



Capital Ratios and Bank Lending: A Matched-Bank Approach

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Motivation

- Concerns about the impact of bank capital on bank lending have been of increased interest recently
- Has been a variety of previous efforts to measure this effect
 - One challenge is separating supply and demand effects
 - Poor economic environment causes loan losses that reduce bank capital and reduce demand for credit.
 - Several ways of trying to get around that problem
 - Control explicitly for economic fundamentals (Hancock and Wilcox 1993, Berrospide and Edge 2010, Gamacorta and Mistrulli 2004)
 - Look for natural experiments or use cross-border nature of banks (Peek and Rosengren 1995, Mora and Logan 2010, Rice and Rose 2010)



Our approach

- Compare banks in the same area that face the same economic conditions. (Also match with respect to indicators of business model.)
 - For many banks local factors have been found to be quite important (Petersen and Rajan 1994; Brevoort, Holmes, and Wolken 2010; Heitfield and Prager 2004)
 - Ability of differences in capital ratios to explain differences in loan growth rates ought to reflect supply issues rather than demand issues.
 - Ought to provide a good way of removing demand effects
 - Limited to smaller banks where locality matters more.



Overview of Results

- Find that capital mattered during the crisis years, but not earlier in the decade
- Clearest impact on growth of commercial real estate loans
 - Impact on other loan types less clear
- Effects matter most when regulatory capital ratios closest to binding
- Taken together, these findings demonstrate substantial heterogeneity in the relationship between bank capital and lending.



What we do

- Determine bank location
 - Use branch location and deposit data based on FDIC Summary of Deposits
 - Compute a bank location based on center of gravity of the bank as the deposit weighted center of the branches
 - Aggregate banks within holding companies
- Discard banks if more than 20 percent of deposits are from outside a state-specific radius.
 - (Radius determined by population density)
- Discard banks where lending base may not reflect deposit base (credit card banks)



What we do (contd.)

- Match banks based first on location, size, and business model
 - Business model incorporates various balance sheet and income ratios (share of loan portfolio consisting of different types of loans, composition of liabilities, share of revenue/expenses from different activities).
 - Standardize ratios to make comparable
- Construct 1:1 matches based on minimum sum of square differences in ratios within a bank area and within size range.
 - Interested in the differences between the capital ratios and loan growth rates of these two institutions.
- Construct 1:N matches based by matching reference bank to all other banks within a specified distance and of similar size where the sum of square differences is less than a particular cut-off.
- For robustness also include a specification that uses MSA fixed effects.



Regression analysis

- Regress differences between matched groups in loan growth on differences in capital ratios
 - For 1:1 matching, this reflects the differences between the two banks
 - For 1:N matching, compare reference bank to average for group of matched banks
 - Need to drop one bank from the set to avoid collinearity issues.
- For MSA fixed effect regression, just use levels of different variables
- Coefficients on capital should be the same regardless whether we use differences between matched banks or fixed effect

Some math

- Fixed effect:

$$\log\left(\frac{\text{loan}_{it+1}}{\text{loan}_{it}}\right) = \alpha + \beta(\text{CapRat}_{it}) + \gamma_1 \log\left(\frac{\text{loan}_{it}}{\text{loan}_{it-1}}\right) + \gamma_2 \log\left(\frac{\text{loan}_{it-1}}{\text{loan}_{it-2}}\right) + \delta(\text{bank variables}_{it}) + \rho MSA_{it} + \varepsilon_{it}$$

- Matched sample:

$$\begin{aligned} \log\left(\frac{\text{loan}_{it+1}}{\text{loan}_{it}}\right) - \log\left(\frac{\text{loan}_{mt+1}}{\text{loan}_{mt}}\right) &= \beta(\text{CapRat}_{it} - \text{CapRat}_{mt}) \\ &+ \gamma_1 \left[\log\left(\frac{\text{loan}_{it}}{\text{loan}_{it-1}}\right) - \log\left(\frac{\text{loan}_{mt}}{\text{loan}_{mt-1}}\right) \right] + \gamma_2 \left[\log\left(\frac{\text{loan}_{it-1}}{\text{loan}_{it-2}}\right) - \log\left(\frac{\text{loan}_{mt-1}}{\text{loan}_{mt-2}}\right) \right] \\ &+ \delta(\text{bank variables}_{it} - \text{bank variables}_{mt}) + (\varepsilon_{it} - \varepsilon_{mt}) \end{aligned}$$



Regression analysis details

- Data from June call reports
- Loan growth rates calculated over one year periods
 - Include unused commitments when using total loans (not when using different types of loans)
- Focus on regulatory capital ratios (as opposed to target levels of bank capital)
- Require banks to have at least three years of data.

Table 1. Summary Statistics

	1-1 Matching Sample (N=12,878)		1-N Matching Sample (N=29,725)		MSA FE Sample (N=45,093)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Number of Matches per Bank	1	0	6.12	6.08	--	--
Distance between Matched Banks (in miles)	22.28	15.46	23.68	13.26	--	--
Size Ratio of Matched Banks	1.21	0.70	1.05	0.60	--	--
Growth Rate of Total Loans and Commitments	0.05	0.12	0.06	0.12	0.06	0.13
Leverage Ratio	0.10	0.02	0.10	0.02	0.10	0.02
Risk-adjusted Tier 1 Capital Ratio	0.14	0.05	0.14	0.05	0.14	0.05
Total Risk-adjusted Capital Ratio	0.15	0.05	0.15	0.05	0.15	0.05
Charge-off Rate (in percent)	0.30	0.94	0.30	0.97	0.32	1.10
Non-performing loans (in percent)	2.48	2.36	2.45	2.37	2.33	2.38
Log of Total Assets	11.76	0.99	11.72	0.98	11.71	1.12
Fraction of Commercial and Industrial Loans	0.15	0.08	0.15	0.09	0.16	0.10
Fraction of Commercial Real Estate Loans	0.31	0.19	0.31	0.19	0.29	0.19
Fraction of Residential Real Estate Loans	0.28	0.13	0.28	0.14	0.26	0.15
Fraction of Consumer Loans	0.09	0.07	0.09	0.08	0.10	0.09

Table 3. Effect of Capital Ratio 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** (0.060)	0.065 (0.034)	0.062 (0.033)	0.185** (0.047)	0.054* (0.025)	0.052* (0.026)	0.244** (0.047)	0.144** (0.028)	0.139** (0.028)
One Year Lag of Loan Growth	0.217** (0.012)	0.218** (0.012)	0.218** (0.012)	0.212** (0.011)	0.213** (0.011)	0.213** (0.011)	0.227** (0.013)	0.232** (0.013)	0.232** (0.013)
Two Year Lag of Loan Growth	0.064** (0.012)	0.064** (0.011)	0.064** (0.012)	0.063** (0.010)	0.063** (0.010)	0.063** (0.010)	0.043** (0.008)	0.047** (0.008)	0.047** (0.008)
Charge-off Rate (annualized)	-0.008** (0.001)	-0.008** (0.001)	-0.008** (0.001)	-0.009** (0.001)	-0.009** (0.001)	-0.009** (0.001)	-0.008** (0.001)	-0.008** (0.001)	-0.008** (0.001)
Percent of Non-Performing Loans	-0.008** (0.001)	-0.008** (0.001)	-0.008** (0.001)	-0.008** (0.001)	-0.008** (0.001)	-0.008** (0.001)	-0.010** (0.001)	-0.010** (0.001)	-0.010** (0.001)
Adjusted R ²	0.123	0.122	0.122	0.12	0.119	0.119	0.237	0.237	0.237
N	12,878	12,878	12,878	29,725	29,725	29,725	44,841	44,841	44,841

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



Regression results

- Overall, positive but economical small effect of capital on lending.
- Effect is similar in matched and fixed-effect samples for the leverage ratio. Effect is a bit stronger for the fixed-effect sample with the risk-adjusted ratios.
- Charge-off and non-performing loan rates negatively impact loan growth.

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 R ²	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 R ²	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	0.018	0.001	0.084	0.210	0.205	0.158	0.205	0.514**	0.684**
	(0.130)	(0.116)	(0.162)	(0.129)	(0.112)	(0.110)	(0.137)	(0.103)	(0.085)
Adjusted R ²	0.160	0.207	0.214	0.200	0.160	0.104	0.107	0.154	0.303
N	5,083	5,159	5,162	5,108	5,006	4,840	4,778	4,861	4,844

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. 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	-0.075	-0.069	-0.036	0.041	0.101	0.097	0.032	0.320**	0.422**
	(0.060)	(0.061)	(0.084)	(0.068)	(0.067)	(0.072)	(0.064)	(0.070)	(0.057)
Adjusted R ²	0.161	0.207	0.214	0.199	0.159	0.105	0.105	0.155	0.306
N	5,083	5,159	5,162	5,108	5,006	4,840	4,778	4,861	4,844

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. Standard errors in parenthesis are clustered at the state level. * significant at 0.05 level and ** significant at 0.01 level.



Regression results by year

- Capital ratios matter in 2008 and 2009, but not earlier in the decade
 - Similar pattern using leverage ratio and total capital ratio
- During the past few years, a one percentage point increase in the capital ratio raises lending by .3 to .4 percentage points.
 - Somewhat smaller effect than has been found in the literature.
- Effect is similar regardless in matched and fixed-effect samples

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** (0.085)	0.461* (0.203)	0.510** (0.145)	0.264* (0.108)	0.305 (0.244)
Risk-adjusted Tier 1 Capital Ratio	0.267** (0.059)	0.155 (0.149)	0.214** (0.073)	0.012 (0.069)	0.208 (0.145)
Total Risk-adjusted Capital Ratio	0.259** (0.058)	0.139 (0.150)	0.204** (0.075)	0.000 (0.070)	0.214 (0.144)
N	4,197	2,230	3,334	3,597	569
1-N Matching Sample					
Leverage Ratio	0.435** (0.057)	0.426* (0.167)	0.542** (0.105)	0.223** (0.081)	0.376* (0.172)
Risk-adjusted Tier 1 Capital Ratio	0.220** (0.042)	0.157 (0.103)	0.238** (0.069)	-0.075 (0.061)	0.213* (0.093)
Total Risk-adjusted Capital Ratio	0.214** (0.042)	0.135 (0.101)	0.227** (0.068)	-0.084 (0.060)	0.211* (0.091)
N	9,652	5,614	8,115	8,538	1,284
MSA FE Sample					
Leverage Ratio	0.500** (0.064)	0.561** (0.166)	0.778** (0.141)	0.451** (0.087)	0.239 (0.167)
Risk-adjusted Tier 1 Capital Ratio	0.297** (0.042)	0.131 (0.074)	0.354** (0.081)	-0.013 (0.040)	0.170 (0.109)
Total Risk-adjusted Capital Ratio	0.287** (0.042)	0.108 (0.074)	0.339** (0.081)	-0.025 (0.040)	0.166 (0.109)
N	14,483	9,424	11,564	12,238	3,473



Testing for a non-linear impact

- Create three indicator variables for capital ratios:
 - Low – below 25th percentile
 - Medium – between 25th and 75th percentile
 - High – above 75th percentile
- Interact these with the capital ratios of the reference and matched bank(s)

Allow for a non-linear effect

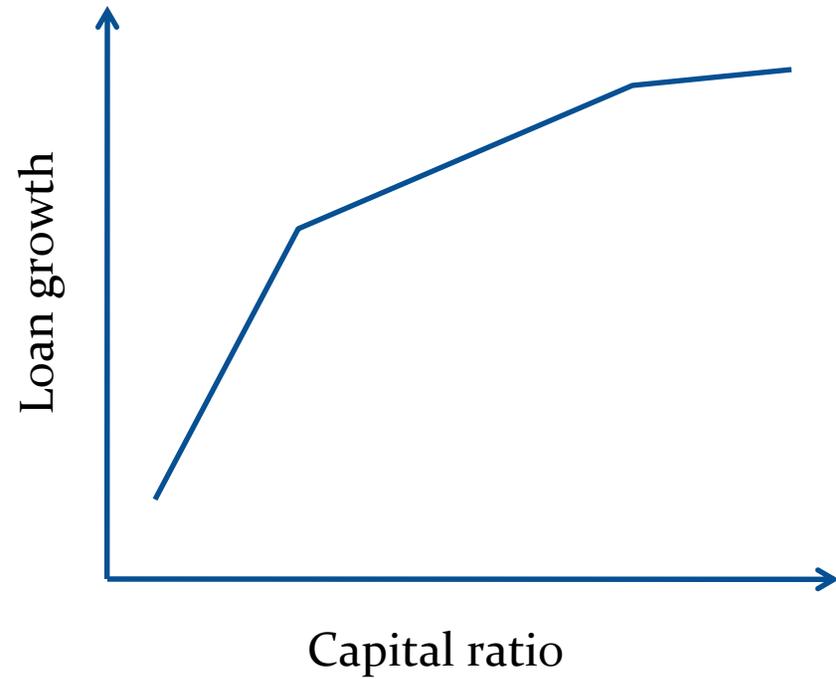
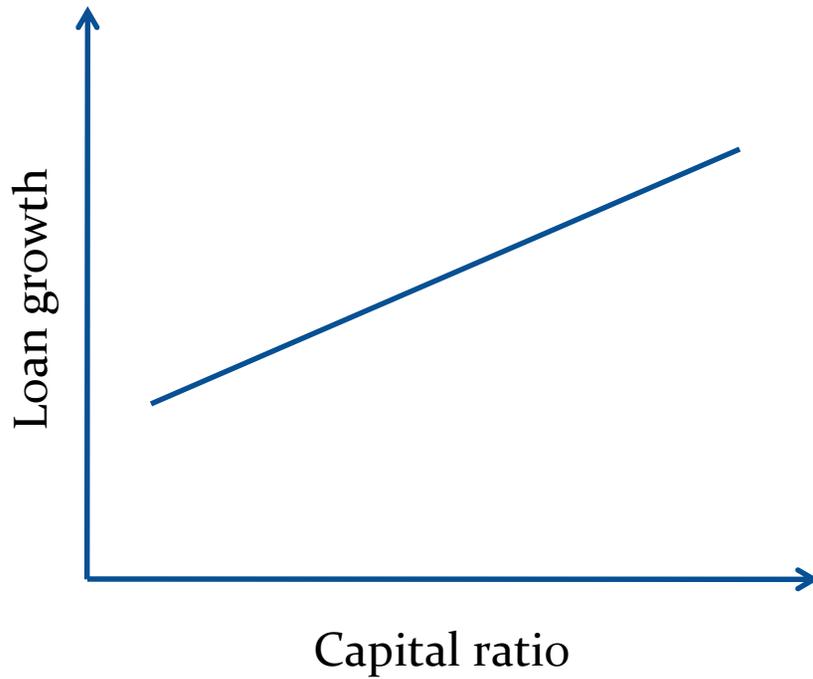


Table 8. Nonlinear Effect of Capital Ratio on Lending in 2007-2009

	Leverage Ratio (1)	Risk-adjusted Tier 1 (2)	Total Risk-adjusted (3)
1-1 Matching Sample			
Capital Ratio*Low	2.428** (0.438)	2.062** (0.364)	2.200** (0.388)
Capital Ratio*Middle	0.832** (0.245)	0.231 (0.164)	0.235 (0.173)
Capital Ratio*High	0.594* (0.238)	0.185* (0.083)	0.182* (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** (0.276)	1.765** (0.495)	1.862** (0.453)
Capital Ratio*Middle	0.640** (0.226)	0.338** (0.098)	0.340** (0.092)
Capital Ratio*High	0.379* (0.142)	0.069 (0.054)	0.070 (0.058)
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	1.506** (0.361)	1.332** (0.333)	1.118** (0.388)
Capital Ratio*Middle	0.962** (0.219)	0.384** (0.134)	0.395** (0.132)
Capital Ratio*High	0.477** (0.167)	0.110 (0.072)	0.107 (0.069)
P-Value for test $\beta_{low}=\beta_{high}$	0.017	<0.001	0.007
N	14,483	14,483	14,483



Robustness

- We change the size and distance thresholds in the matching.
- We include the matching variables as additional controls in the matched-sample regressions.
- We change dependant variable to loan growth (excluding commitments) as well as core loan growth.
- For examining loan type results, we pool together only 2008 and 2009 (exclude 2007).
- For examining the non-linearity results, we try different threshold values.



Conclusion

- Use matched samples of banks to estimate effect of capital ratios on loan growth over the next year
 - Find somewhat smaller effects than others
 - Only significant in recent years
 - This latter result consistent with some recent work
- Growth of certain types of loans appear to be more strongly affected
- Effect of capital ratios is non-linear
 - Quite strong when ratios are closer to binding
 - Not too strong when ratios further from binding