Finance and Economics Discussion Series
Divisions of Research & Statistics and Monetary Affairs
Federal Reserve Board, Washington, D.C.

Capital Ratios and Bank Lending: A Matched Bank Approach

Mark Carlson, Hui Shan, and Missaka Warusawitharana

2011-34

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Missaka Warusawitharana[*]

This paper examines the impact of bank capital ratios on bank lending by comparing differences in loan growth to differences in capital ratios at sets of banks that are matched based on geographic area as well as size and various business characteristics. We argue that such comparisons are most effective at controlling for local loan demand and other environmental factors. For comparison we also control for local factors using MSA fixed effects. We find, based on data from 2001 to 2009, that the relationship between capital ratios and bank lending is insignificant until the recent financial crisis. We also find that the effect of capital ratios on loan growth varies by type of loan, with some of the strongest effects in recent years being for commercial real estate loans. Finally, we show that the elasticity of bank lending with respect to capital ratios is higher when capital ratios are relatively low, suggesting that the effect of capital ratio on bank lending is nonlinear.

JEL Classification: E51, G21, G28

Keywords: Regulatory capital, bank capital, bank lending

[*] Federal Reserve Board, 20th Street and Constitution Avenue NW, Washington DC, 20551. Carlson: mark.a.carlson@frb.gov, Shan: hui.shan@frb.gov, Warusawitharana: missaka.n.warusawitharana@frb.gov. We thank staffs of the Board of Governors of the Federal Reserve and of the Federal Reserve Bank of New York as well as participants at the Federal Reserve System applied microeconomics conference for valuable comments. The views presented in this paper are solely those of the authors and do not necessarily represent those of the Federal Reserve Board or its staff.

Section 1. Introduction

The impact of regulatory capital requirements on bank lending has been debated for some time.[1] In the wake of the recent financial crisis, the topic has seen renewed attention as concerns arose that large losses at banks would reduce their capital and restrain their lending and as the regulatory community discussed increases in bank capital (See Greenlaw, Hatzius, Kashyap, and Shin 2008; Mora and Logan 2010; Berrospide and Edge 2010; Rice and Rose 2010).

A perennial challenge when testing the impact of capital on loan growth is separating supply from demand. For example, changes in the economic environment that affect bank capital also likely affect the demand for loans. Deteriorations in the economic environment can cause losses for banks that decrease bank capital; declines in bank capital might result in the regulatory capital ratios becoming binding, or coming closer to binding than the bank might prefer, and prompt the bank to curtail lending. At the same time, deteriorations in economic activity may also reduce the number of borrowers seeking loans.[2]

Scholars have attempted to deal with the supply versus demand problem in a number of ways. Some have used the cross-country nature of banking to see what the impact of a capital shock to banks in one country has on their lending behavior in other countries, where demand is presumably not affected by the shock (Peek and Rosengren 1995, Mora and Logan 2010). Others have looked for natural experiments that have resulted in an exogenous shock to bank capital (Rice and Rose 2010). Still others have embedded the banking system in a dynamic model in which proxies for demand are included directly (Hancock and Wilcox 1993, Berrospide and Edge 2010, Gamacorta and Mistrulli 2004).

In this paper, we deal with the supply versus demand problem in a new and innovative way. Reasoning that banks in the same location face the same economic environment, we compare each bank to a matched set of neighbors to test whether differences in the capital ratios between the bank and its matched neighbors correspond to differences in loan growth during the

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[1] A number of papers have provided theoretical reasons why capital ratios should matter. The general argument is that since banks are relatively opaque, adverse selection problems result in a premium on risky bank liabilities. As bank capital ratios deteriorate, this risk premium becomes larger and banks are less able, and find it considerably more expansive, to issue risky liabilities to fund new assets (Stein 1998, Jayaratne and Morgan 2000, Kishan and Opiela 2000, Ven Den Heuvel 2002). Thakor (1996) provides a slightly different reason where he argues that binding capital requirements increase the cost of funds and thus results in more rationing. Ven Hoose (2007) provides a useful survey of the theoretical literature.

[2] See Peek and Rosengren (2010) for a detailed discussion of the endogeneity issue.

following year.[3] As the local environment for these institutions is the same, differences in outcomes ought to be related to differences between the banks. To construct the matched set of neighboring banks, we first use geographic constraints as this factor is vital for ensuring that the paired institutions face the same environment. Subject to the location restriction, we then select neighboring institutions that are of roughly similar size and who have similar portfolios of assets and liabilities.[4] We create a set of neighboring banks for each bank for each year between 2001 and 2009. (We actually create two sets of neighboring banks as we construct a one-to-one (1-1) matched set and a one-to-several (1-N) matched set.)

Our technique has a number of benefits. First, we avoid the concern that any list of observables related to local economic conditions may omit some variables, or may not fully capture all the factors, that are important for economic conditions and local demand. We argue that using matching, which differences out the local effects, is a more robust way to deal with local economic conditions. Second, our matching approach provides a fairly large number of observations, about 3,000 bank groups per year, that allow a number of useful experiments. In addition to testing whether the capital levels matter, we can also explore whether the effect varies over time and whether certain types of lending—such as commercial real estate or consumer lending—are more likely to be affected by bank capital status. Further, we can examine whether the impact of differences in capital ratios matters more when the regulatory threshold is closer to binding.

A disadvantage to our approach is that we are limited to studying a sample of smaller institutions with a well-defined geographic scope and for whom our assumption that the banks receive most of their business form the local vicinity seems most plausible. On balance, we believe that the advantages decidedly outweigh the disadvantages.

To confirm that our results are robust, we use metropolitan statistical area (MSA) fixed effects as an alternate method of controlling for variation in local demand conditions. Fixed location effects provide a general control for the local environment. The benefit of the fixed

[3] A variety of research has indicated that banks are quite closely tied to their local economy. Pederson and Rajan (1994) find that the local environment was important for banks lending using data from the late 1980s. Aubuchon and Wheelock (2010) find that, even a decade after the removal of branch banking restrictions, many banks operate in a small number of markets and are vulnerable to local economic distress. Brevoort, Holmes, and Wolken (2010) look at reports by small businesses regarding the distance to their lender and find that the median distance between the business and the commercial bank they interact with was around 4 miles in 2003.

[4] As described in greater detail below, our empirical analysis relies exclusively on publicly available data for a sample of commercial banks in the United States.

effect approach is its simplicity—it does not require auxiliary assumptions on the degree of closeness required to define neighboring banks. The limitation of this approach is that an MSA fixed effect effectively compares banks based only on its geographic location, compared to our matching method which examines banks based on geography, size, and business model characteristics. Arguably, the comparison between a bank and its matched set of neighbors, which involves smaller geographic areas and incorporates bank business models, provides a more robust control for variation in local demand conditions.

Out main results indicate that banks that had higher actual capital ratios tended to have stronger loan growth over the next year.[5] The coefficients in our regression analysis suggest that the size of the impact of a lower capital ratio on loan growth is somewhat smaller than has been found in some other studies. Perhaps more interestingly, we find that the effect varies over time. The effect is fairly strong during the recent financial crisis, in the years 2007 to 2009, but we do not find any significant association between capital ratios and loan growth during the years 2001 to 2006.[6,7]

Focusing more sharply on the years from 2007 to 2009, we find that certain types of lending appear more sensitive to capital adequacy than other types. In particular, we find fairly strong associations between differences in growth rates of commercial real estate lending and differences in capital ratios. Growth in other types of lending are associated with the leverage ratio but not other capital ratios.

We also find evidence that the relationship between capital ratios and loan growth is non-linear. Again focusing on the period from 2007 to 2009, we divide banks into groups depending on whether the capital ratio for the reference bank in the group is low, medium or high. We find that the capital ratios have a notably larger impact on loan growth when the capital ratio of the bank is low than when it is high. These results are especially true for risk-adjusted capital ratios.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 discusses the data and our method for matching banks. The analysis and results are presented in Section 4. Section 5 concludes.

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[5] Note that the results are with respect to higher actual capital ratios and not regulatory capital minimums.

[6] Other research has uncovered complementary findings. For instance, Berger and Bouwman (2009) find that well-capitalized banks tend to gain market share during banking crises.

[7] To be precise about the timing, we use 2007 to denote a regression of loan growth from the end of the 2nd quarter of 2007 to the end of the 2nd quarter of 2008 on bank capital as of the end of the 2nd quarter of 2007.

Section 2. Related literature

In this section, we review some of the previous literature that has examined the question of whether bank capital affects bank lending.[8] We first describe some of the approaches used to distinguish supply effects on bank lending from demand effects. Typically previous research has dealt with the supply and demand issue by either controlling explicitly for economic conditions or by looking for "natural" experiments where there is an exogenous shock that affects bank capital, and thus only supply, without affecting broader economic activity or the demand for loans. We then review the discussion in the literature regarding the use of regulatory capital ratios in these studies of bank lending, as opposed to using estimates of banks desired capital ratios.

Section 2.1 Attempts to separate demand from supply

As noted earlier, one of the key issues in determining whether bank capital affects the supply of bank loans is controlling for changes in demand. The concern is that the same conditions that result in reduced bank capital, such as the state of the economy, also reduce the demand for bank loans and, thus, create an alternative link between bank capital and bank lending. Such a link makes determining the size and significance of any relationship more difficult. One common approach is thus to control explicitly for economic conditions that might be related to loan demand such as unemployment rates, real personal income growth, commercial real estate vacancy rates, or real GDP growth. Some researchers have then used cross sectional or panel data analysis that uses regional variation in bank health and economic conditions to determine a relationship between bank capital and bank lending (Bernanke and Lown 1991, Berger and Udell 1994, Cornett, McNutt, Srahan, Tehranian 2011). Other researchers have placed bank capital and economic variables in a dynamic framework, such as a vector autoregression (Hancock, Laing, and Wilcox 1995, Hancock and Wilcox 1993, Gambacorta and Mistrulli 2004 and Berrospide and Edge 2010). While this approach can work well in certain circumstances, it produces results that are generally sensitive to specific modeling assumptions.

[8] There is a related literature on the impact of bank capital/solvency on the pricing of credit. Papers such as Hubbard, Kuttner, and Palia, (2002) have found that banks with lower capital ratios tend to charge higher rates on their loans, primarily to borrowers for which information costs are likely to be important. Other recent related work deals with bank capital and liquidity creation. Berger and Bouwman (2009a) find that increased capital boosted liquidity creation for larger banks but reduced it for smaller banks.

Generally this approach has found that bank capital does indeed impact bank lending, though estimates of the size of the effect have ranged notably across studies.[9] Among the estimates pointing to a larger effect, Bernanke and Lown (1991) find that a one percentage point increase in the capital/asset ratio increased the growth rate of loans by 2.6 percentage points while Hancock and Wilcox (1993) find that each $1 that banks fell short of regulatory capital reduced bank credit by $3.[10] Some of the more recent research has pointed to a somewhat smaller impact; Berrospide and Edge (2010) find that a one percentage point increase in the capital-to-asset ratio implies a 1.2 percentage point increase in the loan growth rate after controlling for the endogenous responses of other model variables.

An alternative method for separating supply and demand effects is to find a natural experiment where a shock impacts bank capital and potentially loan supply but does not affect loan demand; any change in loan growth could then be attributed to the impact of bank capital on loan supply. A common strategy is to look at multinational banks and observe how negative shocks originating in one country have impacted lending in another country. Peek and Rosengren (2000) look at the impact on the U.S. commercial real estate market from a deterioration in the condition of Japanese banks. Mora and Logan (2010) use losses on United Kingdom (UK) banks' loans to non-UK residents and see how this affected lending to UK residents. Puri, Rocholl, and Steffen (2011) look at whether loan application rejection rates at German savings banks were affected by exposures to German Landesbanken which were in turn exposed to, and suffered large losses from, the U.S. subprime housing market. One natural experiment that does not rely on cross-border banking is Rice and Rose (2010) who look at the impact on U.S. banks from write-downs of preferred stock issued by Fannie Mae and Freddie Mac when the two institutions were place into conservatorship by the government and dividends on preferred stock were eliminated. The results in papers using natural experiments also generally point to bank capital having an economically and statistically important impact on loan growth. In most cases, the results of the experiments do not allow for an estimate of the size of the impact; one exception is Mora and Logan (2010) who find that a one percent decline in capital reduced lending to UK residents by .67 percent.

[9] Ashcraft (2006) argues, and finds some evidence that capital is not very important, especially for larger banks that can rely on support from a parent bank holding company.

[10] Hancock and Wilcox also estimated the effect of a shortfall in bank capital relative to a target level of capital. Here the effects were somewhat smaller: an additional $1 in capital boosted loan growth by $1.5.

Section 2.2 Use of regulatory versus target capital

Another issue discussed in previous literature regarding the response of lending to shocks to capital is the issue of which capital ratio matters. Some previous research, such as Bernanke and Lown (1991) and Gembacorta and Mistrulli (2004), has focused more on the absolute levels of capital or thought about them with respect to regulatory minimums. Another approach that has been used, such as in Hancock, Laing, and Wilcox (1995), has been to focus on the level of capital relative to an estimated "target" capital ratio on the part of the bank. Target capital is typically estimated using partial adjustment models in which trends in capital are driven by movements toward the desired level of capital, earnings, size, and other bank specific factors as well as random shocks. Analysis using target capital ratios has the advantage that it takes account of the fact that some may have preferences for particular capital ratios and may adjust lending policies to reach those ratios even if the ratios otherwise appear "normal." However, analysis using target levels of capital is subject to concerns that the estimation procedure for the target level is misspecified. (See Berrospide and Edge 2010 for a more detailed discussion.) In this paper, we focus on either the absolute level or on the capital ratio relative to the minimum regulatory requirements for being well-capitalized.[11]

Section 3. Data and methodology

Here we discuss the data employed in the study and the method used for constructing the matched sets.

Section 3.1 Data

Income and balance sheet data for individual banks comes from the Reports of Income and Condition (Call Report). The balance sheet data we collect includes information on different types of loans held by the bank, the liability structure of the banks, and the components of the regulatory capital ratios. The dependent variable in our regression analysis is loan growth. As noted earlier, we calculate loan growth rates on an annual basis. When calculating total loans, we include unused commitments (though our results are not sensitive to doing so), but do not

[11] However, to the extent that banks with the same business model might have the same target level of bank capital, the matching strategy used in our paper might implicitly take account of target bank capital levels.

include unused commitments when examining individual loan types as information on such commitments are not systematically available for all loan types over the entire sample period. We also include information on income and expenses that allow us to compute items such as the bank's dependence on interest versus non-interest income as well as average rates paid on different types of deposits. We also collect information on delinquent loans and loans being charged-off so that we can control for measures of the credit quality of banks' portfolios.

In order to compare banks in similar areas (and thus facing similar economic conditions), we need to calculate the operating area for each institution.[12] To determine the operating area, we merge the Call Report data with the Summary of Deposits from the FDIC, which provides information on the street addresses of branches and the deposits located in those branches. The street addresses of the bank branch are translated to latitude and longitude data using geo-coding software. The Summary of Deposits data are only reported at the end of each June. Thus, we construct all our balance sheet variables using Call Report data as of the end of the second quarter of each year, and focus on changes in annual growth in loans from the end of the second quarter of each year to the end of the second quarter in the following year.

Decisions regarding lending policies and growth strategies are generally made at the bank holding company level rather than by individual banks in the holding company structure.[13] Further, considering the entire holding company likely provides a better assessment of the economic environment faced by the institution. Thus we consolidate the balance sheet and branch information to the holding company level. We build the consolidated institutions in this manner rather than using the information reported in the bank holding company consolidated reports (Y-9 regulatory filing) as it greatly facilitates using the branch location data, which is vital for our determination of the local economic environment of the banks. New banks also experience more rapid growth than older institutions. For this reason, we require the bank holding company to have at least three years of data to be included in the sample. Since bank mergers will distort the loan growth series we use in the study, we discard any bank that was involved in a merger over the period we measure loan growth.

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[12] For some banks, location may not provide a good indication of where the bank is making loans, such as banks that are predominantly in the credit card business. We exclude these institutions from our analysis. We also exclude other unusual types of banks such as industrial banks, non-deposit trusts, and banker's banks.

[13] As a robustness check, we repeat the estimation using bank holding companies with only one bank (i.e. institutions where there is no difference between the bank and bank holding company). We find similar results using this sample of institutions.

With all this information, we compute the location of each bank or bank holding company structure—referred to as a "bank," for short, from now on. For banks with a single office, this procedure is straightforward. For banks that have multiple branches, we calculate the weighted center of all the offices of the bank holding company, where the weights reflect the relative size of the branches in terms of deposits.[14] As the home office generally has the most deposits, the location of the geographic center of the bank is typically not too distant from the home office. We use this weighted center as the location of the bank. Banks with far flung branch networks likely face a range of economic environments. Thus, in order to have only banks whose center corresponds economic conditions faced by that bank, we exclude from our sample banks that do not have 80 percent of their total deposits within a specified distance, which varies inversely with the density of the state, from the weighted center of the bank.[15]

Section 3.2 Methodology for forming the sets of neighboring banks

The basic assumption in our model is that banks, especially smaller banks, tend to lend locally and thus, two banks in the same location face similar demand for loans. Petersen and Rajan (1994) find evidence of this in the late 1980s using information from the Small Business Administration. Recent work has further confirmed these findings and also demonstrated that it remains true despite the removal of many branch banking restrictions and the subsequent wave of mergers and acquisitions. Brevoort, Holmes, and Wolken (2010) look at small businesses borrowers and the median distance between the small business and its commercial bank is about 4 miles and that only 16.5 percent of small businesses reported having a relationship with a bank that was more than 30 miles away. Similarly, Aubuchon and Wheelock (2010) find that many banks predominantly serve local clientele, and remain exposed to local economic shocks, despite length of time since the removal of restrictions on branch banking. Providing further evidence about the geographic scope of banks, Heitfield and Prager (2004) find evidence that most types of deposits markets are also local in nature.

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[14] We calculated the weighted center using a spherical geometry formula. In practice, this is very similar to taking a weighted average of the latitude and longitude of each bank branch location.

[15] In particular, we limit our sample to banks in the 48 continental states and Washington DC. For the most densely populated state, New Jersey, we require banks to have 80% of their deposits within a radius of 50 miles. We scale the radius for other states by the square root of the ratio of the density of New Jersey (the densest state) to the density of the state the bank is located in. The distance increases to 750 miles for the least densely populated state, Wyoming. We treat Washington DC as having the same density as New Jersey.

Forming the set of neighboring banks involves two stages. Because our goal is to compare banks experiencing the same economic conditions and the same demand for credit, as a first stage we limit neighboring banks to be within the same geographic area and to be of roughly the same size. We require banks to be within the same geographic area by imposing a cut-off such that all neighboring banks be located within a particular distance of the weighted center of the bank. As less densely populated areas likely have banks that are similarly less densely located, we allow the distance cutoff used in our matching algorithm to vary with the population density of the state in which the bank is located.[16] The cut-off distance we use ranges from 10 miles in New Jersey to 150 miles in Wyoming.[17] We limit neighboring banks to be of roughly the same size by requiring that the total assets of all neighboring banks to be between one-third and three times the total assets of the bank.

Once we have restricted the set of possible neighboring banks to be in the same location and to be of roughly the same size, we then limit matched banks by business model characteristics. Banks with different business models might be differently affected by the economic environment even in the same location, so we match banks based on the similarity of balance sheets and income/expenses. For each bank we compute a variety of ratios reflecting the importance of different types of loans in each bank's portfolios, ratios reflecting the dependence on "core" versus "managed" liabilities, and importance of different income and expense items as a share of the total.[18] We standardize these ratios and compute the sum of squared differences between the ratios for each bank and all possible neighboring banks.

We construct two different matched sets.[19] In the first case, we match each bank with one other bank (we refer to this as 1-1 matching). Here we extract pairs of banks with the lowest sum of squared differences. Once a bank has been matched to another bank, it is removed from the eligible set of banks. We continue the matching process until the sum of squared differences

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[16] For banks that are located in multiple states, we assign them to the state that contains the largest amount of deposits.

[17] Note that these cut-offs are tighter than those for required deposit proximity. Distance cut-offs for neighbors based on density are scaled as before, using the square root of the ratio of the density of New Jersey (the densest state) to the density of the state the bank is located in. Results are robust to tighter cut-offs.

[18] Specifically these ratios are: commercial and industrial to total loans, commercial real estate loans to total loans, residential real estate loans to total loans, consumer loans to total loans, managed liabilities (such as large time deposits, federal funds borrowed) to interest bearing liabilities, securities to the sum of securities and loans, interest income to total income, interest expense to total expense, and the bank's net interest margin. These items are similar, though more extensive, to those used by Gambarcorta and Marques-Ibanez (2011) to proxy for a bank's business model.

[19] See Zhao (2004) for a discussion of some technical issues related to matching.

exceeds a particular threshold: the sum of the standardized variances of the ratios used to reflect a bank's business model (given that we standardize the variance of all the ratios to be .01, the threshold is effectively .09). In each year, we obtain about 1400 pairs of matched banks. The set of matches is recalculated each year; because a bank that has been paired to another bank is no longer eligible to be paired with another bank, changes in one pair will impact subsequent matches. Thus, the persistence of matched pairs from year to year is fairly low.[20]

In the second case, we match each bank to all neighboring banks (we refer to this as 1-N matching) that have a normalized sum of square differences of less than the sum of the standardized variance of each ratio, the threshold used previously.[21] In each year, we obtain about 3,300 independent observations in the 1-N matched sample.

Section 3.3 Summary statistics

Table 1 displays the summary statistics of our two matched samples and the unmatched sample used in the MSA fixed effect analysis. Even though the matching samples and the MSA fixed effects sample are constructed differently, Table 1 shows that they contain banks of similar characteristics with respect to size, capital ratios, and balance sheet and income variables. (Here and elsewhere in the paper, we assign the bank to the MSA in which the bank's headquarters is located.) In the 1-N matched sample, each bank is on average matched with 6 other banks. The average distance between matched banks is a just a bit more or just a bit less than 23 miles, depending on whether we are considering the 1-N matched sample or the 1-1 matched sample. As noted above, we allow distances between matched banks to be greater in less densely populated states; to show the impact of this procedure, we also report the distance between banks in population-density adjusted "New Jersey miles" (see Section 3.2). In terms of these adjusted distances, banks are much closer together, suggesting the larger distances allowed for less densely populated states has a notable impact on the distance between banks measure in miles. The 1-1 matched sample is the smallest sample, but nevertheless contains a sizable number of observations.

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[20] Among all the bank pairs matched in year *t*, approximately 40 percent of them remain matched pairs in year *t+1*.

[21] One complication is that the above procedure obtains N observations from each set of N banks that contain all of the neighboring banks of each bank in the set (an alternate characterization of such a set is that it is the smallest possible set such that any bank in the set will not have a matched bank outside the set). Since each observation involves differencing one bank with the average of all of its neighbors, these N observations will be linear. As such, we drop 1 observation from each such set of N banks.

During our sample period, total loans and commitments grow at an average of 5 to 6 percent per year. The average capital ratios are much higher than the minimum requirement for being well capitalized. For example, a bank needs to have 6 percent risk-adjusted tier 1 capital ratio to be regarded as well capitalized, and the average observed in our sample is 14 percent. (Previous work has also noted that smaller banks tend to hold more capital relative to assets. See for instance Demsetz and Strahan 1995.) In our sample, real estate loans, including both commercial and residential, constitute over half of banks' portfolio. These ratios are a bit higher than industry averages, but generally reflective of the averages for small banks.

The ratios on which banks are matched, the average difference in these ratios, and whether the differences are statistically different than zero are shown in Table 2. In most cases the differences are small on average, although the sample sizes are sufficiently large that the differences are often statistically significant. Also in Table 2, we report differences in some balance sheet ratios that we do *not* match on. Here again, the differences are generally quite small. In some cases, the differences are statistically different than zero, although not more often than the ratios we do match on. That items we do not match on are also generally similar between matched banks reinforces our view that the matched institutions are fairly comparable and provides some reassurance that there are not likely to be substantial unobserved differences between the matched banks.

Figure 1 shows the difference in leverage ratio between matched banks in the two matched samples. The distributions of differences are centered around zero and fairly symmetric. More importantly, there appears to be sufficient variation in these differences for our estimation to be effective. The corresponding figures for the other two capital ratios show a bit more variation (unreported).

Section 4. Analysis and results

In this section, we describe the setup of our analysis and present the results.

Section 4.1 Setup

The relationship between loan growth and a capital ratio can be modeled in the following way:

$$log\left(\frac{loan_{it+1}}{loan_{it}}\right) = \alpha + \beta CR_{it} + \mathbf{\Pi Z_{it}} + D_{it} + \varepsilon_{it}$$

CR_{it} is a regulatory capital ratio of bank *i* at year *t*—the leverage ratio, risk-adjusted tier 1 capital ratio, or total risk-adjusted capital ratio, and β is our key parameter of interest. $\boldsymbol{Z_{it}}$ is a vector of exogenous variables that affect loan growth. D_{it} captures the demand for loans in the area where the bank is located and may not be observable to econometricians. To the extent that the bank's capital ratio (CR_{it}) is correlated with local economic factors that may influence demand for loans, omitting D_{it} in the regression model would lead to biased estimates of β.

One simple way of controlling for local demand (D_{it}) is to include MSA fixed effects in the regression. Specifically, we estimate the following model using all banks that are eligible for inclusion in the matched sample:[22]

$$log\left(\frac{loan_{it+1}}{loan_{it}}\right) = \alpha + \beta CR_{it} + \gamma_1 log\left(\frac{loan_{it}}{loan_{it-1}}\right) + \gamma_2 log\left(\frac{loan_{it-1}}{loan_{it-2}}\right)$$
$$+\delta CO_{it} + \rho NP_{it} + MSA_{it} + \varepsilon_{it}$$

CO_{it} is the charge-off rate, and NP_{it} is the percent of non-performing loans. The MSA fixed effects control for common factors in year *t* that all banks within the same MSA face, including local economic condition and local demand for loans.[23] We also control for two years of lagged loan growth in our specification to allow for dynamics in the outcome variable. Since we require that the bank have several years of loan growth data, new banks are not included in the sample and our results will not be driven by differences in capital ratio and loan growth between new banks and mature banks. (In this specification we also control for all the balance sheet variables used in matching banks.)

Alternatively, we can control for local demand for loans (D_{it}) using the matching strategy. Once we obtain groups of matched banks that locate in the same geographic area, are

[22] We do apply the restrictions described previously such as requiring banks to have 80% of their deposits within a specific radius, having at least three years of data, not being a credit card bank, etc.
[23] Approximately 30 percent of the sample banks are outside of MSAs. For these banks, we control for county fixed effects instead. However, our results do not change if we exclude banks that are located outside of MSAs.

of comparable size, and have similar portfolio and business model, we can take the differences between the reference bank and its matched counterpart(s) and estimate the following model:

$$log\left(\frac{loan_{it+1}}{loan_{it}}\right) - log\left(\frac{loan_{mt+1}}{loan_{mt}}\right) = \beta(CR_{it} - CR_{mt})$$
$$+\gamma_1\left[log\left(\frac{loan_{it}}{loan_{it-1}}\right) - log\left(\frac{loan_{mt}}{loan_{mt-1}}\right)\right] + \gamma_2\left[log\left(\frac{loan_{it-1}}{loan_{it-2}}\right) - log\left(\frac{loan_{mt-1}}{loan_{mt-2}}\right)\right]$$
$$+\delta(CO_{it} - CO_{mt}) + \rho(NP_{it} - NP_{mt}) + (\varepsilon_{it} - \epsilon_{mt})$$

In the 1-1 matched sample, m indexes the bank that is matched to bank i. In the 1-N matched sample, variables with subscript m are the averages of all the banks that are matched to bank i in year t. The identification assumption of our matching strategy is that banks that are matched together face the same local demand ($D_{it} = D_{mt}$). By taking differences, we net out these common demand factors that may influence loan growth.[24] As a result, the coefficient of interest, β, only captures the effect of capital ratio on bank lending through supply channels. Note that β is the same in the fixed effect specification and the matched bank specifications despite the shift from using capital ratios levels at individual banks to using differences in capital ratios between banks.

The matching strategy implies a more flexible specification than the MSA fixed effects model. In particular, it allows banks of different sizes or business models to respond to local demand differently, whereas the MSA fixed effect model assumes that all banks, regardless of size or loan portfolio, have the same response to local demand factors. If we find very different results using the two methods, it suggests that the distinction between the identification assumptions of these two methods is empirically important. On the other hand, if we find similar results using the MSA fixed effects and the matching strategy, it suggests that MSA fixed effects may be a decent proxy for local demand factors, even though in theory the matching strategy controls better for supply versus demand effects.

[24] As part of our analysis, we also tried including controls for the structure of the banking environment, such as the level of competition. Like other local factors, the levels of these variables drop out in the matched sample analysis. We tried interacting measures of the level of competition with the capital ratios but did not find any significant effects.

Section 4.2 Baseline results

Results using observations from all years in a pooled sample are shown in Table 3. We find some evidence in favor of capital ratios impacting loan growth. The evidence is strongest for the leverage ratio which is significant in both matched bank samples and in the fixed effect sample. The other capital ratios are significant in the 1-N matched sample, highly significant in the fixed effect regression, and not quite statistically significant in the 1-1 matched sample. However, the magnitude of our estimates is smaller than what the previous literature has found. For example, while previous studies find that a one percentage point increase in capital ratio raises lending by 1-2 percentage points, our estimates using the matched banks suggest that a one percentage point increase in capital ratio raises lending by a considerably more modest 0.05-0.2 percentage points. Estimates using the fixed effect approach are similar. With respect to the other variables, we find some persistence in loan growth rates (i.e. banks that had relatively high growth rates tend to continue to have relatively high growth rates). Relatively poor loan performance, as measured by charge-off rates and non-performing loan rates, tend to be associated with slower subsequent loan growth rates. Finally, we note that the coefficients are generally quite similar between the matched bank samples and the MSA fixed effect sample, which supports the idea that these are different ways of estimating the same relationship.[25]

We next estimate our model for each year from 2001 through 2009, which allows the effect of capital ratio on bank lending to vary over time. Tables 4 to 6 present these results. To conserve on space, we report only the coefficients on the capital ratios. For all three regulatory capital ratios, we find that the relationship between the capital ratio and growth in bank lending over the subsequent year is largely insignificant in the years prior to the recent financial crisis. The coefficients on the capital ratios turn decidedly positive in 2007, and are in some cases significant, and become decidedly significant in 2008 and 2009.[26] In the years where the

[25] In robustness checks not shown, we also try including additional controls such as log of total assets and fractions of different types of loans. The estimates remain virtually the same as the baseline results. The baseline specification uses loans plus commitments. We also looked at these two components separately. For loans, the results are very similar. For commitments, the coefficients are larger but less precisely estimated.

[26] Prior to the financial crisis, the loan securitization market was booming. During the crisis, this market stopped abruptly. We investigated whether this dynamic might be a factor in our results and find little evidence supporting that hypothesis. Relatively few of the institutions in our sample, which tend to be smaller institutions, appear to have securitized loans. When indicator variables for securitizing loans were included in the regression, they were insignificant and did not change the other coefficients.

estimates are significant, the coefficients are larger than in the pooled sample, but still somewhat lower than has been found in the previous literature.

Our finding that capital ratios matters more during crisis periods is consistent with other related recent work. Using a panel of larger banks from 15 different countries and covering the period since 1999, Gambacorta and Marques-Ibanez (2011) also find that bank capital had a stronger effect on loan growth during the recent financial crisis. While not the focus of their paper, Cornett, McNutt, Strahan, and Tehranian (2010) find a stronger effect of capital on credit expansion during the recent crisis than during more normal periods. Looking over a longer time period and multiple crises, Berger and Bouwman (2009b) find that banks with higher capital tend to expand their market share (as measured by liquidity creation and by total assets) during and after banking and market crises. They also find that the effect is more pronounced for smaller institutions, which constitute a large portion of our sample. Also relatedly, Demirguc-Kunt, Detragiache, and Merrouche (2010) find that bank equity prices are not sensitive to differences in capital ratios across banks prior to the financial crisis, but are sensitive to such differences during the crisis.

Section 4.3 Different loan categories

Banks typically make a variety of types of loans. In this section, we examine whether there are differences in the sensitivity of growth rates of different types of loans to bank capital ratios. The types of loans that we consider are commercial and industrial (C&I) loans, commercial real estate (CRE) loans, residential real estate (RRE) loans, and consumer loans. As the relationship between the capital ratios and growth in bank lending was strongest from 2007 to 2009, we focus on those years.

Our results are presented in Table 7. We again show just the coefficients on the capital ratios but the other controls are included in the regressions. The relationships between each capital ratio and the growth of different loan types are estimated separately, but are shown together in the table for ease of comparison.

We find the most robust relationship between capital ratios and loan growth for commercial real estate loans, where the coefficients are significant for all capital ratios in all sample groups. As noted above, CRE loans were the largest share of loans in banks' portfolios; there was also a sharp drop in these loans between 2007 and 2008. This sharp movement may make it easier to identify differences between banks. We generally find that C&I loan growth and residential real estate loan growth were related to bank leverage ratios but do not find an impact of the other capital ratios.[27] We find a relationship between consumer loan growth and capital ratios in the 1-N matched sample for all capital ratios, but do not find a significant relationship in the 1-1 matched sample or the fixed effect sample.

Section 4.4 Nonlinearity

Our final test is of whether the association between capital ratios and subsequent loan growth is larger when the capital ratio is closer to its regulatory minimum requirement as opposed to being substantially above the minimum requirement.[28] Such a nonlinearity might arise as banks worry more about regulatory thresholds as they become close to being binding or, as in Valencia (2008), if banks seek to maintain some precautionary level of capital. To test this hypothesis, we interact capital ratio with three indicator variables. The indicator for "low" capital is set to one if bank capital is below the 25th percentile of the distribution, the indicator for "medium" capital is one if bank capital is between the 25th and the 75th percentile, and the indicator for "high" capital is set to one if bank capital is above the 75th percentile.[29] These interaction terms allow the relationship between capital ratio and bank lending to vary at different capital ratio levels. For the fixed effect sample, we estimate the following model:

$$log\left(\frac{loan_{it+1}}{loan_{it}}\right) = \alpha + \beta_{low}CR_{it} \cdot 1(CR_{it} < p25) + \beta_{mid}CR_{it} \cdot 1(p25 \le CR_{it} < p75)$$
$$+\beta_{high}CR_{it} \cdot 1(CR_{it} \ge p75) + \theta_1 \cdot 1(p25 \le CR_{it} < p75) + \theta_2 \cdot 1(CR_{it} \ge p75)$$
$$+\gamma_1 log\left(\frac{loan_{it}}{loan_{it-1}}\right) + \gamma_2 log\left(\frac{loan_{it-1}}{loan_{it-2}}\right) + \delta CO_{it} + \rho NP_{it} + MSA_{it} + \varepsilon_{it}$$

Function $1(\cdot)$ returns one if the statement in the parentheses is true.

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[27] Some previous work, such as Hancock, Laing, and Wilcox (1995) also found that C&I loans were more strongly impacted by capital ratios than other types of loans.

[28] Some previous analysis has touched on this question. Gambacorta and Mistrulli (2004) find that Italian banks with more capital relative to the regulatory minimum see less contraction in lending in response to monetary policy shocks or cyclical downturns. Hancock, Laing, and Wilcox (1995) report a somewhat different sort of nonlinearity. They find that banks with a shortfall relative to target capital have large balance sheet responded to a capital shock, while banks with a surplus relative to their target had very little response.

[29] Results are robust to different thresholds.

For the matched samples, we take the differences between the reference bank and its matched counterpart(s) and estimate:

$$log\left(\frac{loan_{it+1}}{loan_{it}}\right) - log\left(\frac{loan_{mt+1}}{loan_{mt}}\right) = \beta_{low}[CR_{it} \cdot 1(CR_{it} < p25) - CR_{mt} \cdot 1(CR_{mt} < p25)]$$
$$+\beta_{mid}[CR_{it} \cdot 1(p25 \leq CR_{it} < p75) - CR_{mt} \cdot 1(p25 \leq CR_{mt} < p75)]$$
$$+\beta_{high}[CR_{it} \cdot 1(CR_{it} \geq p75) - CR_{mt} \cdot 1(CR_{mt} \geq p75)]$$
$$+\theta_1[1(p25 \leq CR_{it} < p75) - 1(p25 \leq CR_{mt} < p75)] + \theta_2[1(CR_{it} \geq p75) - 1(CR_{mt} \geq p75)]$$
$$+\gamma_1\left[log\left(\frac{loan_{it}}{loan_{it-1}}\right) - log\left(\frac{loan_{mt}}{loan_{mt-1}}\right)\right] + \gamma_2\left[log\left(\frac{loan_{it-1}}{loan_{it-2}}\right) - log\left(\frac{loan_{mt-1}}{loan_{mt-2}}\right)\right]$$
$$+\delta(CO_{it} - CO_{mt}) + \rho(NP_{it} - NP_{mt}) + (\varepsilon_{it} - \epsilon_{mt})$$

We again focus on the years 2007 to 2009 when the impact of bank capital on loan growth was strongest.

Our results, which appear in Table 8, provide strong evidence of a nonlinear effect. While we find that capital ratio has a positive relationship with loan growth for all capital ratio categories, the effect is large and statistically significant when capital ratio is closer to the regulatory minimum requirement and becomes smaller and less significant as capital ratio increases. For example, when capital ratio is below the 25th percentile of its distribution, our estimates suggest that a 1 percentage point increase in capital ratio raises bank lending by 1.6 percent to 2.4 percent in the next year; such results are similar in size to previous results in this literature. (These results are from the matched samples. The impact is a slightly smaller .9 percent to 1.2 percent in the fixed effect sample.) When capital ratio is above the 75th percentile of its distribution, however, the estimates suggest that capital ratios had a much more modest impact on bank lending, if any. When we test the null hypothesis that $\beta_{low} = \beta_{high}$, it is rejected at 0.05 significance level for all samples groups and all capital ratio measures.

Section 5. Conclusion

In this paper, we test whether capital ratios influence loan growth. We do so by comparing differences in loan growth to differences in capital ratios for banks matched by location as well as by size and balance sheet. Our matched groups include both a group where banks are matched with the most similar bank and a group where a bank is matched with all similar neighbors. For robustness, we also estimate a more standard panel regression using MSA fixed effects to control for local factors affecting loan demand.

We find evidence that, all else equal, banks whose actual capital ratios were relatively high had stronger loan growth in 2008 and 2009, during the recent financial crisis, but that there was not an apparent association during the preceding several years. Other recent research, such as Berger and Bouwman (2009b) and Demirguc-Kunt, Detragiache, and Merrouche (2010), have also noted that relationships between bank capital and other items such as market share and equity prices, tend to become larger during banking crises.

One theoretical reason why bank capital matters is that the opacity of banks and difficulties valuing their assets results in some potential adverse selection in the market for risky bank debt. High bank capital may reduce concerns about adverse selection problems. Thus, banks may find it quite difficult to issue risky debt to fund assets and increase their leverage (see Jayaratne and Morgan 2000, Stein 1998, Van den Heuvel 2002).[30] These particular problems may have been exceptionally acute during the financial crisis. This scenario provides one potential explanation for our finding that capital ratios mattered for loan growth in 2008 and 2009. Other factors may also have played a role. During ordinary times, banks have several options for raising capital, such as through retaining earnings or equity issuance, so that banks can manage their capital and the regulatory ratios are not a significant impediment to expansion. However, during the crisis, banks experienced losses and it was difficult, or considerably more expensive, for many banks to issue equity. These other factors may have meant that the ability of banks to manage their balance sheet was severely curtailed and the regulatory capital ratios could become more binding. There may be other reasons as well and more research will need to be done on the changing sensitivity of loan growth to bank capital.

Our finding that capital ratios mattered only during the financial crisis may have certain implications for policymakers considering changes to bank capital regulation, especially viewed in conjunction with theories regarding asymmetric information and risky bank debt. Our findings suggest that changing bank capital requirements at a time in which the banking industry is under financial stress might notably affect their lending volumes, but that changing

[30] As Van den Heuvel (2002) points out, this argument suggests that the Modigliani-Miler theorem does not hold for banks largely due to the opacity of their assets.

requirements under more typical financial conditions is unlikely to be very influential for lending. We were also able to analyze other facets of the relationship between capital ratios and loan growth. Our results indicate that certain types of loans, in particular CRE loans are found to be more sensitive than other loan types to capital ratios. We also find that the impact of capital ratios on loan growth is nonlinear. Loan growth at banks with relatively low levels of capital, where the regulatory minimum capital ratios are closer to being binding, tends to be notably more responsive to actual capital ratios than loan growth at banks that have relatively high capital ratios where the regulatory minimums are less binding.

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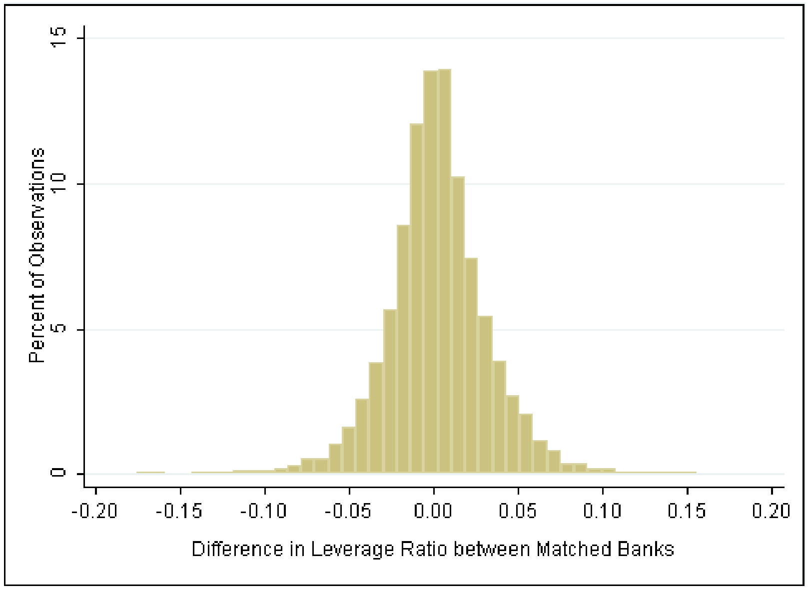
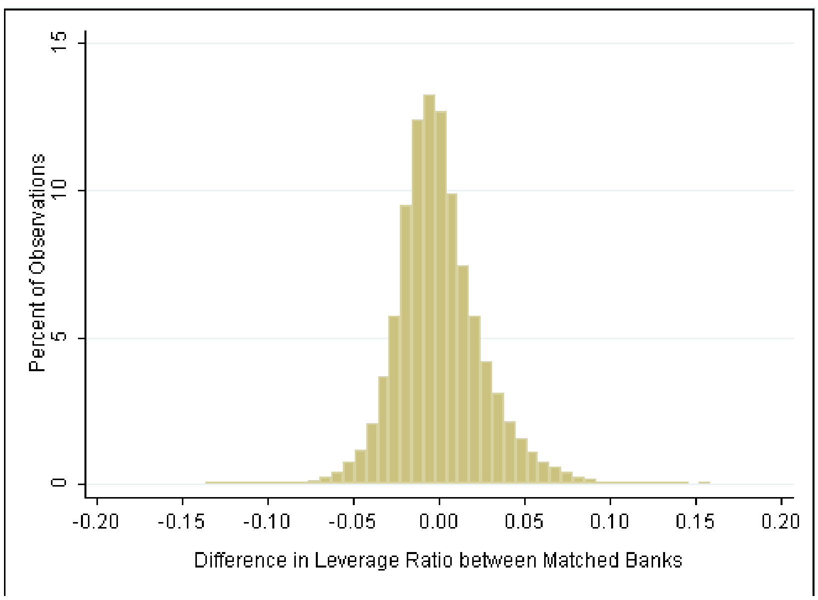
Figure 1
Distribution of differences in leverage ratio across matched banks



1 to 1 matched sample



1 to N matched sample

Table 1. Summary Statistics

	1-1 Matching Sample (N=12,878)			1-N Matching Sample (N=29,725)			MSA FE Sample (N=44,564)		
	Mean	Median	S.D.	Mean	Median	S.D.	Mean	Median	S.D.
Number of Matches per Bank	1	1	0	6.12	4.00	6.08	--	--	--
Distance between Matched Banks (in miles)	22.28	19.75	15.46	23.68	21.81	13.26	--	--	--
Distance between Matched Banks (in NJ miles)	5.85	6.15	2.65	6.13	6.27	1.68	--	--	--
Size Ratio of Matched Banks	1.21	1.03	0.70	1.05	0.70	0.60	--	--	--
Growth Rate of Total Loans and Commitments	0.05	0.05	0.12	0.06	0.05	0.12	0.10	0.09	0.02
Leverage Ratio	0.10	0.09	0.02	0.10	0.09	0.02	0.14	0.13	0.05
Risk-adjusted Tier 1 Capital Ratio	0.14	0.13	0.05	0.14	0.13	0.05	0.16	0.14	0.05
Total Risk-adjusted Capital Ratio	0.15	0.14	0.05	0.15	0.14	0.05	0.15	0.14	0.05
Charge-off Rate (annualized, in percent)	0.30	0.07	0.94	0.30	0.07	0.97	0.31	0.06	1.05
Non-performing loans (in percent)	2.48	1.86	2.36	2.45	1.83	2.37	2.31	1.69	2.34
Total Assets (in millions)	222	123	432	209	118	375	261	114	738
Fraction of Commercial and Industrial Loans	0.15	0.14	0.08	0.15	0.14	0.09	0.16	0.14	0.10
Fraction of Commercial Real Estate Loans	0.31	0.28	0.19	0.31	0.28	0.19	0.29	0.26	0.19
Fraction of Residential Real Estate Loans	0.28	0.26	0.13	0.28	0.26	0.14	0.26	0.25	0.15
Fraction of Consumer Loans	0.09	0.08	0.07	0.09	0.08	0.08	0.10	0.07	0.09

Table 2: Compare the Characteristics of Matched Banks

	1-1 Matching Sample				1-N Matching Sample			
	Bank 1	Bank 2	Diff	P-Value	Bank 1	Bank 2	Diff	P-Value
Variables used in Matching								
Log of Total Assets	11.76	11.74	-0.02	0.083	11.72	11.80	0.08	<0.001
Fraction of Commercial and Industrial Loans	0.15	0.16	0.00	0.002	0.15	0.15	0.00	0.560
Fraction of Commercial Real Estate Loans	0.31	0.32	0.00	0.384	0.31	0.32	0.01	<0.001
Fraction of Residential Real Estate Loans	0.28	0.28	0.00	0.808	0.28	0.28	0.00	<0.001
Fraction of Consumer Loans	0.09	0.09	0.00	0.060	0.09	0.09	-0.01	<0.001
Managed Liability to Interest-Bearing Liability Ratio	0.25	0.25	0.00	0.011	0.25	0.25	0.00	0.003
Securities to Securities and Loans Ratio	0.25	0.24	-0.01	<0.001	0.25	0.25	0.00	0.207
Interest Income to Total Income Ratio	0.89	0.89	0.00	0.072	0.89	0.89	0.00	<0.001
Interest Expense to Total Expense Ratio	0.41	0.42	0.00	0.064	0.42	0.42	0.00	0.041
Bank's Net Interest Margin (in percent)	0.20	0.20	-0.01	0.009	0.20	0.16	-0.01	<0.001
Variables not used in Matching								
Savings Deposits to Core Deposits Ratio	0.30	0.30	0.00	0.346	0.29	0.30	0.01	<0.001
Total Loans to Assets Ratio	0.66	0.67	0.01	<0.001	0.66	0.67	0.00	<0.001
Treasury/Agency Securities to Total Securities Ratio	0.48	0.48	0.00	0.519	0.48	0.47	-0.02	<0.001
Large Time Deposits to Managed Liability Ratio	0.76	0.77	0.00	0.551	0.77	0.74	-0.03	<0.001
Cash and Treasury/Agency Securities to Deposit Ratio	0.18	0.17	-0.01	<0.001	0.18	0.18	-0.01	<0.001

Table 3. Effect of Capital Rato on Lending, 2001-2009

	1-1 Matching Sample			1-N Matching Sample			MSA FE Sample		
	Leverage Ratio	Risk-Adj Tier 1	Total Risk-Adj	Leverage Ratio	Risk-Adj Tier 1	Total Risk-Adj	Leverage Ratio	Risk-Adj Tier 1	Total Risk-Adj
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Capital Ratio	0.203**	0.065	0.062	0.185**	0.054*	0.052*	0.210**	0.076**	0.071**
	(0.060)	(0.034)	(0.033)	(0.047)	(0.025)	(0.026)	(0.047)	(0.026)	(0.026)
One Year Lag of Loan Growth Rate	0.217**	0.218**	0.218**	0.212**	0.213**	0.213**	0.225**	0.226**	0.226**
	(0.012)	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)	(0.013)	(0.013)	(0.013)
Two Year Lag of Loan Growth Rate	0.064**	0.064**	0.064**	0.063**	0.063**	0.063**	0.053**	0.053**	0.053**
	(0.012)	(0.011)	(0.012)	(0.010)	(0.010)	(0.010)	(0.008)	(0.008)	(0.008)
Charge-off Rate (annualized, in percent)	-0.008**	-0.008**	-0.008**	-0.009**	-0.009**	-0.009**	-0.008**	-0.008**	-0.008**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Percent of Non-Performing Loans	-0.008**	-0.008**	-0.008**	-0.008**	-0.008**	-0.008**	-0.010**	-0.010**	-0.010**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Adjusted R^2	0.123	0.122	0.122	0.120	0.119	0.119	0.248	0.247	0.247
N	12,878	12,878	12,878	29,725	29,725	29,725	44,564	44,564	44,564

Note: The dependent variable is the growth rate of total loans and commitments. Columns (7), (8), and (9) include linear controls for the matching variables, the year fixed effects, and the MSA fixed effects. Standard errors in parenthesis are clustered at the state level. * significant at 0.05 level and ** significant at 0.01 level.

Table 4. Effect of Leverage Ratio on Lending by Year

	2001	2002	2003	2004	2005	2006	2007	2008	2009
1-1 Matching Sample	-0.085	0.096	0.143	0.191	0.045	0.031	0.458**	0.544**	0.489**
	(0.129)	(0.120)	(0.158)	(0.152)	(0.101)	(0.119)	(0.163)	(0.167)	(0.151)
Adjusted R2	0.104	0.144	0.149	0.107	0.089	0.071	0.124	0.136	0.229
N	1,430	1,501	1,455	1,481	1,427	1,387	1,375	1,390	1,432
1-N Matching Sample	-0.051	0.041	0.168	0.199	0.086	0.001	0.249*	0.515**	0.576**
	(0.118)	(0.101)	(0.113)	(0.124)	(0.098)	(0.093)	(0.107)	(0.116)	(0.094)
Adjusted R2	0.100	0.140	0.116	0.119	0.101	0.076	0.113	0.159	0.197
N	3,306	3,464	3,386	3,391	3,301	3,225	3,167	3,214	3,271
MSA FE Sample	0.084	0.053	0.151	0.272	0.223	0.151	0.244	0.319**	0.474**
	(0.144)	(0.118)	(0.160)	(0.138)	(0.118)	(0.107)	(0.139)	(0.101)	(0.091)
Adjusted R^2	0.169	0.220	0.226	0.211	0.166	0.117	0.120	0.174	0.327
N	5,074	5,138	5,151	5,096	4,991	4,830	4,756	4,821	4,707

Note: The dependent variable is the growth rate of total loans and commitments. Other control variables not shown include two lags of the dependent variable, charge-off rate, and percent non-performing loans. The MSA FE sample regressions also include linear controls of the matching variables and the MSA fixed effects. Standard errors in parenthesis are clustered at the state level.
* significant at 0.05 level and ** significant at 0.01 level.

Table 5. Effect of Risk-Adjusted Tier 1 Capital Ratio on Lending by Year

	2001	2002	2003	2004	2005	2006	2007	2008	2009
1-1 Matching Sample	-0.084	-0.083	-0.001	0.068	0.040	-0.029	0.198*	0.325**	0.290**
	(0.080)	(0.049)	(0.096)	(0.080)	(0.059)	(0.089)	(0.095)	(0.104)	(0.100)
Adjusted R^2	0.105	0.144	0.148	0.106	0.090	0.071	0.119	0.135	0.228
N	1,430	1,501	1,455	1,481	1,427	1,387	1,375	1,390	1,432
1-N Matching Sample	-0.071	-0.058	0.025	0.043	0.037	-0.040	0.091	0.286**	0.300**
	(0.060)	(0.049)	(0.059)	(0.075)	(0.047)	(0.058)	(0.063)	(0.072)	(0.055)
Adjusted R^2	0.101	0.140	0.115	0.118	0.101	0.076	0.111	0.157	0.194
N	3,306	3,464	3,386	3,391	3,301	3,225	3,167	3,214	3,271
MSA FE Sample	-0.016	-0.075	-0.020	0.122	0.091	0.079	0.071	0.169**	0.217**
	(0.077)	(0.064)	(0.089)	(0.094)	(0.076)	(0.079)	(0.072)	(0.063)	(0.062)
Adjusted R^2	0.168	0.220	0.225	0.210	0.165	0.117	0.118	0.172	0.323
N	5,074	5,138	5,151	5,096	4,991	4,830	4,756	4,821	4,707

Note: The dependent variable is the growth rate of total loans and commitments. Other control variables not shown include two lags of the dependent variable, charge-off rate, and percent non-performing loans. The MSA FE sample regressions also include linear controls of the matching variables and the MSA fixed effects. Standard errors in parenthesis are clustered at the state level.
* significant at 0.05 level and ** significant at 0.01 level.

Table 6. Effect of Total Risk-adjusted Capital Ratio on Lending by Year

	2001	2002	2003	2004	2005	2006	2007	2008	2009
1-1 Matching Sample	-0.090	-0.085	0.003	0.066	0.047	-0.024	0.190*	0.314**	0.287**
	(0.080)	(0.050)	(0.095)	(0.080)	(0.059)	(0.088)	(0.094)	(0.106)	(0.099)
Adjusted R^2	0.105	0.144	0.148	0.106	0.090	0.071	0.119	0.134	0.227
N	1,430	1,501	1,455	1,481	1,427	1,387	1,375	1,390	1,432
1-N Matching Sample	-0.073	-0.064	0.020	0.044	0.038	-0.034	0.087	0.273**	0.299**
	(0.060)	(0.050)	(0.059)	(0.075)	(0.047)	(0.058)	(0.062)	(0.071)	(0.055)
Adjusted R^2	0.101	0.140	0.115	0.118	0.101	0.076	0.111	0.156	0.194
N	3,306	3,464	3,386	3,391	3,301	3,225	3,167	3,214	3,271
MSA FE Sample	-0.023	-0.076	-0.021	0.132	0.090	0.083	0.062	0.158*	0.209**
	(0.075)	(0.064)	(0.088)	(0.092)	(0.074)	(0.078)	(0.070)	(0.061)	(0.063)
Adjusted R^2	0.168	0.220	0.225	0.210	0.165	0.117	0.118	0.172	0.322
N	5,074	5,138	5,151	5,096	4,991	4,830	4,756	4,821	4,707

Note: The dependent variable is the growth rate of total loans and commitments. Other control variables not shown include two lags of the dependent variable, charge-off rate, and percent non-performing loans. The MSA FE sample regressions also include linear controls of the matching variables and the MSA fixed effects. Standard errors in parenthesis are clustered at the state level.
* significant at 0.05 level and ** significant at 0.01 level.

Table 7. Effect of Capital Ratio on Lending in 2007-2009 by Loan Types

	All Loans (1)	C&I (2)	CRE (3)	RRE (4)	Consumer (5)
1-1 Matching Sample					
Leverage Ratio	0.490**	0.461*	0.510**	0.264*	0.305
	(0.085)	(0.203)	(0.145)	(0.108)	(0.244)
Risk-adjusted Tier 1 Capital Ratio	0.267**	0.155	0.214**	0.012	0.208
	(0.059)	(0.149)	(0.073)	(0.069)	(0.145)
Total Risk-adjusted Capital Ratio	0.259**	0.139	0.204**	0.000	0.214
	(0.058)	(0.150)	(0.075)	(0.070)	(0.144)
N	4,197	2,230	3,334	3,597	569
	All Loans (1)	C&I (2)	CRE (3)	RRE (4)	Consumer (5)
1-N Matching Sample					
Leverage Ratio	0.435**	0.426*	0.542**	0.223**	0.376*
	(0.057)	(0.167)	(0.105)	(0.081)	(0.172)
Risk-adjusted Tier 1 Capital Ratio	0.220**	0.157	0.238**	-0.075	0.213*
	(0.042)	(0.103)	(0.069)	(0.061)	(0.093)
Total Risk-adjusted Capital Ratio	0.214**	0.135	0.227**	-0.084	0.211*
	(0.042)	(0.101)	(0.068)	(0.060)	(0.091)
N	9,652	5,614	8,115	8,538	1,284
	All Loans (1)	C&I (2)	CRE (3)	RRE (4)	Consumer (5)
MSA FE Sample					
Leverage Ratio	0.382**	0.513**	0.810**	0.304**	0.147
	(0.065)	(0.185)	(0.136)	(0.104)	(0.169)
Risk-adjusted Tier 1 Capital Ratio	0.177**	0.180	0.372**	0.106	0.065
	(0.040)	(0.094)	(0.083)	(0.062)	(0.116)
Total Risk-adjusted Capital Ratio	0.164**	0.145	0.350**	0.085	0.060
	(0.040)	(0.090)	(0.083)	(0.060)	(0.117)
N	14,284	9,303	11,412	12,089	3,449

Note: The dependent variable is the growth rate of total loans and commitments in column (1) and the growth rate of each type of loan in columns (2)-(5). Columns (2)-(5) are conditional on the corresponding type of loans is at least 10 percent of the bank portfolio. Other control variables not shown include two lags of the dependent variable, charge-off rate, and percent non-performing loans. The MSA FE sample regressions also include linear controls of the matching variables and the MSA fixed effects. Standard errors shown in parenthesis are clustered at the state level. * significant at 0.05 level and ** significant at 0.01 level.

Table 8. Nonlinear Effect of Capital Ratio on Lending in 2007-2009

	Leverage Ratio (1)	Risk-adjusted Tier 1 (2)	Total Risk-adjusted (3)
1-1 Matching Sample			
Capital Ratio*Low	2.428**	2.062**	2.200**
	(0.438)	(0.364)	(0.388)
Capital Ratio*Middle	0.832**	0.231	0.235
	(0.245)	(0.164)	(0.173)
Capital Ratio*High	0.594*	0.185*	0.182*
	(0.238)	(0.083)	(0.089)
P-Value for test $\beta_{low}=\beta_{high}$	<0.001	<0.001	<0.001
N	4,197	4,197	4,197
1-N Matching Sample			
Capital Ratio*Low	2.088**	1.681**	1.639**
	(0.276)	(0.266)	(0.296)
Capital Ratio*Middle	0.640**	0.319**	0.349**
	(0.226)	(0.081)	(0.082)
Capital Ratio*High	0.379*	0.014	0.035
	(0.142)	(0.066)	(0.066)
P-Value for test $\beta_{low}=\beta_{high}$	<0.001	<0.001	<0.001
N	9,652	9,652	9,652
MSA FE Sample			
Capital Ratio*Low	1.248**	1.099**	0.889*
	(0.376)	(0.293)	(0.335)
Capital Ratio*Middle	0.644**	0.217	0.200
	(0.230)	(0.138)	(0.135)
Capital Ratio*High	0.426*	0.040	0.019
	(0.174)	(0.072)	(0.073)
P-Value for test $\beta_{low}=\beta_{high}$	0.052	<0.001	0.008
N	14,284	14,284	14,284

Note: The dependent variable is the growth rate of total loans and commitments. Low is defined as below the 25th percentile. Middle is defined as between the 25th and 75th percentiles. High is defined as above the 75th percentile. Other control variables not shown include two lags of the dependent variable, charge-off rate, and percent non-performing loans. The MSA FE sample regressions also include linear controls of the matching variables and the MSA fixed effects. Standard errors in parenthesis are clustered at the state level. * significant at 0.05 level and ** significant at 0.01 level.