDIC, which we use to collect our sample of failed banks.

To examine whether regulatory intervention is associated with competition, we run the following regression using the control variables defined in equation (4):

$$\text{ENFORCE or FAILED} = \alpha + \beta_1 \text{ COMPETITION} + \Sigma\beta_j \text{ CONTROLS}_j + \varepsilon. \tag{5}$$

The dependent variable is an indicator variable equal to 1 if the bank is targeted for a regulatory enforcement action (ENFORCE) or if the bank was closed (FAILED) during 2008–2010. All other variables are as previously defined in the discussion of equation (3).

Panel A of Table 4 reports our results on whether a bank's competitive environment affects the probability of its receiving a regulatory enforcement order. Column 1 shows the relation between the five ex ante risk proxies and the probability of regulatory enforcement. All of the risk proxies are statistically significant in the expected direction, except liquidity, which is statistically insignificant. Columns 2 and 3 indicate that banks in more competitive environments are less likely to receive enforcement orders from regulators, as measured by a -1.778 coefficient for COMPETITION-H and -1.453 for COMPETITION-C. The most significant driver of receiving an enforcement letter seems to be the regulatory overseer. Based on the first three columns, if a bank is overseen by the FED (OCC), it is approximately 3% (7%) more likely to receive an enforcement letter than if it is overseen by the FDIC.[11]

Columns 4 and 5 of Table 4 show that when we add the five bank-action variables from the precrisis period, INTEREST_MARGIN, TIER_1, ASSET_RISK, ROA, and LIQUIDITY, to the model, the magnitude and statistical significance of the coefficients on our competition proxies are somewhat mitigated. The coefficient for COMPETITION-H is -1.387 and is statistically significant at the 5% level, and the coefficient on COMPETITION-C is -0.737, significant at the 10% level. A 1-standard-deviation change in COMPETITION-H (COMPETITION-C)

[11] This is based on the change in marginal effects for a 1-unit change in the indicator variables.

is associated with a 0.5% (0.4%) difference in the probability of a bank receiving an enforcement letter. The unconditional probability of receiving an enforcement action is 8.6%, suggesting a modest effect for competition. As a comparison, a 1-standard-deviation change in the size of the bank (TOTAL_ASSET) is also associated with a 0.5% difference in the probability of its receiving an enforcement letter in both regressions. These analyses, combined with those in the first two columns, suggest that greater competition is associated with the probability of a bank receiving an enforcement order.

We examine whether a bank's competitive environment increases its risk of failure in Panel B of Table 4. Our results are similar to those in Panel A. However, although the three regulators differ in the frequency of enforcement actions, the identity of the regulatory agency overseeing the bank is not a significant predictor of bank failure. Competition is negatively related to bank failures in the crisis period. Specifically, the coefficients for COMPETITION-H and COMPETITION-C are −2.733 and −1.845 and are statistically significant in columns 2 and 3.

TABLE 4

Bank Competition and Regulatory Actions

Table 4 presents the results of logistic regressions that examine the relation between bank actions and regulatory actions in terms of regulatory enforcement orders and bank failures. The dependent variables in Panels A and B are regulatory enforcement orders (ENFORCE) and bank failures (FAILED), respectively. All of the variables are as defined in Table 2. The *t*-statistic of each coefficient is provided in parentheses below the coefficient. Significance levels are based on 2-tailed tests. ** and * indicate significance at the 1% and 5% levels, respectively.

	1	2	3	4	5
Panel A. Regulatory Enforcement Orders (ENFORCE)					
Constant	−9.460** (−18.64)	−8.374** (−23.87)	−8.684** (−23.77)	−9.430** (−18.61)	−9.511** (−18.70)
COMPETITION-H		−1.778** (−3.63)		−1.387* (−2.57)	
COMPETITION-C			−1.453** (−4.03)		−0.737 (−1.89)
INTEREST_MARGIN	0.333** (7.27)			0.323** (7.05)	0.316** (6.79)
TIER_1	−0.068** (−4.13)			−0.069** (−4.25)	−0.071** (−4.30)
ASSET_RISK	0.042** (9.16)			0.041** (8.93)	0.041** (8.98)
ROA	−0.526** (−12.60)			−0.528** (−12.64)	−0.521** (−12.43)
LIQUIDITY	−0.011 (−0.86)			−0.012 (−0.91)	−0.012 (−0.89)
TOTAL_ASSET	0.079** (2.96)	0.050 (1.93)	0.044 (1.71)	0.075** (2.79)	0.072** (2.67)
LOAN_TO_ASSET	0.013* (2.35)	0.039** (10.35)	0.039** (10.31)	0.013* (2.34)	0.013* (2.27)
LOAN_REAL_ESTATE	0.035** (10.75)	0.027** (9.35)	0.025** (8.46)	0.035** (10.81)	0.034** (10.14)
UNINSURED_DEPOSIT	0.007* (2.40)	0.019** (6.70)	0.017** (5.95)	0.007* (2.28)	0.006* (2.06)
FED	0.933** (7.90)	0.898** (7.95)	0.914** (8.07)	0.948** (8.01)	0.951** (8.02)
OCC	0.513** (4.47)	0.474** (4.31)	0.471** (4.28)	0.524** (4.56)	0.521** (4.53)
No. of obs.	7,351	7,351	7,351	7,351	7,351
Pseudo-R^2	0.176	0.106	0.108	0.177	0.176

(continued on next page)

TABLE 4 (continued)
Bank Competition and Regulatory Actions

	1	2	3	4	5
Panel B. Bank Failures (FAILED)					
Constant	−11.331** (−13.29)	−11.736** (−18.93)	−12.083** (−18.91)	−11.292** (−13.27)	−11.405** (−13.33)
COMPETITION-H		−2.733** (−3.94)		−2.403** (−3.12)	
COMPETITION-C			−1.845** (−3.33)		−1.065 (−1.74)
INTEREST_MARGIN	0.322** (4.59)			0.303** (4.32)	0.298** (4.19)
TIER_1	−0.148** (−5.04)			−0.149** (−5.12)	−0.151** (−5.15)
ASSET_RISK	0.065** (8.64)			0.063** (8.33)	0.063** (8.41)
ROA	−0.542** (−9.57)			−0.548** (−9.64)	−0.535** (−9.42)
LIQUIDITY	−0.123** (−3.71)			−0.123** (−3.75)	−0.123** (−3.73)
TOTAL_ASSET	0.063 (1.45)	0.044 (1.05)	0.040 (0.94)	0.057 (1.30)	0.054 (1.24)
LOAN_TO_ASSET	0.003 (0.30)	0.050** (7.94)	0.049** (7.89)	0.003 (0.32)	0.002 (0.23)
LOAN_REAL_ESTATE	0.055** (9.59)	0.048** (9.15)	0.044** (8.35)	0.055** (9.66)	0.053** (9.07)
UNINSURED_DEPOSIT	0.005 (1.13)	0.020** (4.92)	0.019** (4.44)	0.005 (0.98)	0.004 (0.83)
FED	−0.022 (−0.11)	0.075 (0.38)	0.086 (0.43)	−0.003 (−0.01)	−0.002 (−0.01)
OCC	0.182 (1.02)	0.159 (0.93)	0.148 (0.87)	0.205 (1.14)	0.199 (1.10)
No. of obs.	7,351	7,351	7,351	7,351	7,351
Pseudo-R^2	0.242	0.137	0.137	0.246	0.243

Again, these results are mitigated but still significant when we add five bank actions in columns 4 and 5. The fact that competition measures are still statistically significant in both the enforcement and bank failure tests after we control for the five dimensions of bank risk taking is important and implies that the ex ante risk measures, even collectively, are not a sufficient statistic for the effect of competition on the risk of bank failure. This suggests that examining the effect of competition using ex ante risk proxies understates the overall effect of competition on bank failure.

In Table 5, we examine the robustness of our results to an alternative measure of bank competition, the Panzar–Rosse (1987) H-statistic as adapted by Claessens and Laeven (2004). This proxy measures the elasticity of interest revenue with respect to the bank's input prices, specifically as we calculate it, to interest, personnel, and other operating and administrative expenses. This measures the long-run tendency of banks to pass on cost increases. Higher values indicate greater competition. The drawback of this measure, and the reason that we use it in robustness rather than primary tests, is that it assumes that the banking industry is in long-run equilibrium. Because our study focuses on the financial crisis, during which we find a significant change in bank competition, this assumption does not likely hold for our sample period. However, a number of recent studies rely upon

TABLE 5

Alternative Measure of Competition: Panzar–Rosse (1987) H-Statistic

Table 5 presents the comparison of the Panzar–Rosse (1987) H-statistic between banks that were subjected to regulatory actions (enforcement actions (ENFORCE) and bank failures (FAILED)) and those that were not. "The H-statistic is calculated by estimating the sum of the elasticities of reduced-form revenue equations with respect to factor input prices. . . . In other words, the H-statistic measures the ability of a bank to pass on increases in factor input prices to customers" (Schaeck et al. (2009), p. 714). Higher values of the H-statistic indicate more competitive markets. ** and * indicate significance at the 1% and 5% levels, respectively.

	ENFORCE		
	Yes	No	Difference
H-STATISTIC	0.7581	0.8997	−0.1416*
	FAILED		
	Yes	No	Difference
H-STATISTIC	0.6988	0.8885	−0.1897*

the H-statistic; for completeness we also use this measure. A higher score indicates a greater degree of competition, with 1 indicating a perfectly competitive market. We find that H-STATISTIC is significantly lower for banks that received regulatory enforcement letters and those that failed, compared with those that did not. This is consistent with our hypothesis that greater competition in the banking industry increases banking stability.

V. Competition and Real Estate Prices

We next examine the relationship between banking competition and changes in real estate prices both before and during the crisis. We obtain data on residential real estate prices from the Federal Housing Finance Agency, which maintains a quarterly house price index (HPI) of single-family house prices. The HPI is a weighted, repeat-sales index, meaning that it measures the average price changes in repeat sales or refinancings on the same properties. This information is obtained by reviewing repeat mortgage transactions on single-family properties with mortgages that have been purchased or securitized by Fannie Mae or Freddie Mac since Jan. 1975. We use the state-level HPI to calculate the changes in housing prices for each of the 50 states and Washington, DC.

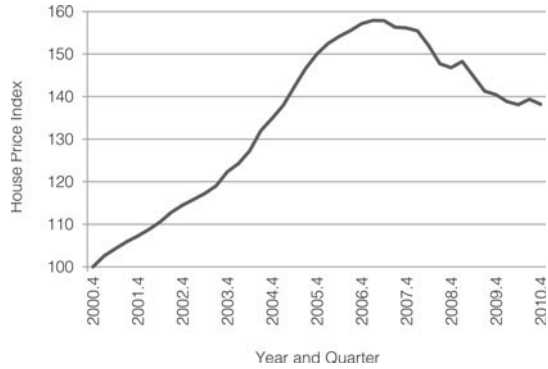
The national pattern of residential real estate prices in the United States is presented in Figure 2. As can be seen from the figure, the drop in housing prices starts in 2007 and precedes the start of the financial crisis. Hence, we define the "crisis period" for the housing price analyses to be between 2007 and 2010, rather than 2008 to 2010. There is a clear, monotonic increase in the national HPI in the precrisis period from the beginning of 2000 to the end of 2006. Over this time period, housing prices increased by almost 60% nationwide. However, from the beginning of 2007 through the end of 2010, the HPI dropped about 12%. Although the HPI at the end of 2010 is still well above that at the end of 2000, this drop represents a dramatic reversal in the real estate pricing trend.

In this section, we examine the role of competition in influencing housing price changes from two time periods, 2001–2006 and 2007–2010. For the analyses in this section, we use the average competition proxies measured from 2001

FIGURE 2

Pattern of Real Estate Prices in the United States

Figure 2 presents the pattern of real estate prices from Q4 2000 to Q4 2010. We obtain real estate prices from the Federal Housing Finance Agency, which maintains a quarterly HPI of single-family home prices. We rescale the HPI so that the base period is Q4 2000 and assign it an index of 100.



to 2006. Table 6 provides, for each state, some descriptive information about our measures of competition (not as yet multiplied by −1), HERFINDAHL and CONCENTRATION, and changes in the HPI, for 2001–2006 and 2007–2010 separately, across the 50 states and Washington, DC. We find statistics similar to those in Table 2. Kansas has the lowest HERFINDAHL at 0.027, whereas Utah has the highest at 0.370; Iowa has the lowest CONCENTRATION at 0.249, and Delaware has the highest at 0.915. The change in the HPI is positive for the 2001–2006, ranging from 0.186 in Michigan to 1.414 in Washington, DC. The change in the HPI from 2007 to 2010 is mostly negative and ranges from −0.466 in Nevada to 0.120 in North Dakota.

To examine the relation between changes in housing prices and competition, we rely on the following basic regression specification:

$$(6) \quad \text{HPI\_CHANGE} = \alpha + \beta_1 \text{ COMPETITION} + \Sigma\beta_j \text{ CONTROLS}_j + \varepsilon.$$

The dependent variable is HPI_CHANGE, either for 2001–2006 (the pre-crisis period) or 2007–2010 (the crisis period). As in our previous regressions, COMPETITION is either COMPETITION-H or COMPETITION-C. To control for potential correlated omitted variables, we include a number of control variables (CONTROLS) that correspond to each period. Our controls are WALK, CH_UNEMPLOYMENT, CH_GDP_PER_CAPITA, and CH_POPULATION. WALK is an indicator variable equal to 1 if the state is a nonrecourse mortgage state. We use the classification from Ghent and Kudlyak (2011), who show that nonrecourse status affects mortgage defaults. CH_UNEMPLOYMENT is the percentage change in the unemployment rate over the measurement period. CH_GDP_PER_CAPITA is the percentage change in gross domestic product (GDP) per capita over the measurement period. CH_POPULATION is the percentage change in population over the measurement period. The sample in the analyses consists of 51 observations, specifically, the 50 states and Washington, DC.

TABLE 6

Distribution of Bank Competition and Housing Price Changes across the 50 States and Washington, DC

Table 6 presents the average Herfindahl index (HERFINDAHL) and the concentration ratio (CONCENTRATION) of banks operating within each of the 50 states and Washington, DC, from 2001 to 2006. For each year, the Herfindahl index and the concentration ratio are computed using the distribution of the branch deposits within a state in the year. The Herfindahl index is the Herfindahl index of deposits held by banks within the state. The concentration ratio is the percentage of deposits held by the five largest banks within the state. The table also presents the changes in the HPI (HPI_CHANGE) over two periods: i) 2001–2006 and ii) 2007–2010. Each change is computed as the HPI at the end of the period minus the HPI at the beginning of the period, divided by the HPI at the beginning of the period.

State	HERFINDAHL (2001–2006)	CONCENTRATION (2001–2006)	HPI_CHANGE (2001–2006)	HPI_CHANGE (2007–2010)
AK	0.254	0.900	0.599	0.019
AL	0.091	0.631	0.373	−0.005
AR	0.039	0.362	0.368	−0.014
AZ	0.220	0.810	1.049	−0.378
CA	0.101	0.591	1.226	−0.329
CO	0.070	0.490	0.291	−0.032
CT	0.104	0.623	0.685	−0.107
DC	0.166	0.816	1.414	−0.080
DE	0.263	0.915	0.808	−0.114
FL	0.093	0.567	1.251	−0.372
GA	0.085	0.567	0.345	−0.104
HI	0.236	0.914	1.220	−0.134
IA	0.023	0.249	0.273	0.029
ID	0.098	0.526	0.677	−0.163
IL	0.032	0.298	0.475	−0.115
IN	0.036	0.328	0.200	−0.013
KS	0.027	0.297	0.281	0.019
KY	0.028	0.319	0.276	0.022
LA	0.092	0.567	0.463	0.024
MA	0.095	0.526	0.612	−0.111
MD	0.088	0.586	1.131	−0.183
ME	0.073	0.504	0.692	−0.066
MI	0.082	0.562	0.186	−0.196
MN	0.116	0.485	0.533	−0.138
MO	0.055	0.428	0.373	−0.041
MS	0.059	0.498	0.355	−0.019
MT	0.069	0.479	0.664	−0.001
NC	0.186	0.763	0.346	−0.014
ND	0.041	0.366	0.424	0.120
NE	0.033	0.347	0.230	0.005
NH	0.196	0.767	0.667	−0.134
NJ	0.068	0.492	0.932	−0.136
NM	0.093	0.555	0.594	−0.060
NV	0.211	0.726	1.091	−0.466
NY	0.117	0.616	0.784	−0.081
OH	0.066	0.507	0.196	−0.054
OK	0.036	0.351	0.314	0.062
OR	0.112	0.667	0.757	−0.160
PA	0.055	0.443	0.616	−0.025
RI	0.170	0.807	0.992	−0.186
SC	0.082	0.553	0.393	−0.029
SD	0.344	0.590	0.364	0.066
TN	0.074	0.543	0.346	−0.005
TX	0.057	0.459	0.295	0.058
UT	0.370	0.814	0.470	−0.085
VA	0.083	0.593	0.916	−0.110
VT	0.128	0.684	0.726	−0.011
WA	0.100	0.616	0.730	−0.137
WI	0.064	0.472	0.392	−0.048
WV	0.075	0.541	0.405	0.006
WY	0.065	0.469	0.678	0.036
Mean	0.108	0.560	0.598	−0.078

In Table 7, we present the results of our examination of the relationship between banking competition and housing prices over both the precrisis and crisis periods. The dependent variable in the first (last) two columns is the change in real estate prices from 2001 to 2006 (2007 to 2010). The results in columns 1 and 2

TABLE 7

Bank Competition and Changes in Real Estate Prices

Table 7 presents the regression analysis of the relation between bank competition and changes in real estate prices. The sample consists of the 50 states and Washington, DC, resulting in 51 observations. In columns 1 and 2, the dependent variable is the percentage change in the HPI, HPI_CHANGE, from 2001 to 2006. In columns 3 and 4, the dependent variable is the percentage change in the HPI from 2007 to 2010. For each of the two periods, COMPETITION-H (COMPETITION-C) is the average deposits-weighted Herfindahl index (concentration ratio), which is multiplied by −1 so that higher values indicate more competition. WALK is an indicator variable equaling 1 if the state is a nonrecourse mortgage state, and 0 otherwise. CH_UNEMPLOYMENT is the percentage change in the unemployment rate, CH_GDP_PER_CAPITA is the percentage change in GDP per capita, and CH_POPULATION is the percentage change in population over the relevant subperiod (2001–2006 or 2007–2010). The *t*-statistic of each coefficient is provided in parentheses below the coefficient. Significance levels are based on 2-tailed tests. ** and * indicate significance at the 1% and 5% levels, respectively.

	Dependent Variable: HPI_CHANGE			
	2001–2006		2007–2010	
	1	2	3	4
Constant	0.201 (1.61)	−0.196 (−1.30)	0.055 (1.67)	0.114** (2.74)
COMPETITION-H	−0.939 (−1.71)		0.287* (1.98)	
COMPETITION-C		−0.942** (−4.27)		0.174** (2.59)
WALK	−0.079 (−0.80)	−0.082 (−0.96)	−0.065* (−2.37)	−0.060* (−2.24)
CH_UNEMPLOYMENT	−0.163 (−0.62)	−0.077 (−0.33)	−0.127** (−3.83)	−0.117** (−3.56)
CH_GDP_PER_CAPITA	2.851** (2.76)	2.776** (3.09)	1.064** (3.92)	1.040** (3.95)
CH_POPULATION	1.206 (1.11)	0.757 (0.82)	2.490** (3.22)	2.294** (3.11)
No. of obs.	51	51	51	51
Adj. R^2	0.265	0.443	0.586	0.609

indicate that more competition is associated with lower real estate price increases: The respective coefficients for COMPETITION-H and COMPETITION-C are −0.939 and −0.942, both significant. Thus, we find that more competition within a state's banking environment is associated with a smaller increase in real estate prices over this precrisis period. The relationship between competition and changes in real estate prices during the crisis period is shown in columns 3 and 4. Here, we find that more competition is associated with a smaller decrease in real estate prices: The coefficients for COMPETITION-H and COMPETITION-C are a statistically significant 0.287 and 0.174, respectively. Perhaps not surprisingly, we find that unemployment growth and borrowers' ability to walk away from their mortgage obligations (through nonrecourse mortgages) are strong drivers of the real estate price decline from 2007 to 2010.

The reversal in the sign on the competition coefficients between the first two and last two columns in Table 7 provides us with an interesting insight into the effects of banking competition on real estate prices. States with less competition in the precrisis period experienced a higher run-up in real estate prices. However, these states also experienced the greatest real estate price declines during the financial crisis from 2007 to 2010. This evidence is inconsistent with competition increasing real estate price inflation and suggests instead that a lack of banking competition inflated real estate prices to artificially high levels and contributed to the financial crisis.

Next, to gain more insight into how banking competition may have affected real estate prices, we examine the relation between banking competition and mortgage-lending decisions. For this, we use approval rates on individual mortgage applications collected under the Home Mortgage Disclosure Act (HMDA) of 1975. The HMDA requires financial institutions to record and disclose annual data about home loan applications. Institutions covered by the HMDA are required to keep a Loan Application Register (LAR), which they submit to the government in March of each year. We obtain the 2006 national LAR data from the Federal Financial Examination Council and use it for our analyses of the relation between competition and loan rejection.[12] We keep only observations for which the applications were either approved or denied. We also drop observations for multiple-family homes because this represents a different market than the one for single-family homes, and our housing price data are also only for single-family homes. These data restrictions reduce the sample from 34,105,441 to 22,902,686 observations.

The regression specification that we use to examine the association between competition and loan rejections is:

$$\text{LOAN\_REJECTION} = \alpha + \beta_1 \text{ COMPETITION} + \Sigma\beta_j \text{ CONTROLS}_j + \varepsilon. \tag{7}$$

The dependent variable LOAN_REJECTION is an indicator variable equal to 1 if the loan was rejected, and 0 otherwise. We construct the following control variables (CONTROLS): i) LOAN_AMOUNT; ii) indicator variables identifying loans with special backing from the Federal Housing Administration (LOAN_TYPE2), Veterans Administration (LOAN_TYPE3), or the Farm Service Agency or the Rural Housing Service (LOAN_TYPE4), the omitted loan type (LOAN_TYPE1) consists of regular loans; iii) INCOME; and iv) a series of indicator variables capturing applicants' gender and ethnicity (FEMALE, HISPANIC, NATIVE_AMERICAN, ASIAN, BLACK, and PACIFIC_ISLANDER). LOAN_AMOUNT and INCOME are measured in thousands of dollars. We drop loan applications with missing control variables. The final sample consists of 21,454,463 loan observations. We also include as controls the following state-level variables: WALK, CH_UNEMPLOYMENT, CH_GDP_PER_CAPITA, and CH_POPULATION.

Table 8 presents the descriptive statistics of the sample used in the analyses. We find that 28.9% of home loan applications from our 2006 sample were rejected. The means for COMPETITION-H and COMPETITION-C are −0.121 and −0.618, respectively. About 2.2% of the loan applicants were insured by the Federal Housing Administration (FHA). Almost 70% of home loan applicants in 2006 were men, and 71.1% of all applicants were Caucasian.

In Table 9, we display the results for tests examining the impact of competition on loan rejection rates. This table presents the logistic regression results for

[12] Data are available at http://www.ffiec.gov/hmda/hmdaproducts.htm#LAR_TS. Prior studies using these data typically focus on whether loan originators engage in discriminatory lending practices based on borrower characteristics such as income, gender, and ethnicity (e.g., Canner and Smith (1991), Munnell, Tootell, Browne, and McEneaney (1996)).

TABLE 8

Descriptive Statistics for Loan-Level Analysis

Table 8 provides the descriptive statistics of the variables used to examine the relation between bank competition and the rejection of loan applications. The sample consists of 21,454,463 loan applications. LOAN_REJECTION is an indicator variable equaling 1 if the loan is rejected, and 0 otherwise. COMPETITION-H (COMPETITION-C) is the average deposits-weighted Herfindahl index (concentration ratio) from 2001 to 2006, which is multiplied by −1 so that higher values indicate more competition. WALK is an indicator variable equaling 1 if the state is a nonrecourse mortgage state, and 0 otherwise. CH_UNEMPLOYMENT is the percentage change in the unemployment rate, CH_GDP_PER_CAPITA is the percentage change in GDP per capita, and CH_POPULATION is the percentage change in population, all measured over the 2001–2006 period. The remaining variables are loan-level variables. LOAN_AMOUNT is the applied-for loan amount (in millions). LOAN_TYPE2, LOAN_TYPE3, and LOAN_TYPE4 are indicator variables equaling 1 if the loan application is insured by the FHA, guaranteed by the Veterans Administration, or supported by the Farm Service Agency or the Rural Housing Service, respectively, and 0 otherwise; the base category is conventional loans. INCOME is the loan applicant's income (in thousands). FEMALE is an indicator variable that equals 1 if the loan applicant is female, and 0 otherwise. Indicator variables are created for each ethnic group: HISPANIC, NATIVE_AMERICAN, ASIAN, BLACK, and PACIFIC_ISLANDER, with the base category being CAUCASIAN.

Variable	Mean	Std. Dev.	P25	Median	P75
LOAN_REJECTION	0.289	0.453	0.000	0.000	1.000
COMPETITION-H	−0.121	0.058	−0.153	−0.111	−0.085
COMPETITION-C	−0.618	0.126	−0.683	−0.637	−0.556
WALK	0.481	0.500	0.000	0.000	1.000
CH_UNEMPLOYMENT	−0.028	0.173	−0.143	−0.063	0.106
CH_GDP_PER_CAPITA	0.087	0.047	0.059	0.079	0.135
CH_POPULATION	0.055	0.044	0.017	0.043	0.081
LOAN_AMOUNT	0.178	0.204	0.062	0.128	0.232
LOAN_TYPE2	0.022	0.147	0.000	0.000	0.000
LOAN_TYPE3	0.007	0.081	0.000	0.000	0.000
LOAN_TYPE4	0.001	0.032	0.000	0.000	0.000
INCOME	0.099	0.139	0.048	0.072	0.112
FEMALE	0.315	0.465	0.000	0.000	1.000
HISPANIC	0.132	0.339	0.000	0.000	0.000
NATIVE_AMERICAN	0.009	0.097	0.000	0.000	0.000
ASIAN	0.037	0.188	0.000	0.000	0.000
BLACK	0.111	0.314	0.000	0.000	0.000
PACIFIC_ISLANDER	0.007	0.081	0.000	0.000	0.000

the full loan sample and for two subsamples split by the median income-to-loan-amount ratio. The subsample analysis allows us to investigate whether there is any differential effect of competition on the approval of riskier loans. We find in the first three columns that greater competition, captured by COMPETITION-H, is associated with more loan rejections, as indicated by the statistically significant coefficients of 0.540, 0.893, and 0.493. These results are inconsistent with the notion that competition leads banks to take on more risky loans in a race to the bottom. Instead, they support the hypothesis that competition reduces bank risk taking. The results in the second and third columns indicate that the positive relation between competition and loan rejection is stronger for the riskier subsample, that with a low income-to-loan ratio. In the next three columns, we report the results when using COMPETITION-C as our competition proxy. We continue to find that greater competition is associated with higher loan rejection rates for the overall sample and the sample with a low income-to-loan ratio. Our results for the sample with a high income-to-loan ratio are qualitatively similar but not statistically significant at conventional levels. However, the difference between the two subsamples is statistically significant.

As expected, we find that a borrower with higher income is less likely to have his or her loan rejected. Moreover, if a loan has been backed by a federal agency, the probability of loan rejection lowers. We also find that these effects are stronger in the sample with a low income-to-loan ratio than in the sample with a high income-to-loan ratio. Consistent with previous literature, we also find that race is

TABLE 9

Bank Competition and Loan Rejections

Table 9 presents the results of the logistic regressions that examine the relation between competition and the likelihood of a loan application rejection. The dependent variable is LOAN_REJECTION. All of the variables are as defined in Table 8. Standard errors are clustered by bank. The *t*-statistic of each coefficient is provided in parentheses below the coefficient. Significance levels are based on 2-tailed tests. ** and * indicate significance at the 1% and 5% levels, respectively.

	Dependent Variable: LOAN_REJECTION					
		Income-to-Loan Ratio			Income-to-Loan Ratio	
	All	Low	High	All	Low	High
Constant	−0.708**	−0.506**	−0.793**	−0.647**	−0.401*	−0.733**
	(−4.64)	(−2.86)	(−5.25)	(−3.88)	(−2.15)	(−4.23)
COMPETITION-H	0.540**	0.893**	0.493*			
	(2.99)	(4.65)	(2.31)			
COMPETITION-C				0.203*	0.347**	0.192
				(2.07)	(3.58)	(1.63)
CH_UNEMPLOYMENT	0.123	0.182*	0.028	0.137	0.206*	0.039
	(1.50)	(2.11)	(0.31)	(1.71)	(2.46)	(0.46)
CH_GDP_PER_CAPITA	−0.959**	−1.474**	−0.778*	−0.946**	−1.416**	−0.774*
	(−2.88)	(−4.09)	(−2.12)	(−2.93)	(−3.98)	(−2.19)
CH_POPULATION	−0.983*	−0.431	−1.415**	−0.970*	−0.384	−1.405**
	(−2.11)	(−0.93)	(−2.98)	(−2.19)	(−0.89)	(−3.08)
WALK	0.105**	0.091**	0.121**	0.099**	0.079**	0.117**
	(3.75)	(2.96)	(3.83)	(3.53)	(2.60)	(3.65)
LOAN_AMOUNT	0.075	2.168**	−1.202**	0.072	2.158**	−1.202**
	(0.53)	(9.65)	(−3.52)	(0.52)	(9.66)	(−3.52)
LOAN_TYPE2	−0.830**	−0.899**	−0.671**	−0.830**	−0.899**	−0.670**
	(−6.07)	(−6.01)	(−4.17)	(−6.06)	(−6.01)	(−4.15)
LOAN_TYPE3	−1.383**	−1.471**	−1.112**	−1.383**	−1.470**	−1.112**
	(−10.91)	(−10.69)	(−9.43)	(−10.91)	(−10.70)	(−9.37)
LOAN_TYPE4	−0.783**	−0.889**	−0.572**	−0.791**	−0.900**	−0.581**
	(−4.89)	(−4.81)	(−4.02)	(−4.87)	(−4.79)	(−4.03)
INCOME	−1.743**	−9.376**	−0.394	−1.741**	−9.357**	−0.394
	(−4.37)	(−6.64)	(−1.73)	(−4.36)	(−6.64)	(−1.74)
FEMALE	0.102**	0.050*	0.134**	0.102**	0.051*	0.134**
	(5.19)	(2.50)	(5.92)	(5.19)	(2.52)	(5.92)
HISPANIC	0.242**	0.152*	0.333**	0.243**	0.152*	0.334**
	(4.54)	(2.48)	(7.07)	(4.55)	(2.48)	(7.07)
NATIVE_AMERICAN	0.505**	0.434**	0.554**	0.503**	0.431**	0.552**
	(4.04)	(3.19)	(5.11)	(4.03)	(3.16)	(5.10)
ASIAN	−0.136**	−0.201**	−0.051	−0.137**	−0.204**	−0.052
	(−2.87)	(−3.74)	(−1.15)	(−2.89)	(−3.77)	(−1.16)
BLACK	0.549**	0.471**	0.621**	0.552**	0.476**	0.624**
	(12.62)	(8.89)	(17.23)	(12.75)	(9.01)	(17.53)
PACIFIC_ISLANDER	0.241**	0.186**	0.279**	0.235**	0.176**	0.275**
	(4.47)	(3.22)	(6.26)	(4.29)	(2.96)	(6.10)
Difference between income-to-loan groups		−0.399*			−0.155	
		(−2.24)			(−1.76)	
No. of obs.	21,454,463	10,732,197	10,722,266	21,454,463	10,732,197	10,722,266
Pseudo-R^2	0.013	0.025	0.017	0.016	0.024	0.017

statistically associated with loan rejection rates. Specifically, Asians are less likely and other minorities more likely to have their home loan application rejected than are Caucasians. As noted in the prior literature, these results are not necessarily indicative of discrimination, as there are likely other factors correlated with race that these regressions do not capture, such as the choice of housing stock (Munnell et al. (1996)). Higher growth in unemployment (CH_UNEMPLOYMENT) and GDP per capita (CH_GDP_PER_CAPITA) are associated with fewer loan rejections, whereas greater population growth (CH_POPULATION) is associated with

more rejections. It is possible that when there has been a greater increase in unemployment, borrowers are more hesitant to apply for loans for fear of later losing their jobs. Therefore, only very strong borrowers apply for home loans under these conditions.

Panel A of Table 10 presents the distribution of the purposes for the loan applications. Home purchase, refinancing, and improvement make up 41.50%, 48.49%, and 10.01% of the loan applications in 2006, respectively. We repeat our

TABLE 10

Bank Competition and Loan Rejections by Loan Purpose

Table 10 presents further analyses of the results documented in Table 9. Panel A presents the distribution of the purposes behind the loan application (home purchase, refinancing, and home improvement). The remaining panels present the results of the logistic regressions that examine the relation between competition and the likelihood of a loan application rejection for each of the three purposes: purchase (Panel B), refinancing (Panel C), and improvement (Panel D). The dependent variable is LOAN_REJECTION. Control variables that are included in Table 8 are included but not tabulated. Standard errors are clustered by bank. The *t*-statistic of each coefficient is provided in parentheses below the coefficient. Significance levels are based on 2-tailed tests. ** and * indicate significance at the 1% and 5% levels, respectively.

Loan Purpose		Frequency			Percent		
Panel A. Loan Purpose							
Home purchase		8,903,032			41.50		
Home refinancing		10,403,447			48.49		
Home improvement		2,147,984			10.01		
	Dependent Variable: LOAN_REJECTION						
		Income-to-Loan Ratio			Income-to-Loan Ratio		
	All	Low	High	All	Low	High	
Panel B. Home Purchase Loans							
COMPETITION-H	0.348 (1.43)	0.948** (3.98)	−0.036 (−0.14)				
COMPETITION-C				0.183 (1.72)	0.463** (4.17)	−0.012 (−0.11)	
Constant and controls	Yes	Yes	Yes	Yes	Yes	Yes	
Difference between income-to-loan groups		−0.983** (−6.47)			−0.475** (−6.88)		
No. of obs.	8,903,032	4,402,068	4,500,964	8,903,032	4,402,068	4,500,964	
Pseudo-R^2	0.023	0.029	0.021	0.023	0.029	0.021	
Panel C. Home Refinancing Loans							
COMPETITION-H	1.283** (6.26)	1.456** (6.96)	1.525** (5.26)				
COMPETITION-C				0.545** (4.66)	0.623** (6.03)	0.667** (4.07)	
Constant and controls	Yes	Yes	Yes	Yes	Yes	Yes	
Difference between income-to-loan groups		0.069 (0.28)			0.044 (0.34)		
No. of obs.	10,403,447	5,913,056	4,490,391	10,403,447	5,913,056	4,490,391	
Pseudo-R^2	0.012	0.023	0.011	0.012	0.023	0.011	
Panel D. Home Improvement Loans							
COMPETITION-H	1.076** (4.13)	1.592** (5.05)	1.041** (3.81)				
COMPETITION-C				0.301* (2.15)	0.495** (2.66)	0.316* (2.20)	
Constant and controls	Yes	Yes	Yes	Yes	Yes	Yes	
Difference between income-to-loan groups		−0.551 (−1.66)			−0.178 (−1.04)		
No. of obs.	2,147,984	417,073	1,730,911	2,147,984	417,073	1,730,911	
Pseudo-R^2	0.034	0.044	0.035	0.034	0.043	0.035	

earlier analyses from Table 9 separately for each of these three categories. Panel B presents our results for examining the effects of competition on home purchase loans. For brevity, we report only the coefficients on our competition measures, although we include in this analysis all the controls used in Table 9. We again fail to find results consistent with competition inducing banks to employ more lenient standards for home loan approvals. In fact, we find that greater competition is associated with a higher probability of rejection for home purchase loans for borrowers with a low income-to-loan ratio.

In Panel C of Table 10, we present our results for refinancing loan applications. For these loan applications, we find results for the full sample, the sample with a low income-to-loan ratio, and the sample with a high income-to-loan ratio to be consistent with greater competition resulting in higher loan application rejection rates. In the full sample, we find that a 1-standard-deviation difference in COMPETITION-H (COMPETITION-C) is associated with a 1.7% (1.5%) difference in the probability of the loan being rejected. Unlike the other types of loans, we do not find any differences between the low and the high income-to-loan groups for refinancing loans. Given that interest rates were rising during the period leading up to 2006, it is unlikely that these refinancing loans are driven solely by borrowers trying to take advantage of lower rates.

Finally, in Panel D of Table 10, we show the results using the smaller subset of home improvement loans. Similar to the other major categories of mortgage loans, we find evidence consistent with greater competition being related to stricter lending standards. We find statistically significant results for all six specifications. In addition, we find that the effect is most pronounced for the riskiest loans, although this difference is statistically significant only for the tests using COMPETITION-H. Overall, the loan rejection tests presented in Tables 9 and 10 support our earlier analyses, which also find results consistent with competition not inducing excessive risk taking but actually alleviating it.

VI. Conclusion

Using the recent financial crisis as our setting, we reexamine the effect of banking competition on the stability of the banking sector. We employ two distinct approaches. Our first approach examines the effects of competition on stability at the bank level. Consistent with the predictions of Boyd and De Nicoló (2005), we find that banks facing greater competition earn lower interest margins and make investments with lower risk. We also find that banks facing more competition have lower profitability, cash holdings, and Tier 1 capital than other banks. We follow up on this analysis by examining the link between banking competition and both regulatory enforcement actions against troubled banks and bank failures, which more directly measure bank stability. We predict and find that banks facing greater competition are less likely to be targeted for regulatory enforcement and are less likely to fail.

In our second set of tests, we examine the macro effects of banking competition and risk taking. In particular, we focus on the effect of competition on risk taking in the residential real estate market. We argue that if a lack of competition encourages risky investment behavior in the residential mortgage market, this will

lead to a greater supply of credit. This lending would have driven up real estate prices leading into the crisis and have been followed by a greater drop in real estate prices during it. Our findings are consistent with this hypothesis, suggesting that the degree of banking competition affects housing prices.

We corroborate the findings on housing prices by examining the relation between lending standards in the mortgage market and bank competition. We find evidence that states with greater competition have stricter lending standards in the form of a greater fraction of rejected mortgage applications. These results suggest that weaker lending standards in states with lower competition were associated with the housing market's boom and bust. Overall, our study suggests that within the United States, greater banking competition is associated with greater rather than lower financial stability.

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