Bank Capital and Lending: An Analysis of Commercial Banks in the United States

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Abstract

This paper empirically evaluates the impact of bank capital on lending patterns of commercial banks in the United States. We construct an unbalanced quarterly panel of around seven thousand medium sized commercial banks over sixty quarters, from 1996 to 2010. Using two different measures of capital namely the capital adequacy ratio and tier 1 ratio, we find a moderate relationship between bank equity and lending. We also use an innovative instrumenting methodolgy which helps us overcome the endogeneity issues that are common in such analyses. Our results are broadly consistent with some other recent studies that have analyzed US banking data.

JEL Codes: G21, G28, G32
Key words: Bank Capital Buffers, Regulation, Risk Weighted Assets

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1 Introduction

The banking sector is one of the most regulated ones today and bank capital regulation is of utmost importance. The commercial banks in the United States face capital requirements based on the the Basel Core Banking Principles. The government of the United States is still in the implementation phase of Basel III guidelines. The banks in the United States have to hold about eight percent capital (Tier 1 and Tier 2)[1] as a fraction of it's risk weighted assets. They do not default at eight percent but are declared undercapitalized. The regulatory authority, which is the Federal Deposit Insurance Corporation in the context of the USA, takes over the bank only if the bank capital is less than two percent of the risk weighted assets in which case the bank is said to be critically undercapitalized. The cost of defaulting or even being undercapitalized could be substantial. It could lead to the bank's franchise being revoked, in the worst case scenario. Obviously, the bank would take steps to ensure such a state never occurs. Hence they take decisions on how much capital to hold and this choice is indeed a difficult one for reasons that will be discussed later in the paper. Banks do not have complete control over their regulatory capital asset ratios simply because the returns on the assets are stochastic. Thus the banks hold buffers to absorb such negative shocks. In a bad state of nature, this buffer will act as a cushion and prevent the capital ratio going below the minimum stipulated ratio. Therefore, the regulators would want the banks to hold more capital so that it can act as a protection in bad times. Also having more capital means that the bank will have enough resources to lend and thereby mitigating the procyclicality problem associated with capital requirements.

In the aftermath of the financial crisis, there has been some work that tries to explore the linkages between financial and real sectors. The effect of changes in bank capital on lending decisions is the primary determinant of the linkage between financial

[1]Tier 1 capital is the core measure of a bank's financial strength from a regulator's point of view. It primarily consists of common stock and retained earnings. It may also include non-redeemable non-cumulative preferred stock. Tier 2 capital represents supplementary capital such as undisclosed reserves, general loan-loss reserves and subordinated debt.

conditions and real activity. This paper takes a step towards quantifying this important relationship. During the financial crisis, when the likelihood of a credit crunch was still under debate, the relation between bank capital and bank lending was a key policy concern. Likewise, when the Troubled Asset Relief Program (TARP) moved to inject capital into banks through the Capital Purchase Program (CPP), the impact of the program on real activity largely focused on the effect of these injections on bank lending. More recently, this question has re-emerged in light of proposals announced by the Basel Committee on Banking Supervision to raise banks' capital requirements and limit leverage ratios, Berropside and Edge (2010).

There are not many recent estimates for the U.S of the impact of changes in bank capital on lending. In the aftermath of the 1990-91 recession, many observers debated whether the newly introduced capital regulations along the Basel guidelines were hindering lending. Although this debate did not yield a concensus, it did result in the development of empirical models that sought to quantify the effect of bank capital on bank lending. For example, Hancock and Wilcox (1993, 1994) estimated models relating changes in individual banks' loan growth to measures of loan demand and bank capital. Similarly, Berger and Udell (1994) specified an equation relating the growth rate of various bank assets to different measures of bank capital ratios. Finally, Bernanke and Lown (1991) developed state-level equations linking bank loan growth to bank capital ratios and employment, for a single state (New Jersey).

In this study, we mainly ask one question. We ask how the bank capital affects the lending decisions of banks. Our sample only includes commercial banks. The data comes from the Call Reports database, maintained by the Federal Reserve Bank of Chicago. We conduct the analysis only for the middle eighty percent of banks, by total assets. In other words, we discard the top and bottom ten percent. The rationale for adopting this strategy has been discussed in section 3. The numbers we obtain are substantially smaller than suggested in statements by US treasury officials post the financial crisis. The reasoning that Berropside and Edge have in their paper, reconciling the two sets of results, applies to our case as well and so for the benefit of the reader, we put forward the justification here.

The statements from the US Treasury suggest that a $1 increase in bank capital leads to a $8 - $10 increase in lending capacity. These magnitudes are reasonable once we make the assumption that banks actively manage their assets to maintain a constant leverage. This view is based on a scetterplot from Adrian and Shin (2007). We reproduce this figure below. The sample period used in figure **??** is 1963 to 2006,

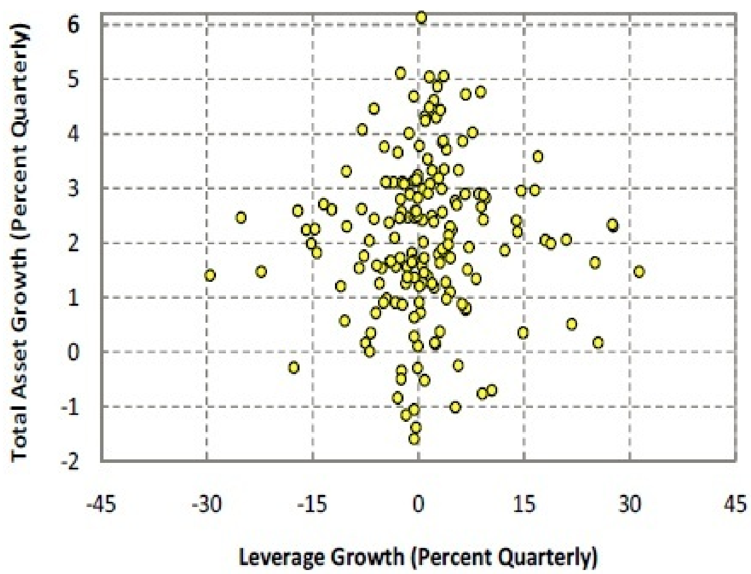

Figure 1: Asset and Leverage Growth (1963-2006)

the same as that employed by Adrian and Shin. The constant leverage ratio is apparent from the scatterplot. This suggests a very active management of assets by commercial banks. This implies that a change in bank capital has a magnified effect with the scaling factor equal to the leverage ratio.

Now, how do we compare our regression results with the Adrian-Shin scatterplots? We must acknowledge the major structural change that took place in the banking sector following the introduction of the Basel Banking Accord, in 1989. Our sample starts from 1996 while Adrian and Shin sample start from 1963. To find out what effect this choice of sample period has on the analysis, consider the figure **??** below, from Berropside and Edge (2010).

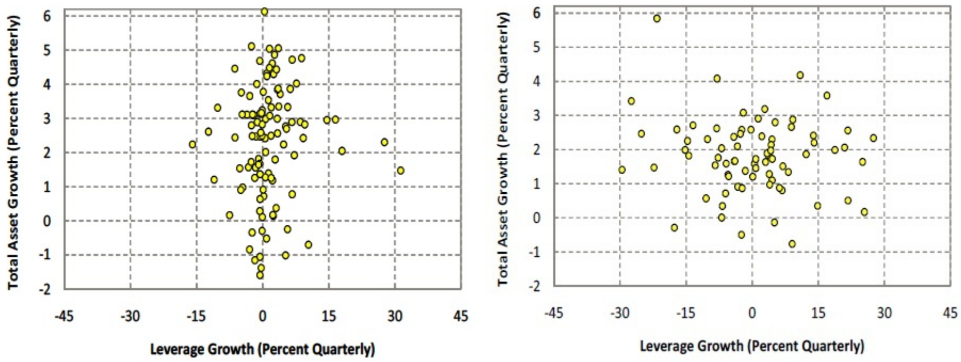

Figure 2: Asset and Leverage Growth (Pre & Post Basel)

The left panel shows relation between asset and leverage growth prior to Basel (1963:Q1-1989:Q4) and this is consistent with the Adrian and Shin assumption. The interesting part is the right panel which plots data post Basel i.e 1990:Q1-2008:Q3. As can be seen from comparing these plots, the feature of the data that has led to the view that commercial banks actively manage their assets to maintain constant leverage is much more of an artifact of the early part of the sample and is considerably less evident in the latter part. Indeed, in the latter part of the sample, there is no obvious correlation between asset and levearge growth.

Our contribution in this paper is twofold. Primarily we are interested in quantifying the relationship between bank capital and our measure of lending. As explained earlier, this is an important policy question while dealing with the subject of real and financial sector linkages. Secondly, we develop an innovative instrumenting methodolgy that helps us address the endogeneity issues related with the simultaneous determination of bank capital and lending, by banks.

The rest of the paper is organized as follows. Section 2 surveys the literature, section 3 describes the dataset we use, section 4 explains the empirical model, variables and methodolgy, section 5 presents the estimation results and section 6 concludes. The graphs and tables are placed in the appendix.

2 Related Literature

The impact of bank capital on lending is one of the key questions that arises when we want to explore macro-financial linkages. It is hence surprising that there are not many recent estimates for the United States of the impact of changes in bank capital on lending. In the aftermath of the 1990-91 recession, Hancock and Wilcox (1993, 1994) estimated models relating changes in individual banks' loan growth to measures of loan demand and bank capital. The methodolgy developed in Hancock and Wilcox (1993) could be problematic and a bit difficult to interpret for the following reason. They measure response of lending to excess/shortfall of capital from a target ratio. The issue here is that this equation could be misspecified. If the target is poorly specified, then the excess/shortfall is also poorly specified. Berger and Udell (1994) specified an equation relating the growth rate of various bank assets to different measures of bank capital ratios. Finally, Bernanke and Lown (1991) developed state-level equations linking bank loan growth to bank capital ratios and employment, for a single state (New Jersey).

If we look beyond the United States, there are some studies that seek to quantify this relationship between bank equity and credit extension. Peek and Rosengren (1997), Puri, Rocholl and Steffen (2010) use loan applications from German Landesbanks to examine the effect of shocks to capital on the supply of credit by comparing the performance of affected and unaffected banks. Gianetti and Simonov (2010) use Japanese data to perform a similar exercise concerning bank bailouts. These papers do find a relevant role for capital in determining loan volumes, although they do not explicitly compare the magnitudes of the effects they find with those implied by the constant leverage view. Another group of papers use firm and bank loan-level data; these include Jimenez, Ongena, and Peydro (2010), who use Spanish data, and Albertazzi and Marchetti (2010), who use data on Italy. These papers find sizeable effects of low bank capitalization and scarce liquidity on credit supply.

The papers using Spanish and Italian data find a larger value for the impact of capital on loans. Santos and Winton (2010), using US loan level data (syndicated loans), obtain relatively small effects of bank capital on lending. Also, Elliot (2010) uses simulation based techniques to find small effects of capital ratios on loan pricing and loan volumes for U.S. banks. De Nicolo and Lucchetta (2010) use aggregate data for the G-7 countries and conclude that credit demand shocks are the main drivers of bank lending cycles. Our magnitudes of this effect are modest and appear consistent with other papers that employ U.S. data.

3 Data and Stylized Facts

For this analysis we prepared an unbalanced panel of commercial banks balance sheet data. Our data covers sixty quarters from 1996:Q1 to 2010:Q4. The data is obtained from the Consolidated Report of Condition and Income, referred to as the Call Reports. The Federal Deposit Insurance Corporation requires all regulated financial institutions to file periodic information. These data are maintained and published by the Federal Reserve Bank of Chicago.[2]

The appendix provides a detailed documentation of the data. Regulatory capital requirements have undergone a few changes ever since their inception in the late 1980s. In 1985-1986, banks had to hold a primary capital exceeding 5.5% of assets. By the end of the decade, this rose to 7%. Effective December 31, 1990, the banks were required to hold a total capital of 7.25% as a fraction of risk weighted assets with the Tier 1 capital being at least 3.25%. These ratios were further increased to 8% and 4% following the implementation of Basel I in the end of 1992. Then on, these ratios have remained fairly stable. In our sample, we do not encounter such sudden changes.

Table 1 in the appendix gives the summary statistics of the data. We have 343,752 observations on commercial banks in the United States. We ignore the top and bottom deciles. To elaborate, we rank the banks by average size (measured by log of total assets) over the sample period and then drop the top decile and bottom deciles. The

[2]Historic data from 1976 to 2010 is available at the Chicago Federal Reserve website. Beginning with the March 31, 2011, call reports are only available from the FFIEC Central Data Repository's Public Data Distribution site (PDD)

reason for adopting this strategy stems from our instrumenting methodology. We use the real estate exposure of a bank times the change in real estate prices as an instrument for bank capital. The land price change acts as the exogeneous shock in our model. The bigger banks in the US are sufficiently diversified and do not respond to local land price changes as their medium sized counterparts. The idea behind dropping the smallest banks was that these banks show unusually high capital ratios. This is because they have limited or no access to capital markets and retain a substantial share of their earnings. Further, the smallest banks are extremely small as a percentage of total bank assets and do not add to our analysis. We think that it is only the relatively smaller/medium sized banks that are more sensitive to local land price movements. We only include banks that have a capital adequacy ratio less than or equal to 25%. We also drop the banks if we find that the loan growth rate exceeds 50% in a particular quarter. Having said that, it is indeed interesting to see if there is a difference in behavior among banks of different sizes. As pointed out earlier, we found a major difference in assets once we sorted banks and the contrast was stark at the two points at which we truncated the data. Within the remaining 80% of banks, we then divide them at the median and call them big and small for the rest of the analysis. To make it explicit, hereon when we refer to 'whole sample', we mean the medium sized banks, 'big' implies the banks above the median in the sample and similarly for 'small' banks.

As the table shows, we study two different measures of capital, namely the capital adequacy ratio (CAR) and the tier 1 capital ratio. We work with a host of loan to asset ratios in this paper. The loan data we gather comprises loans made to the real estate sector, commercial and industrial loans, agricultural loans and loans to households. LTANR shows the loan to assets ratio where we leave out real estate loans and include the other three categories. LTAR is the loans made to the real estate sector normalized by total assets. The mean real estate lending as a fraction of total assets is about 47% which is quite substantial. The banks are sufficiently exposed to the real estate sector and hence their bank capital should be a lot more sensitive to real estate[3] price

[3] We use real estate price and house price interchangeably in the paper.

movements.

The other variables we have are the growth in the house price index ($g - HPI$). It shows that on average the real estate prices have risen by about 7.4%, in the sample period. This data was collected from the FRED database. The liquidity is just the securities that the bank holds at any given point in time divided by total assets. Loans and securities are the two major components of the bank assets. Chargeoffs are a measure of risk in the banks balance sheet. They are simply the natural logarithm of loan chargeoffs in the given quarter. We use the GDP growth rate as a macro control variable in the regression analysis and as a control for the demand size effects that exist, as is common in the literature.

We now look at some stylized facts in the data. It is useful to look at some of the key variables, in our analysis, for the US at four different points in time, within our sample. Figure 3 shows the distribution of the loan to asset ratios of banks in our sample. Figures 4-6 show how the distribution of bank capital has changed over time.[4] It clearly shows that towards the end of the sample there are many more banks who operate at low levels of capital. The fourth panel represents this all the more being after the financial crisis during which the balance sheets of most banks shrunk leading to a loss in equity. The mass to the left of the 10% capital level has increased irrespective of the measure of capital we use. Figures 7 and 8 show the time series of these variables. The grey bands show the NBER recession dates. This helps us understand the behavior of these variables over time. It is clear how the house prices and the bank capital fell dramatically during the recent financial crisis. We show all three measures of bank capital as discussed earlier.

4 The Empirical Framework

The empirical model we wish to estimate is the following:

[4] We also report the equity asset ratio here. This is just the common equity normalized by total assets.

$$LTANR^s_{i,t} = \alpha_i + \nu_s + \beta K_{i,t} + \gamma_1 BSC_{i,t-1} + \gamma_2 Macro_{t-1} + u_{i,t} \quad (1)$$

Where,

- $LTANR^s_{i,t}$ is the loan to asset ratio of bank i at time t, with headquarters located in state s. Here the loans are all the loans made by the bank except the real estate loans. To elaborate on this point a little more, the loans included in this variable are the industrial/commercial loans, loans to individuals and the loans to agriculture. The only other major lending sector is the real estate sector which is not included in LTA, the reason for which will be outlined below.

- K is a measure of bank capital. We will be working with two different measures of capital. First, we use the capital adequacy ratio which is the Tier 1+ Tier 2 capital as a fraction of risk weighted assets. Second, we use the Tier 1 ratio.

- BSC consists of lagged bank specific controls which include liquidity and log of loan chargeoffs

- Macro controls for the state of the overall macroeconomy i.e. aggregate shocks. We use the growth rate of real GDP as the control. Following the literature, this also helps us account for demand side factors. We can thus exclusively focus on a supply sided mechanism.

- α_i and ν_s are the bank and state fixed effects respectively.

4.1 Endogeneity Issues and IV Estimation

We are aware that the equation above suffers from a potential endogeneity problem. The equation (1) above assumes that the bank sequentially decides first on how much capital to hold and then how many loans to make. In practice, however, this might not be a reasonable assumption. We think that such decisions are not sequential but simultaneous. Hence we find a suitable instrument for bank capital. Our instument is the banks exposure to the real estate sector. Our first stage regression is the following:

$$K_{i,t} = \alpha + \theta \overline{LTAR}^{s}_{i,t-1} * \%\Delta LP_t + controls_{i,t-1} + v_{i,t} \tag{2}$$

Here,

- $\overline{LTAR}$ is the average loans made to the real estate sector over total assets in the last three quarters. It measures the exposure of a bank to this particular sector. The greater the exposure, the greater will the bank capital be sensitive to real estate price movements.

- LP is the real estate price index at the state level. We use the percentage change in LP.

- $controls_{i,t-1}$ includes bank specific and macro controls as discussed earlier.

Here we instrument bank capital by the interaction between the change in real estate prices and real estate exposure of the bank. If the real estate prices in a particular state increase, then the impact on bank capital depends on the banks exposure to the real estate sector. If a bank has sufficient exposure to the real estate market, a rise in land price means that the value of its assets have risen and that in turn means that the bank now has greater equity, liabilities roughly remaining unchanged. On the other hand, if the bank has limited exposure to the real estate sector, this appreciation in land prices will have a much subdued impact on its capital. We report the regression results later to prove the validity of the instrument but it is clear that our instrument is correlated with the bank capital and uncorrelated with the error because our dependent variable is the loans made to all sectors except the real estate sector. This is not correlated with land price movements or loans made to real estate in the last three quarters.

5 Regression Analysis

We report the fixed effects instrumental variable estimation results of the model. We also report the first stage regression results in the IV estimation.

Table 2 shows the first results for the impact of bank capital on lending. This is the baseline specification and we add controls sequentially here. Columns (1)-(4) use the capital adequacy ratio as the measure of capital while columns (5)-(8) use the tier 1 capital ratio. Columns (1) and (5) include no additional controls in the regression. The magnitude of β is significant at the 1% level. We see that on introducing controls, the coefficient remains significant at the 1% level.[5] The baseline results show a subdued impact of bank capital on lending. A 1% point increase in the CAR leads to an increase in the loan to asset ratio in the range of 0.04% and 0.08%. We think that is quite a small impact given that a 1% point increase in the capital adequacy ratio is quite a substantial increase.

Table **??** shows the results of our main IV estimation. The dependent variable is still the loan to asset ratio where the loans exclude those made to real estate sector. The first two columns show results from our entire sample which is all commercial banks except the top and bottom decile. The next two columns show results from banks above the median and the last two columns show results for banks which are below the median. We also use the two measures of capital for each of the three samples. We include state fixed effects in the regression to capture within state changes. We also include lagged macroeconomic and bank specific controls. However, before we discuss the results listed in this table, perhaps we should briefly comment on the first stage regression which is the direct estimation of equation (2). The results are shown in table **??**. We use the percentage change in real estate prices times the three quarter average of real estate loan to asset ratio as the instrument. The two columns predict the CAR and the tier 1 capital respectively. The sign on the instrument is positive and significant at the 1% level, which means that with a rise in asset values, the bank capital increases, assuming

[5]We use lagged liquidity and chargeoffs as bank specific controls and lagged GDP growth as the macro control variable.

that liabilities are roughly unchanged.

Now let us look at table **??** in detail. The coefficient on the capital ratio remains positive and significant at the 1% confidence level, mostly. We find a moderate response of lending to bank capital. As discussed earlier, the magnitudes are much smaller than those suggested by Adrian and Shin (2007) but are in agreement with other papers that use US data and where the sample period starts after the introduction of the Basel Banking Accord in 1989. The other thing to note is that the effect of capital on lending is bigger for the relatively bigger banks. The reason could be as follows. The bigger a bank gets and the more capital it has, it can make more loans than a smaller bank. Bigger banks tend to enjoy greater acccess to financial markets and government guarantees than smaller banks. Hence their LTA responds more to capital than their smaller counterparts. For the whole sample, we find that a 1% increase in capital leads to an increase in the LTA which ranges between 0.08% and 0.14% depending on what measure of capital we use. For the sample above the median, the results are a bit mixed. This effect 0.13% for CAR and we lose significance when we use the tier 1 ratio. For the smaller banks, the range is between 0.05% and 0.07%. Berropside and Edge do not consider separate studies for the different groups of banks as we do but using bank holding company data, they also suggest a low impact of bank capital on lending.

6 Conclusion

This paper seeks to quantify the impact of bank capital on lending as this is one of the key policy questions while analyzing financial-real sector linkages. Using a subset of the commercial banks in the United States and an innovative instrumenting strategy, we find a modest impact of bank equity on lending behavior. Our estimates are broadly consistent with other recent studies in the literature that have worked on US data. Some earlier papers do report much higher estimates but they do not account for the structural change in the banking sector following the introduction of the Basel Core Banking Principles.

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Appendices

A Data Description and Regression Tables

Table 1: **Summary Statistics**

variable	**All Mean**	**All Median**	**All SD**	**Big Mean**	**Big Median**	**Big SD**	**Small Mean**	**Small Median**	**Small SD**
CAR	.1540	.1357	.0629	.1495	.1326	.0587	.1704	.1492	.0737
LTA	.6618	.6804	.1423	.6692	.6878	.1389	.6353	.6513	.1509
Tier 1 Cap	.0944	.0877	.0285	.0925	.0865	.0268	.1015	.0933	.0329
LTAR	.4728	.4787	.1691	.4905	.4978	.1641	.4087	.4013	.1712
LTANR	.1890	.1692	.1197	.1786	.1589	.1166	.2266	.2101	.1231
$\%\Delta LTAR$	.0052	.0034	.0602	.0046	.0034	.0567	.0069	.0035	.0711
$\%\Delta LTANR$	-.0062	-.0077	.0931	.0046	.0033	.0567	-.0045	-.0061	.0984
$\%\Delta HPI$	.0074	.0092	.0169	.0074	.0092	.0174	.0071	.0091	.0148
Liquidity	4.1156	4.1896	1.8572	4.6479	4.7361	1.8235	3.5333	3.6109	1.7135
Chargeoffs	.2102	.1830	.1447	.2028	.1772	.1357	.2175	.1902	.1528
$\%\Delta GDP$	.0064	.0067952	.0070901						

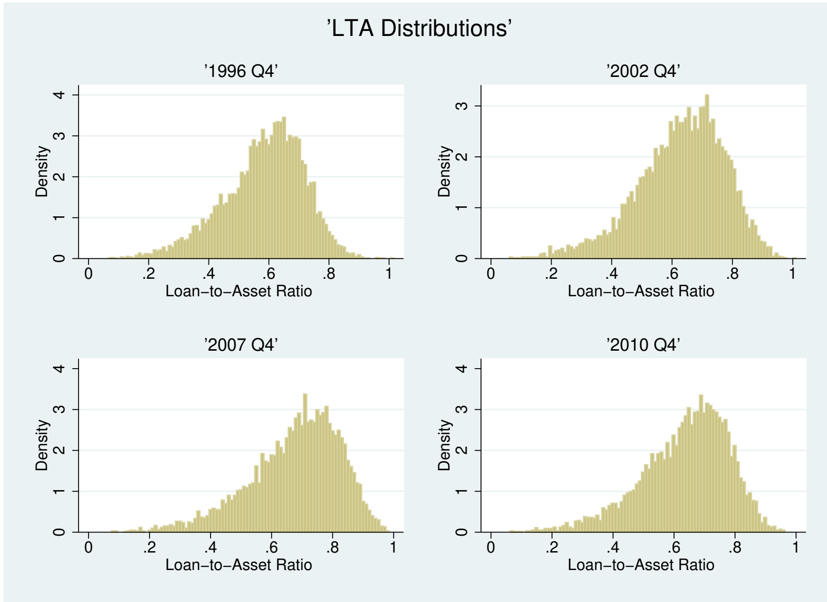

Figure 3: Distributions of the Loan to Asset Ratio

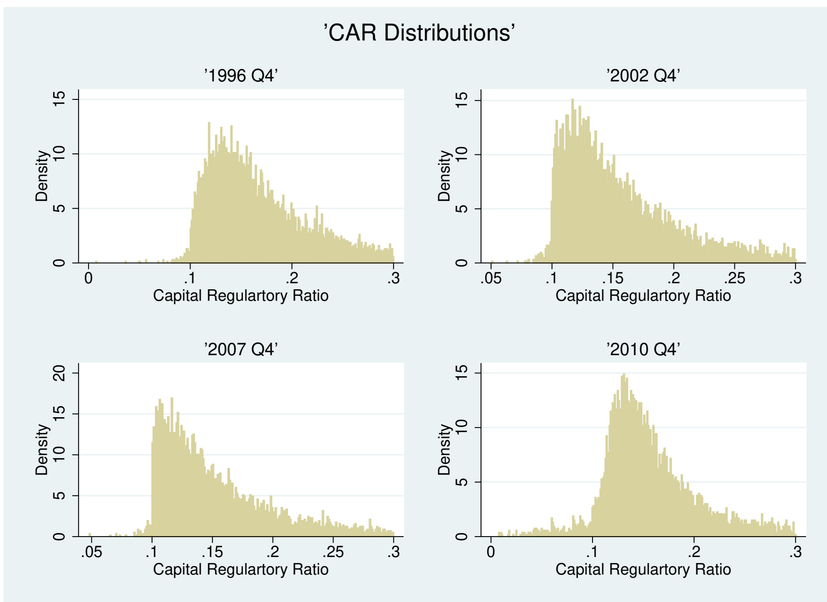

Figure 4: Distributions of the Capital Adequacy Ratio

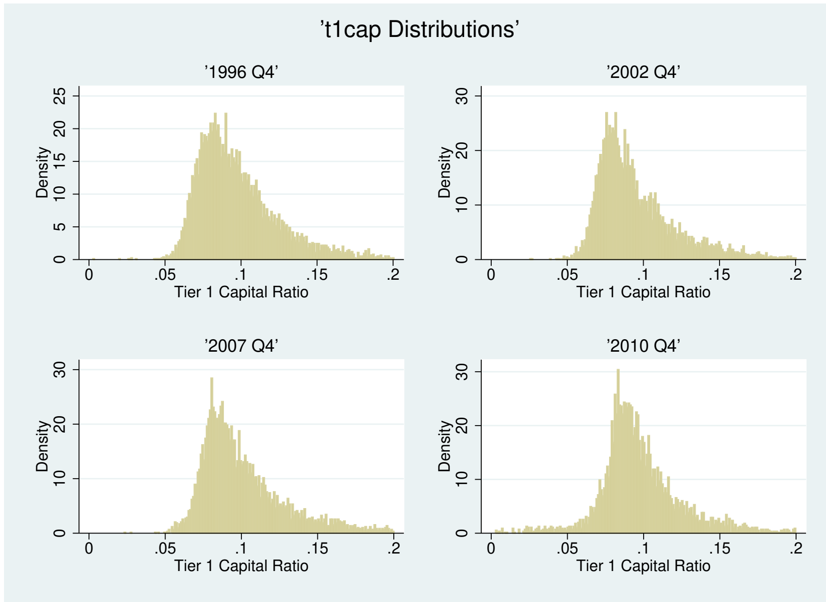

Figure 5: Distributions of the Tier 1 Capital Ratio

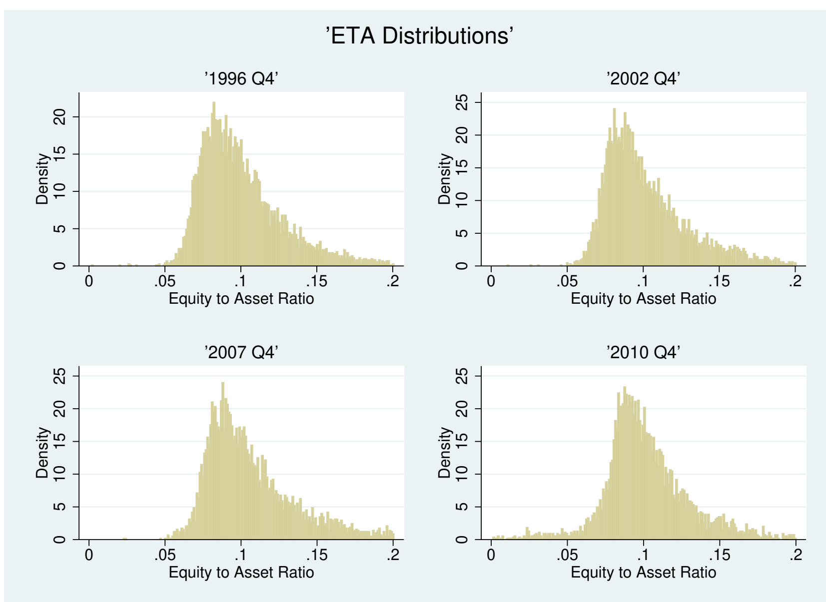

Figure 6: Distribution of the Equity to Asset Ratio

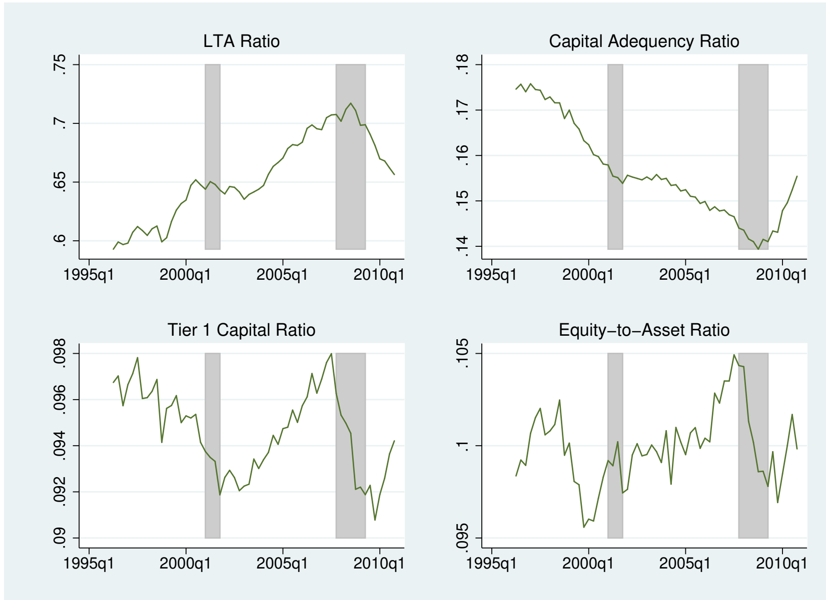

Figure 7: Time series of key variables

Figure 8: Time Series of key variables

Table 2: IV Regression (Adding Controls Sequentially)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	LTANR	LTANR	LTANR	LTANR	LTANR	LTANR	LTANR	LTANR
VARIABLES	CAR	CAR	CAR	CAR	T1 Cap	T1 Cap	T1 Cap	T1 Cap
Capital	0.039***	0.037***	0.064***	0.080***	0.236***	0.053***	0.125***	0.141***
	(0.002)	(0.002)	(0.007)	(0.012)	(0.037)	(0.003)	(0.018)	(0.025)
L.logcharge		-0.583***	-0.897***	-1.064***		-0.180***	-0.224***	-0.227***
		(0.030)	(0.085)	(0.137)		(0.007)	(0.019)	(0.022)
L.liqui			0.001	0.001*			0.012***	0.014***
			(0.001)	(0.001)			(0.002)	(0.003)
L.growth				-0.898***				-0.465***
				(0.189)				(0.154)
Observations	343,752	143,580	126,382	126,382	343,752	143,580	126,382	126,382
Number of id	9,027	6,882	6,735	6,735	9,027	6,882	6,735	6,735

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3: Main IV Regression

	(1)	(2)	(3)	(4)	(5)	(6)
	LTANR	LTANR	LTANR	LTANR	LTANR	LTANR
	CAR	T1 Cap	CAR	T1 Cap	CAR	T1 Cap
VARIABLES	All	All	Big	Big	Small	Small
Capital	0.080***	0.141***	0.135***	0.346	0.050***	0.077***
	(0.012)	(0.025)	(0.048)	(0.226)	(0.006)	(0.010)
L.logcharge	-1.064***	-0.227***	-1.630***	-0.206***	-0.752***	-0.229***
	(0.137)	(0.022)	(0.536)	(0.073)	(0.079)	(0.016)
L.liqui	0.001*	0.014***	0.001	0.034	0.002**	0.008***
	(0.001)	(0.003)	(0.002)	(0.025)	(0.001)	(0.001)
L.growth	-0.898***	-0.465***	-2.061**	-1.797	-0.292***	-0.035
	(0.189)	(0.154)	(0.836)	(1.363)	(0.106)	(0.077)
Observations	126,382	126,382	66,222	66,222	60,160	60,160
Number of id	6,735	6,735	3,343	3,343	3,392	3,392

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4: First Stage Regression

	(1)	(2)
	CAR	T1 Cap
VARIABLES	All	All
$\overline{LTAR} * \%\Delta LP$	5.740***	3.258***
	(1.487)	(1.086)
L.logcharge	11.438***	0.537**
	(0.509)	(0.250)
L.liqui	-0.059***	-0.123***
	(0.008)	(0.006)
L.growth	14.924***	5.394***
	(1.077)	(0.662)
Constant	14.775***	10.913***
	(0.127)	(0.062)
Observations	126,467	126,467
Number of id	6,820	6,820

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1