Bank Capital Requirements*

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Abstract

This paper analyzes the macroeconomic effects of bank capital requirements. Using data for U.S. bank holding companies over the period 1993Q1 to 2012Q1 we document that: a) bank capital requirements bind especially for the largest banks (top 5%), which represent more than 90% of the assets of the financial system; b) bank assets and deposits are procyclical while equity is acyclical; c) an increase in loan loss provisions reduces output, raises the corporate bond spread and the bank capital ratio. We develop a macroeconomic model where financial intermediaries are subject to an equity constraint along the lines of Basel II. Our model, calibrated over the pre-crisis period, generates moments in line with the empirical evidence. A decline in bank assets generates a fall in asset prices and bank loans that reduces output and consumption. The presence of a minimum capital requirement mitigates the impact of financial shocks on output. We use the model to evaluate Basel III proposed introduction of a capital conservation and a counter-cyclical buffer for banks.

Keywords: Banking; Capital Adequacy; Financial Regulation

JEL Codes: E32, E44, G01, R31

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1 Introduction

We examine how financial intermediaries, mainly large Bank Holding Companies (BHCs) in the US behave over the business cycle. We analyze how macroeconomic shocks are propagated in the presence of bank capital requirements, and how the composition of banks' balance sheets affect the business cycle. First, we empirically analyze the cyclical properties of balance sheet variables such as total assets, loans, deposits and equity, and also the equity-to-asset ratio which is subject to supervisory capital regulation.

Covas and Den Haan (2011) document that using firm-level data is important to analyze the cyclical behavior of firm financing i.e. debt vs. equity financing. Hence, in this paper we closely follow their method. We use bank-level data and group banks into quartiles according to their asset size. Then, we construct time series for the balance sheet variables at the group level, and examine the correlation between the cyclical component of these variables and the cyclical component of real per capital GDP, where we use HP-filter to calculate the cyclical component. We show that cyclicality properties of the banking sector is driven by the behavior of the banks that are in the top 25% quartile. Total assets, loans and deposits are procyclical whereas equity is acyclical and equity-to-asset ratio is countercyclical.

According to Basel II bank capital requirements BHCs must have Tier 1 capital of 4% risk-weighted assets (RWAs).[1] BHCs also must have at least 8% of their RWAs as Tier 1 plus Tier 2 capital. We present evidence that there is heterogeneity in banks' behavior in terms of how much regulatory capital they hold and moreover majority of the banks hold at least the minimum capital ratio required. This behavior is also documented by Berger, DeYoung, Flannery, Lee and Oztekin (2008). They find that BHCs that have access to inexpensive external capital can afford to hold less capital which they interpret as BHCs actively managing their capital ratios. We also show that among the well-capitalized banks the smallest banks are prevalent, and among the significantly-undercapitalized banks the largest banks are prevalent.

Next, we present vector autoregression (VAR) evidence to capture the importance of bank capital and how it responds to losses in the banking sector. Particularly we focus on the shocks to loan loss provisions (LLPs) and net charge-offs (NCOs) and how they affect the balance sheet of the banks and the rest of the economy. For this purpose we only focus on the set

[1] Basel regulation and the variables will be be explained in the following sections.

of 15 largest BHCs which constitute about 76% of the total bank assets in our data sample, and almost about 2% of total banks. We acknowledge that knowing the differences between small and large banks and how they manage their capital ratios is crucial especially for the regulators. However as a starting point we focus only on the largest BHCs as they summarize the behavior of the banking sector as a whole. Our VAR analysis shows that an increase in the LLPs or NCOs leads to a decrease in output and an increase in bank capital, which in line with counter-cyclical bank capital ratios.

In the theoretical part, we develop a model with financial intermediaries that face equity constraints as in Basel II. The model consists of households, who can save in risk-free deposits or risky equity; firms that rent capital (from capital producers) and labor to produce goods; and banks that take deposits, issue equity, and make loans to firms. The financial friction consists in a bank equity constraint such that equity should be 8% of total assets. The constraint is modeled as a penalty in terms of the bank's net worth. For example, low bank equity relative to assets could result in limitations to distribute dividends and/or the requirement to recapitalize or simply higher funding rates.

We use the model to analyze the effects of a crisis, which we model as a reduction in banks' assets – a decline in capital quality. The model with capital constraints de-amplifies the initial shock and leads to a smaller output reductions and avoids equity from reaching extremely low levels. In fact, we can use the model to compute the frequency of bankruptcy in the financial system. We show that reducing the minimum capital requirement increases the frequency of bankruptcy.

2 Literature

Recent financial crisis has showed that financial sector has an important role as a source for business cycle fluctuations, and there has been an increased interest in the interaction between banking regulation and macroeconomic fluctuations.

Earlier studies examined the effect of changes in bank capital on bank lending. Bernanke and Lown (1991) find that a decline in bank capital ratios is related to a downfall in the loan growth of banks, however they claim this effects is not so large. Hancock and Wilcox (1993) use an approach that investigates the effect of bank capital ratio deviations relative to an estimated target. They use panel data and show that banks reduce their lending due a short fall in their capital positions. Hancock, Laing and Wilcox (1995) use a panel data VAR and find that after a shock to bank capital, banks decrease their lending and it takes about two to three years to go back to their initial position. Peek and Rosengren (1995) find that poorly capitalized banks that have negative shocks to their capital shrink their liabilities more than better capitalized banks. Lown and Morgan (2006) and Berrospide and Edge (2010) employ VAR models with aggregate data and also find that a disruption in bank capital reduces bank loans, even though the magnitude is not so big.

These studies they establish a positive relationship between bank capital and loan growth however they do not investigate how supply side or demand side shocks affect bank loan growth for a given capital position. Blum and Hellwig (1995) is an early attempt to examine macroeconomic implications of bank capital regulation. They show that fixed bank capital requirements can amplify macroeconomic fluctuations. They argue that banks lend more during booms and lend less during recessions because of the procyclical nature of fixed bank capital requirements. Cecchetti and Li (2008) build on the work of Blum and Hellwig (1995) and also show that bank capital requirements can amplify the effects of shocks on the economy. They also demonstrate that optimal monetary policy can neutralize the procyclical impact of capital requirements. Kishan and Opiela (2000) find empirically that better capitalized banks are more able to maintain loan growth during contractionary monetary policy.

Several studies examine the macroeconomic implications of bank capital requirements.[2] These models are in general partial equilibrium models. Only a few dynamic stochastic general equilibrium models have introduced financial intermediation in general equilibrium macroeconomic models in recent years, and they do not necessarily analyze the balance sheet composition of banks. However the balance sheet composition of banks is important and their lending behavior depends on how well the banks are capitalized.

In a DSGE setting, Meh and Moran (2010) find that bank capital channel amplifies and propagates the effects of shocks on output, investment, and inflation. This amplification affect is more pronounced for technology shocks than monetary policy shocks. However they do not model bank capital requirements. Aikman and Paustian (2006) have a similar model and they examine optimal monetary policy.

[2] Please see VanHoose (2008) and Drumond (2009) for an extensive review.

Covas and Fujita (2010) is similar to our model where they impose capital requirements and assume that raising equity is more costly than raising deposits. Comparing Basel I, which has fixed capital requirements, and Basel II, which has time-varying capital requirements, to a no capital regulation regime, they find modest effects of capital regulation on output fluctuations. However their model does not have the banks making a choice between equity vs. deposit financing.

Gertler and Karadi (2011) and Gertler and Kiyotaki (2010) develop a quantitative monetary DSGE model with financial intermediaries that face endogenously determined balance sheet constraints. They introduce a simple agency problem between intermediaries and their respective depositors: bankers can divert funds from the project and instead transfer them back to the household if the value of remaining a banker is too low. In these models, deposits and loans must be limited and efficient equilibrium cannot be achieved. Most notably, these models do not have bank capital. Gertler, Kiyotaki and Queralto (2011) introduce bank capital in this setup. To raise external funds, banks can raise deposits and issue equity. These models are used to evaluate government credit policy along the lines of the unconventional monetary policy carried out during the financial crisis. In our model banks can issue outside equity as well as deposits and households face a portfolio choice between risky equity and safe deposits along the lines of Gertler et al. (2011). However, the liability composition of the balance sheet of the banks is pinned down by a minimum equity requirement that we model as a penalty.

He and Krishnamurthy (2012) present a model with financial intermediaries where bank reputation limits the amount of equity funding. The model produces systemic states where aggregate bank reputation is low and the banking system faces a binding constraint on equity. Unlike He and Krishnamurthy (2012), our bank capital constraint is written explicitly as a fraction of assets, as specified in the Basel accords. Moreover, we emphasize matching the behavior of bank-level variables at the business cycle level.

3 Historical Background on Bank Capital Regulation

The Basel Committee on Banking Supervision issued a set of minimum capital requirements for banks (Basel I) and it was implemented by G-10 countries by the end of 1992. Basel I accord introduced:

1. Tier 1 Capital, also called core capital, which includes common shareholders' equity, disclosed reserves or retained earnings, and may also include non-redeemable non-cumulative preferred stock;

2. Tier 2 Capital, also called supplementary capital, which includes undisclosed reserves, revaluation reserves, general provisions and general loan-loss reserves, hybrid debt capital instruments, and subordinated term debt;

3. Risk Weighted Assets *(RWA)*, which is a weighted sum of different categories of asset or off-balance-sheet exposure of a bank, where weights are assigned according to broad categories of relative riskiness.

Basel I required banks to hold a core capital ratio *(Tier 1 Capital-to-RWA)* of at least 4%, and a total capital ratio *((Tier 1 + Tier 2) Capital-to-RWA)* of at least 8%. The supplementary capital was also limited to 100% of core capital. In 1989, in the United States, the Federal Reserve, FDIC, and OCC issued plans implementing Basel I requirements, and set deadline of December 1992 for the full implementation of these rules.

The second Basel accord, Basel II, was initially introduced in 2004 and should have become effective in 2008. Basel II redesigned the weighting scheme of RWA assets by allowing for more risk differentiation. In the U.S. a minimum of 4% leverage ratio, which is Tier 1 capital divided by average total assets, was also introduced. Table 1 summarizes the Basel II accord.

Table 1: **Basel II**

Bank Capital Regulation	
Components	Minimum Requirement
Core capital (Tier 1)	$\geq$ 4% of RWA
Supplementary capital (Tier 2)	$\leq$ of 100% of Tier 1
Total capital (Tier 1 + Tier 2)	$\geq$ 8% of RWA
U.S.: Leverage ratio	$\geq$ 4%

With the financial crisis of 2007-2009, Basel II became difficult to implement, and the regulators also noticed the need to revise their requirements. With Basel III banks have to hold a core capital ratio of at least 6%, and the common equity should be at least 4.5% of RWA. Total capital ratio is left unchanged and it still has to be at least 8%. Basel III introduced two new buffers:

1. Capital conservation buffer, which requires banks to hold an additional 2.5% of RWAs during calm times that they can draw down when losses are incurred;

2. Counter cyclical buffer, which requires banks to hold an additional 2.5% of RWAs when authorities judge credit growth is resulting in an unacceptable build up of systematic risk.

Table 2 summarizes the proposed Basel III regulation.

Table 2: **Basel III**

Bank Capital Regulation	
Components	Minimum Requirement
Core capital (Tier 1)	$\geq$ 6% of RWA
of which common equity Tier 1	$\geq$ 4.5% of RWA
Total capital (Tier 1 + Tier 2)	$\geq$ 8% of RWA
Capital Conservation Buffer	
Common equity Tier 1	additional 2.5% of RWA
Counter-cyclical Buffer	
Common equity Tier 1	additional 2.5% of RWA

4 Empirical Evidence

In our analysis we use quarterly data for U.S. bank holding companies between 1993Q1 and 2012Q1. Because the implementation deadline for Basel I rules was December 1992, our data set starts with the first quarter of 1993. Our data sample includes the latest financial crisis period, but for our analysis we sometimes exclude the time period after 2007q4, to eliminate the effects of this extraordinary time period. Also, banks started reporting Tier 1 capital and RWAs in 1996Q1, and Tier 2 capital in 1998Q1 therefore we have missing observations for these variables for the beginning of our sample. And since our theoretical model does not differentiate among different types of assets for risk weighting purposes, we mainly focus on equity-to-asset ratio in our empirical analysis.

The balance sheet data are from the Federal Reserve's Y-9C consolidated financial statements for BHCs, and data definitions are listed in Appendix A. We include banks that existed for at least 50 quarters during the period the 1993Q1-2012Q1 period. We would like to isolate the effect of the banks that enter and exit the system from our analysis to achieve stable results.

We also match this balance sheet information with the stock price information from Center for Research on Stock Prices (CRSP) database using the mapping available from Federal Reserve Bank of New York.[3] As a result of this merge, we lose some observations which are mainly small and non-publicly traded banks. To avoid this decrease in observations in a non-random manner, we use the merged data set only when we need information on stock prices.

First, we examine how the regulatory capital, *TotCap/RWA (Tier 1 plus Tier 2 capital divided by RWAs)*, is distributed across different size groups. We divide the banks into quartiles for each time period by assigning the bank to a size group according to its asset size. Then, we classify the BHCs according to their capital position relative to the regulatory thresholds following Berger et al. (2008). The "well-capitalized" threshold is 10%, and the "adequate capital" threshold is 8%.

- Wellcap_over800 if the BHC's capital ratio exceeds the regulatory standard for "well capitalized" by more than 800 bps,
- Wellcap_600to800 if the BHC's capital ratio is 600-800 bps above the "well capitalized" threshold,
- Wellcap_400to600 if the BHC's capital ratio is 400-600 bps above the "well capitalized" threshold,
- Wellcap_200to400 if the BHC's capital ratio is 200-400 bps above the "well capitalized" threshold,
- Wellcap_0to200 if the BHC's capital ratio is up to 200 bps above the "well capitalized" threshold,
- Adeqcap if the BHC's capital ratio lies between the adequate and well-capitalized thresholds,
- Undercap if the BHC's capital ratio lies less than 100 bps below the adequately capitalized level,

[3] The mapping is available at `http://www.newyorkfed.org/research/banking_research/datasets.html`. The merging is done using the PERMCO from CRSP and the RSSD9001 identifier from FR Y-9C reports.

- Sig-Undercap if the BHC's capital ratio lies more than 100 bps below the adequately capitalized level.

We have a total of 44,049 bank-quarter observations for the period 1998Q1-2012Q1. Tables 3 and A.1 indicate that the majority of the banks were well-capitalized, and they hold more than the regulatory requirement. Table 3 shows the size distribution of banks for a given capital group. Among the significantly undercapitalized banks, the big banks have the largest share. Big banks also have the largest share for banks that hold up to 400 bps above the 10% well capitalized threshold. However, it is the small banks that have the largest share that hold more than 400 bps above the 10% well capitalized threshold.

Table 3: **Regulatory Capital and Size - Row Percentage**

	[0,25]	[25,50]	[50,75]	[75,100]	Total
Sig-Undercap	30.75	15.70	18.49	**35.05**	100
Undercap	**32.99**	24.37	**32.99**	9.64	100
Adeqcap	26.77	**31.83**	29.30	12.09	100
Wellcap_0to200	18.05	23.47	28.89	**29.60**	100
Wellcap_200to400	20.90	25.38	25.71	**28.02**	100
Wellcap_400to600	**26.07**	25.82	23.15	24.96	100
Wellcap_600to800	**29.70**	27.32	20.58	22.39	100
Wellcap_over800	**40.29**	24.82	22.38	12.51	100
Total	25.14	25.21	25.22	24.43	100

Time period: 1998Q1-2012Q1, for banks that exist for at least 50 quarters. The numbers in bold reflect the highest percentage in a given row.

Table A.1 shows that most of the small banks which are at the bottom 25% of the size distribution are very well capitalized. Almost 35% of the smallest banks hold at least 16% equity. As we move to the larger banks this number goes down gradually, and only 16% of the largest banks which are at the top 25% of the size distribution hold at least 16% equity. Medium and large sized banks are hold most around 10-14% equity.

Next, Table 5 has various mean capital ratios for different size groups. In column (1), Tier 1 capital to risk-weighted-asset ratio gradually declines from smaller banks to larger banks. However in column (2) Tier 2 capital to risk-weighted-asset ratio gradually increases from smaller banks to larger banks. Overall, the regulated *(Tier 1+Tier 2)/RWA* ratio follows the pattern of *Tier1/RWA*, i.e. as the size group of the bank increases, the capital ratio gets smaller. In column (4), *Leverage* is the leverage ratio *(Tier 1/Average Total Assets)* that is regulated under Basel rules, and the largest 2% of the banks have the lowest leverage ratio.

In the last three columns we present different equity ratios which could also be potential bank capital ratios that are empirically measured and could be counterparts for the equity-to-asset ratio in our theoretical model, as our model does not differentiate different types of asset in terms of riskiness and equity in terms of quality. In column (5) there is *Equity/RWA* ratio. As the bank size gets larger this ratio gets smaller similar to the *Tier 1+Tier 2* regulatory ratio. For *Equity/Asset* ratio there is not a monotonous decreasing relation between the bank size and capital ratio however, the largest 2% of the banks hold the lowest equity to asset ratio. In the last column, there is *Equity/Loan* ratio, which could also be a potential empirical variable as a counterpart to the equity-to-asset ratio in our theoretical model, since we only have loans on the asset side of the bank's balance sheet. And the largest 2% of the banks have the highest equity-to-loan ratio.

Table 4: **Regulatory Capital and Size - Column Percentage**

	[0,25]	[25,50]	[50,75]	[75,100]	Total
Sig-Undercap	1.29	0.66	0.77	1.52	1.06
Undercap	0.59	0.43	0.59	0.18	0.45
Adeqcap	4.30	5.10	4.69	2.00	4.04
Wellcap_0to200	18.59	24.11	**29.66**	**31.38**	25.9
Wellcap_200to400	22.63	**27.41**	27.75	31.23	**27.23**
Wellcap_400to600	17.96	17.74	15.89	17.70	17.32
Wellcap_600to800	10.82	9.92	7.47	8.39	9.16
Wellcap_over800	**23.82**	14.63	13.19	7.61	14.86
Total	100	100	100	100	100

Time period: 1993Q1-2012Q1, for banks that exist for at least 50 quarters.

Table 5: **Size Classes and Mean Capital Ratios**

	(1) $\frac{Tier1}{RWA}$	(2) $\frac{Tier2}{RWA}$	(3) $\frac{Tier1+2}{RWA}$	(4) $Leverage$	(5) $\frac{Equity}{RWA}$	(6) $\frac{Equity}{Asset}$	(7) $\frac{Equity}{Loan}$
$[0, 25]$	**14.35**	1.36	**15.54**	**9.50**	**14.48**	**9.37**	15.74
$[25, 50]$	13.28	1.33	14.41	9.10	13.39	8.93	14.77
$[50, 75]$	13.01	1.42	14.20	9.18	13.28	9.12	14.98
$[75, 90]$	12.48	1.48	13.71	8.78	13.02	8.90	14.62
$[90, 95]$	11.64	1.99	13.55	8.30	13.06	8.86	14.89
$[95, 98]$	10.05	2.93	12.98	8.10	12.34	9.12	15.91
$[98, 100]$	8.30	**3.34**	11.67	6.59	11.62	8.26	**18.46**
Total	13.10	1.50	14.40	9.06	13.50	9.07	15.15
Start Year	1996q1	1998q1	1998q1	1996q1	1996q1	1993q1	1993q1

Time period: 1998Q1-2012Q1, for banks that exist for at least 50 quarters.

We examine the cyclicality of bank balance sheet variables in Table 6. We measure real economic activity with HP-filtered log of real GDP per capita. We also deflate the bank level variables using GDP deflator and create per capita measures. Then we use HP-filter of the log of this variable to get the cyclical component. For the equity-to-asset ratio, we use the ratio itself.[4] We examine the correlations of the bank variables with GDP lagged one period, current GDP, and one-period-ahead GDP. The first three columns in Table 6 report the correlations for the period 1993Q1-2007Q4, and the last three columns report the correlations for the period 1993Q1-2012Q1. *Panel A* reports the variables that come from the FR Y-9C reports. Most of the balance sheet variables are procyclical, such as assets, loans, liabilities, deposits, stocks (preferred stock plus common stock) and retained earnings,[5] as expected. Loan loss provisions *(LLP)* and net charge offs *(NCO)* are countercyclical. Except for equity all these correlations are statistically significant at the 10% level. The reason why equity is not significantly correlated with output is because equity is negatively correlated with output for the bottom 75% of the banks, whereas it is positively correlated with top 25% of the banks. Even though these numbers are not statistically significant, they point out that the sign of the correlation is different for different size groups, and the overall positive correlation is driven by the largest banks.

Panel B reports variables that come from FR Y-9C reports merged with CRSP database which has information about share prices. Since not all the banks are publicly traded, the merged data set includes only 18,258 bank-quarter observations from 1993Q1 till 2011Q4. Value of total shares outstanding, which is the number of shares times price, is procyclical, and share prices are positively correlated only with future GDP. Equity premium and return on bank stocks are countercyclical. Again, these correlations are statistically significant at the 10% level.

Next, in Table 7 we report the cross correlations of aggregate variables: output, consumption, investment and aggregated bank level variables. In this Table we also include various return measures: return on average equity *(ROAE=Net Income/Average Equity)*, return on liabilities *(ROL=Net Income/Liabilities)*, return on average assets *(ROAA=Net Income/Average Assets)*, net interest margin *(NIMA=Net Interest Margin/Average Assets)*. As expected, assets, loans, liabilities, deposits, retained earnings, and stocks are positively correlated with output, consumption, and investment. Equity is only positively correlated with consumption

[4] We also investigate the cyclicality for different size groups. We aggregate the level variables for each group and each quarter, deflate using GDP deflator, calculate the per capita measure, and then take the HP filter of the log of the variable. For the equity-to-asset ratio, we use the group mean. The results for different size groups can be found in Appendix A in Tables A.3-A.6.

[5] $\text{Retained Earnings}_t = \text{Retained Earnings}_{t-1} + \text{Net Income}_t - \text{Dividends}_t$

Table 6: **Cyclicality in the Aggregate Data**

	1993Q1-2007Q4			1993Q1-2012Q1		
	Y_{t-1}	Y_t	Y_{t+1}	Y_{t-1}	Y_t	Y_{t+1}
Panel A: FR Y9-C						
Asset	**0.305**	**0.308**	**0.266**	**0.237**	**0.221**	0.172
	(0.019)	(0.017)	(0.040)	(0.039)	(0.054)	(0.137)
Loan	**0.370**	**0.361**	**0.312**	**0.310**	**0.248**	0.155
	(0.004)	(0.005)	(0.015)	(0.006)	(0.030)	(0.182)
Liability	**0.342**	**0.349**	**0.306**	**0.280**	**0.262**	**0.204**
	(0.008)	(0.006)	(0.017)	(0.014)	(0.021)	(0.077)
Deposit	**0.222**	**0.257**	**0.277**	0.046	0.127	**0.199**
	(0.092)	(0.047)	(0.032)	(0.694)	(0.271)	(0.085)
Ret. Earn.	**0.486**	**0.510**	**0.489**	**0.560**	**0.644**	**0.660**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Equity	0.074	0.050	0.031	-0.131	-0.105	-0.030
	(0.578)	(0.707)	(0.817)	(0.261)	(0.365)	(0.796)
Stocks	**0.230**	**0.227**	**0.220**	-0.052	0.080	**0.193**
	(0.079)	(0.081)	(0.092)	(0.654)	(0.489)	(0.095)
LLP	**-0.378**	**-0.413**	**-0.504**	**-0.388**	**-0.511**	**-0.627**
	(0.003)	(0.001)	0.000	(0.001)	(0.000)	(0.000)
NCO	**-0.474**	**-0.493**	**-0.573**	**-0.563**	**-0.617**	**-0.672**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
E/A	**-0.387**	**-0.329**	-0.214	-0.075	-0.003	0.102
	(0.002)	(0.010)	(0.101)	(0.521)	(0.976)	(0.379)
Panel B: FR Y9-C merged with CRSP						
No. of Shares × Stock Price	**0.444**	**0.521**	**0.586**	**0.278**	**0.477**	**0.588**
	(0.000)	(0.000)	(0.000)	(0.016)	(0.000)	(0.000)
Stock Price	0.082	0.182	**0.279**	**0.244**	**0.271**	**0.311**
	(0.535)	(0.163)	(0.031)	(0.035)	(0.018)	(0.007)
Equity Premium	**-0.469**	**-0.452**	**-0.484**	**-0.238**	-0.154	**-0.208**
	(0.000)	(0.000)	(0.000)	(0.039)	(0.184)	(0.073)
Return on Stocks	**-0.440**	**-0.427**	**-0.463**	**-0.212**	-0.129	-0.183
	(0.000)	(0.001)	(0.000)	(0.068)	(0.267)	(0.116)

Time period: 1993Q1-2012Q1, for banks that exist at least 50 quarters. The correlations that are significant at the 10% are reported in bold, and the values reported in parenthesis are the p-values.

and investment. Loan loss provision and net charge-offs however are negatively correlated with output, consumption, and investment. Equity-to-asset ratio and return on average equity are negatively correlated with output and consumption. The rest of the return variables, ROL, ROAA, and NIMA are all negatively correlated with output, consumption, and investment.

We also run a vector autoregression (VAR) model with a sample of banks consisting only of the largest BHCs. Following Covas, Rump and Zakrajsek (2012) our sample includes 15 BHCs over the 1989Q1-2012Q1 period and they are listed on Table 8.[6]

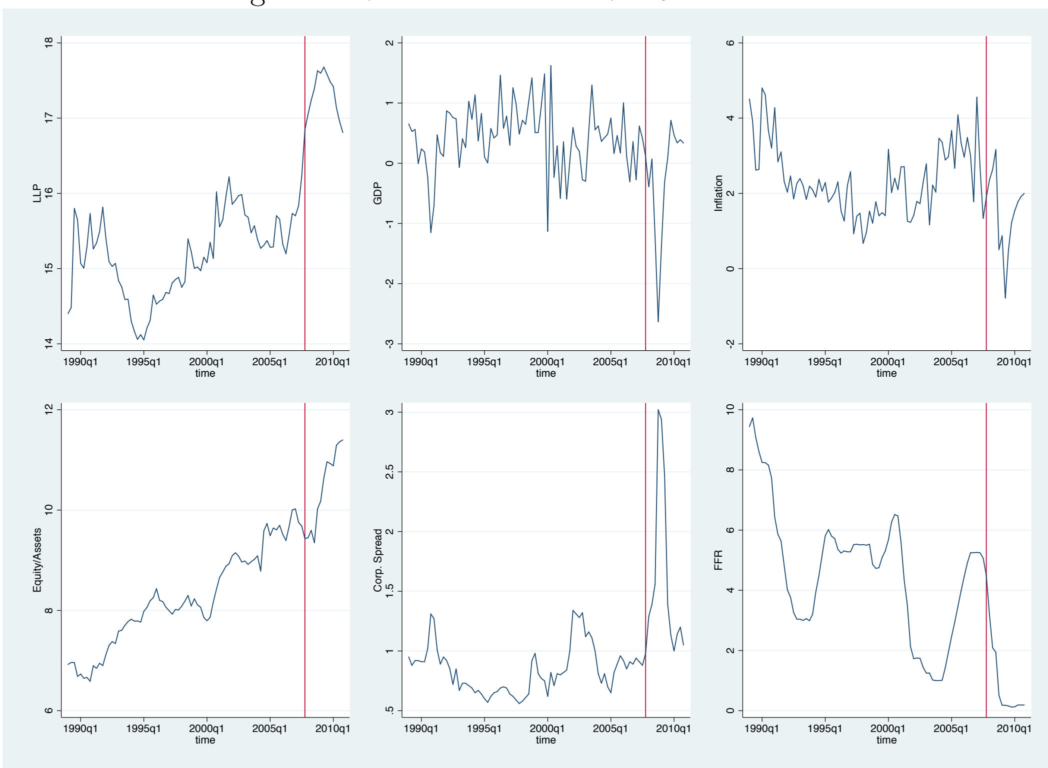
We estimate a VAR model similar to Lown and Morgan (2006) and Berrospide and Edge (2010). These studies examine the effect of bank capital ratio shock to output growth through its effect on loan growth. They find modest effects of bank capital on lending. In order to be more in line with our theoretical model, we use shocks to loan loss provisions as a shock to the asset side of the bank.[7] These shocks will be equivalent to quality of capital shocks in our model.

Our core VAR consists of six variables: loan loss provisions, real per capita GDP growth, GDP price inflation, bank equity to asset ratio, corporate bond spread, and fed funds rate. The three aggregate variables (real per capita GDP growth, GDP price inflation, fed funds rate) are standard components of a monetary policy VAR. We use two variables (loan loss provisions and bank equity to asset ratio) to model the banking sector, and the corporate bond spread is used to take into account expected future economic activity. We also do robustness analysis using the net charge-offs instead of loan loss provision to see whether using a different proxy would change our empirical results. The identifying assumption implicit in the recursive ordering of the VAR implies that loan loss provision shocks have an immediate impact on the other variables. We also experiment with changing the order of loan loss provisions by placing them after inflation and our results do not change qualitatively.

[6]We use the merger files that contain information to identify all bank and BHC acquisitions and mergers from `http://www.chicagofed.org/webpages/publications/financial_institution_reports/merger_data.cfm`. We use this information to take into account previous mergers and acquisitions and adjust the data by aggregating bank level variables.

[7]We also use net charge offs as a robustness check and our results are similar.

Figure 1: Variables used in VAR estimation



We estimate the model over the 1989Q1-2012Q1 period with two lags of endogenous variables. The plots of the variables are shown in Figure 1 and the summary statistics are reported on Table 9.

Figure 2 shows the response of the variables to a positive shock to loan loss provisions. The solid line is for the estimation that includes the whole time period, and the dashed line includes the time period until 2007Q4. For both of the time periods the results are qualitatively similar. An increase in loan loss provisions leads to a decline in output and an increase in corporate spreads. The monetary authority responds by decreasing the interest rate to stimulate the economy and the banks respond to the shock by increasing their equity to asset ratios. Table 10 shows the forecast variance decomposition for output growth at various horizons. We see that after four quarters, 78% of the the variation in output is explained by output shocks, 7% by variation in loan loss provisions, and 6% by variation in corporate spreads. And after five years, 68% of the variation in output is explained by its own shocks, and loan loss provisions still explain 7%. Inflation and corporate spreads explain

Table 7: **Correlations - 1993Q1-2007Q4**

	GDP	Cons.	Inv.	Assets	Loan	Liab.	Deposits	R.E.	Equity	Stocks	LLP	NCO	E/A	ROAE	ROL	ROA	NIM
GDP	1																
Cons.	**0.859**	1															
	0.000																
Inv.	**0.921**	**0.698**	1														
	0.000	*0.000*															
Assets	**0.244**	**0.305**	0.192	1													
	0.060	*0.018*	*0.142*														
Loan	**0.421**	**0.401**	**0.442**	**0.861**	1												
	0.001	*0.002*	*0.000*	*0.000*													
Liability	**0.276**	**0.322**	**0.223**	**0.995**	**0.857**	1											
	0.033	*0.012*	*0.087*	*0.000*	*0.000*												
Deposits	**0.331**	**0.407**	**0.347**	**0.793**	**0.819**	**0.768**	1										
	0.010	*0.001*	*0.007*	*0.000*	*0.000*	*0.000*											
Ret. Earn.	**0.447**	**0.514**	**0.514**	**0.430**	**0.578**	**0.425**	**0.586**	1									
	0.000	*0.000*	*0.000*	*0.001*	*0.000*	*0.001*	*0.000*										
Equity	0.205	**0.287**	**0.219**	**0.833**	**0.855**	**0.800**	**0.818**	**0.548**	1								
	0.116	*0.026*	*0.092*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*									
Stocks	**0.245**	**0.360**	**0.136**	**0.733**	**0.625**	**0.710**	**0.677**	0.166	**0.701**	1							
	0.059	*0.005*	*0.302*	*0.000*	*0.000*	*0.000*	*0.000*	*0.205*	*0.000*								
LLP	**-0.490**	**-0.357**	**-0.696**	-0.065	**-0.309**	-0.078	**-0.241**	**-0.534**	**-0.257**	0.001	1						
	0.000	*0.005*	*0.000*	*0.623*	*0.016*	*0.554*	*0.063*	*0.000*	*0.048*	*0.997*							
NCO	**-0.582**	**-0.472**	**-0.730**	0.004	**-0.240**	-0.023	-0.191	**-0.485**	-0.113	0.025	**0.903**	1					
	0.000	*0.000*	*0.000*	*0.978*	*0.065*	*0.863*	*0.143*	*0.000*	*0.391*	*0.848*	*0.000*						
E/A	**-0.311**	**-0.393**	-0.185	**-0.258**	-0.054	**-0.274**	-0.164	-0.062	-0.030	**-0.380**	-0.045	0.050	1				
	0.016	*0.002*	*0.157*	*0.047*	*0.681*	*0.034*	*0.210*	*0.636*	*0.821*	*0.003*	*0.733*	*0.702*					
ROAE	**-0.230**	**-0.319**	-0.199	0.044	-0.069	0.042	-0.080	**-0.333**	0.009	0.058	-0.046	0.004	**-0.241**	1			
	0.078	*0.013*	*0.128*	*0.741*	*0.603*	*0.751*	*0.543*	*0.009*	*0.944*	*0.657*	*0.725*	*0.978*	*0.064*				
ROL	**-0.355**	**-0.416**	**-0.299**	-0.098	-0.151	-0.117	-0.122	**-0.333**	-0.020	-0.033	-0.065	0.015	0.142	**0.839**	1		
	0.005	*0.001*	*0.020*	*0.454*	*0.249*	*0.374*	*0.354*	*0.009*	*0.877*	*0.801*	*0.623*	*0.912*	*0.280*	*0.000*			
ROAA	**-0.359**	**-0.469**	**-0.279**	-0.065	-0.112	-0.073	-0.129	**-0.360**	-0.024	-0.082	-0.069	0.007	0.113	**0.926**	**0.939**	1	
	0.005	*0.000*	*0.031*	*0.623*	*0.395*	*0.580*	*0.327*	*0.005*	*0.855*	*0.533*	*0.600*	*0.960*	*0.391*	*0.000*	*0.000*		
NIMA	**-0.223**	**-0.335**	**-0.271**	-0.053	-0.139	-0.046	**-0.237**	**-0.487**	-0.150	-0.057	**0.309**	**0.325**	-0.196	**0.572**	**0.364**	**0.501**	1
	0.086	*0.009*	*0.036*	*0.685*	*0.290*	*0.729*	*0.068*	*0.000*	*0.254*	*0.668*	*0.017*	*0.011*	*0.133*	*0.000*	*0.004*	*0.000*	

Time period: 1993Q1-2007Q4, for banks that exist at least 50 quarters. The numbers in italics are p-values.

Table 8: **List of Bank Holding Companies**

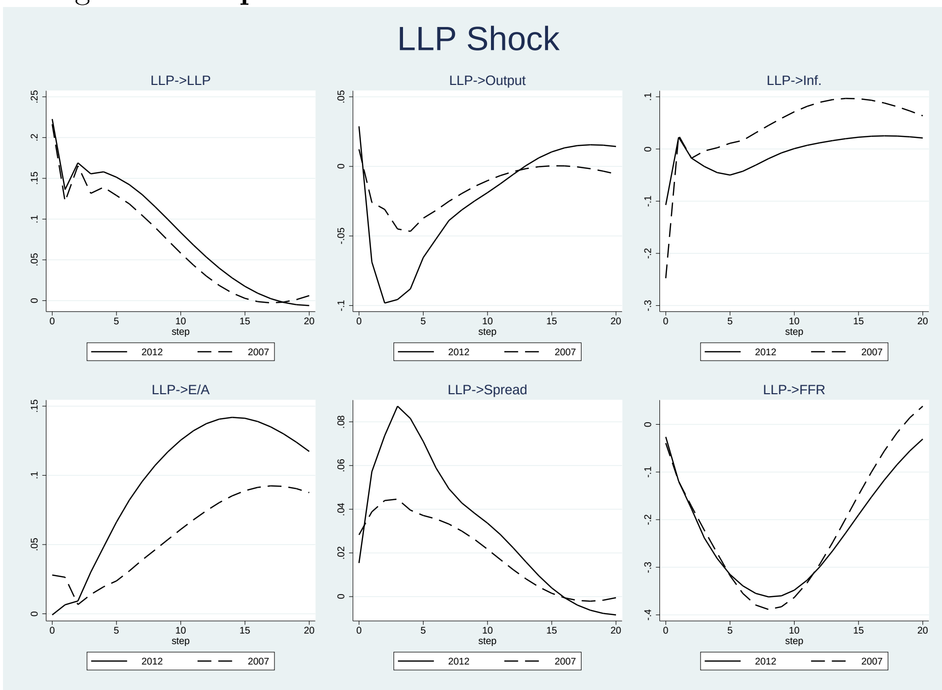
Bank Holding Company	Ticker
Bank of America	BAC
BB&T Corporation	BBT
Citigroup Inc.	C
Citizens Financial	RBS
Comerica Inc.	CMA
Fifth Third Bancorp	FITB
JPMorgan Chase & Co.	JPM
KeyCorp	KEY
M&T Bank Corp.	MTB
PNC Financial Services Group	PNC
Regions Financial Corporation	RF
SunTrust Banks Inc.	STI
U.S. Bancorp	USB
Wells Fargo & Company	WFC
Zions Bancorporation	ZION

Table 9: **Summary statistics**

Variable	**Mean**	**Std. Dev.**
Output Growth	0.311	0.653
Inflation	2.248	1.007
Fed Funds Rate	3.893	2.497
Corp. Spread	0.958	0.412
Equity/Asset	0.087	0.014
LLP/Asset	0.001	0.001
NCO/Asset	0.001	0.001
Deposit/Asset	44.096	5.256
Loan/Asset	53.346	5.011
Ret. Earn./Asset	4.604	0.768

Time period: 1993Q1-2012Q1

Figure 2: **Response to a Shock in Loan Loss Provisions**



about 6% of the variation in output, and equity to asset ratio explain about 3% of the output fluctuations.

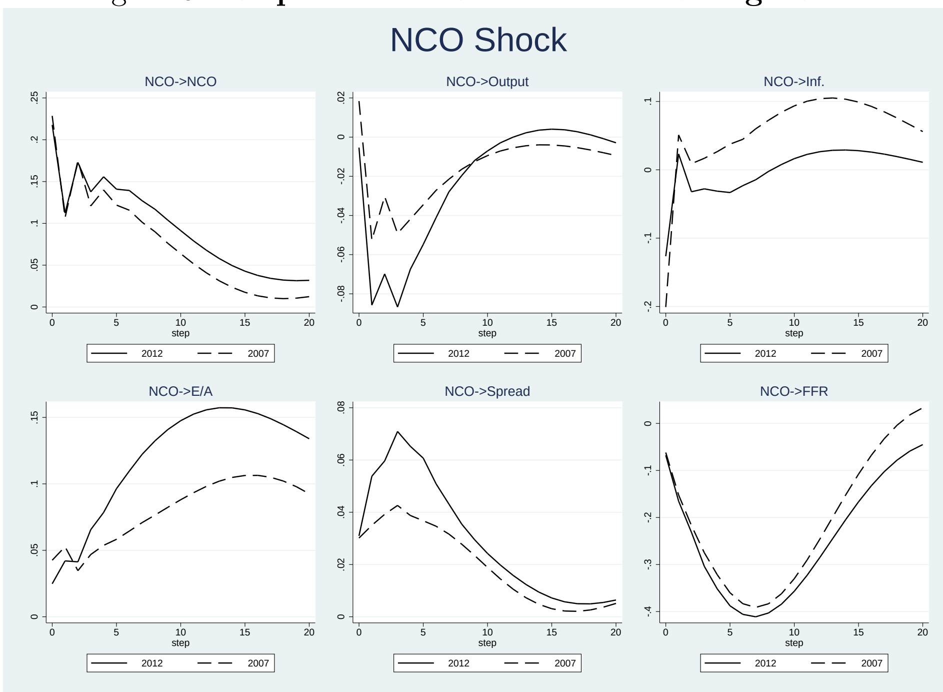
Table 10: **Forecast Error Variance Decomposition for Output Growth - LLP**

Horizon	LLP	Output	Inf	E/A	Corp Spread	FFR
1	0.000	1.000	0.000	0.000	0.000	0.000
2	0.043	0.872	0.000	0.006	0.059	0.021
3	0.058	0.812	0.039	0.007	0.058	0.026
4	0.070	0.783	0.049	0.009	0.058	0.032
8	0.077	0.728	0.065	0.018	0.056	0.055
12	0.075	0.695	0.066	0.021	0.063	0.081
16	0.074	0.680	0.066	0.026	0.063	0.091
20	0.073	0.676	0.066	0.029	0.062	0.093

Time period: 1989Q1-2012Q1

Figure 3 shows the response of the variables to a positive shock to net charge-offs. An increase in net charge-offs leads to a decline in output, an increase in corporate spreads, and an increase in the banks' equity to asset ratio like in a loan loss provision shock. The rest of the variables in the VAR respond to the net charge-off shock similar to the loan loss provision shock. Table 11 shows the forecast variance decomposition for output growth at various horizons. We see that after four quarters, 82% of the

Figure 3: **Response to a Shock in Net Charge-Offs**



the variation in output is explained by output shocks, 4% by variation in net charge-offs, and 9% by variation in corporate spreads. And after five years, 73% of the variation in output is explained by its own shocks, and net charge-offs explain about 5%. Inflation and equity to asset ratio explain 4% of the variation in output, and corporate spreads explain almost 9%.

Table 11: **Forecast Error Variance Decomposition for Output Growth - NCO**

Horizon	NCO	Output	Inf	E/A	Corp Spread	FFR
1	0.002	0.998	0.000	0.000	0.000	0.000
2	0.018	0.886	0.001	0.011	0.076	0.009
3	0.027	0.843	0.022	0.015	0.083	0.011
4	0.037	0.821	0.027	0.015	0.087	0.014
8	0.051	0.772	0.035	0.024	0.083	0.035
12	0.051	0.745	0.035	0.028	0.087	0.054
16	0.051	0.734	0.036	0.033	0.086	0.059
20	0.051	0.730	0.036	0.038	0.086	0.060

Time period: 1993Q1-2012Q1

5 The Model

5.1 Households

We consider an infinite horizon model with households, firms and banks. The basic structure of our model follows Gertler et al. (2011). The representative household consists of members distributed over the unity interval; the fraction f of members are bankers and the fraction $1-f$ are workers. The bankers operate the financial intermediaries, which are described in detail later. In every period there is a constant, exogenous probability ϵ that a banker becomes a worker and that a worker becomes a new banker. The workers choose how much labor to supply and consume non-durable goods. In our model households are the ultimate capital providers. In particular, workers provide funds to the financial intermediaries, which in turn make loans to firms. Financial intermediaries, which we will refer to as banks, offer two one-period financial instruments to workers: deposit and equity. Deposit is a risk-free asset that pays a non-state contingent, predetermined rate of return; equity, on the other hand, is risky because it pays a state-contingent rate of return. Hence, workers can choose among two different assets with which to save.

Formally, households maximize expected discounted utility

$$\max_{C_t, D_t, E_t, L_t} \sum_{t=0}^{\infty} \beta^t E_0 \left\{ \frac{(C_t - hC_{t-1})^{1-\sigma}}{1-\sigma} - \nu \frac{L_t^{1+\varphi}}{1+\varphi} \right\}, \quad 0 < \beta < 1, \tag{1}$$

where C_t is current consumption, L_t is labor supply, β is the discount factor, σ is the coefficient of relative risk aversion, φ is the inverse Frisch elasticity of labor supply, ν is the weight of labor in the utility function and h is the parameter capturing habit persistence. Households maximize (1) subject to the budget constraint

$$C_t + D_t + X_t q_t = L_t w_t + R_{D,t-1} D_{t-1} + R_{X,t} X_{t-1} q_{t-1} + \Pi_t - T_t, \tag{2}$$

where X_t is bank equity purchased at t at price q_t, D_t are deposits and $R_{D,t-1}$ is the gross non-state-contingent rate of return determined at $t-1$ and paid on deposits taken at $t-1$, $R_{X,t}$ is the gross state-contingent rate of return paid on equity purchased at time $t-1$ and w_t is the wage. Π_t is net distributions from ownership of bank equity and capital producing firms and transfers from old bankers and to new bankers; T_t are lump-sum taxes levied by the government to finance government expenditure. Households choose consumption, labor supply, deposits and equity and the first-order conditions are, respectively,

$$\lambda_t = (C_t - hC_{t-1})^{-\sigma} - \beta h (C_{t+1} - hC_t)^{-\sigma}, \tag{3}$$

$$\nu L_t^{\varphi} = \lambda_t w_t, \tag{4}$$

$$\lambda_t = \beta R_{D,t} E_t \lambda_{t+1}, \tag{5}$$

$$\lambda_t = \beta E_t \left[R_{X,t+1} \lambda_{t+1} \right]. \tag{6}$$

Let $\Lambda_{t,t+1}$ denote the household's stochastic discount factor between t and $t+1$. Then equations (5) and (6) can be rewritten respectively as

$$R_{D,t} E_t \Lambda_{t,t+1} = 1, \tag{7}$$

$$E_t \left[R_{X,t+1} \Lambda_{t,t+1} \right] = 1. \tag{8}$$

Household choices of labor and consumption are fairly standard. Conditional on time t, the rate of return on deposits is predetermined and riskless. On the other hand, the rate of return on equity is state-contingent and varies with economic conditions. Households take prices, rate of returns and wages as given.

In our model households face a portfolio choice problem. They can save by investing either in deposits or in equity. In the deterministic steady state, these two assets must offer the same rate or return and portfolio allocation is indeterminate from the point of view of consumers. When we consider the second-order approximation of the model and the risky steady state, the two assets will offer different rate of returns that reflect their hedging properties. As a result, households will prefer a specific portfolio allocation. On the supply side, deposits and equity are offered by banks.

In a model where banks are unconstrained in the composition of their liabilities, the equilibrium is the solution of a two-sided optimal portfolio allocation by banks and households. In our model banks face a constraint which effectively puts a lower limit on the amount of equity relative to assets. This implies that banks may not be free to choose their liability composition and that the supply of equity and deposits by banks may well be determined by regulation. In this case, the portfolio choice of households will play a role in determining the equilibrium rate of returns of deposits and assets.

5.2 Capital Producers

Capital producers are firms that produce new capital using final output subject to adjustment costs. More precisely, capital producers choose investment to maximize present and future expected profits, which can be written as

$$\max_{I_t} E_0 \sum_{t=0}^{\infty} \Lambda_{t,t+1} \left\{ Q_t I_t - \left[1 + f\left(\frac{I_t}{I_{t-1}} \right) \right] I_t \right\}, \tag{9}$$

where Q_t is the price of capital in terms of the consumption good at time t, $f(I_t/I_{t-1})I_t$ are investment adjustment costs with $f' > 0, f'' > 0$. Capital producers produce new capital at unitary cost $1 + f$, which is then sold to output-producing firms at the price Q_t. The first-order condition of capital producers is

$$Q_t = 1 + f\left(\frac{I_t}{I_{t-1}} \right) + f'\left(\frac{I_t}{I_{t-1}} \right) \frac{I_t}{I_{t-1}} - E_t \left[f'\left(\frac{I_t}{I_{t-1}} \right) \left(\frac{I_t}{I_{t-1}} \right)^2 \right], \tag{10}$$

which is the standard equation that defines Tobin's Q. The profits of capital producers are distributed in lump-sum fashion to households.

5.3 Firms

Output producing firms are perfectly competitive. They produce using a standard technology characterized by constant returns to scale in capital and labor. At the beginning of each period firms hire labor at the wage rate w_t, which they take as given, and purchase capital from capital producers. Firms take loans from banks to purchase capital, which needs to be paid before production takes place. More precisely, in period t firms take total loans $Q_t S_t$ from banks, which are then used to purchase installed and new capital. Firms receive funding by issuing state-contingent claims on future return from capital; banks purchase these claims and therefore are the owners of capital. Loans S_t can therefore be interpreted as the security backed by capital; this security has price Q_t and it pays the state-contingent rate of return to capital $R_{K,t+1}$. Formally firms choose labor and new capital to maximize profits

$$\max_{I_t, L_t} A_t K_t^{\alpha} L_t^{1-\alpha} - w_t L_t - R_{K,t} Q_{t-1} S_{t-1} + Q_t S_t - Q_t I_t, \tag{11}$$

subject to

$$S_t = (1-\delta) K_t + I_t, \tag{12}$$

$$K_{t+1} = \Psi_{t+1} S_t, \tag{13}$$

where we define the gross rate of return to loans as follows

A_t is a standard technology shock to production and Ψ_t is a shock to capital quality. As in Merton (1973), Gertler and Kiyotaki (2010) and Gertler et al. (2011), we assume an exogenous source of variation for the quality of capital. A shock to the quality of capital affects the economy directly through its effect on capital and therefore output production and indirectly through its effect on the balance sheet of banks of changes in claim prices and returns. Firms maximize profits subject to two constraints. (12) defines the securities issued at t to purchase installed capital and investment; δ is the rate of depreciation of capital. (13) defines quality-adjusted capital held by the firm, which differs from loans by the quality shock. $R_{K,t}$ is the rate of return paid to total loans taken at time $t-1$.

Firms choose labor L_t and I_t and demand loans $Q_t S_t$. The first-order condition relative to labor is

$$w_t = (1-\alpha) \frac{Y_t}{L_t}, \tag{14}$$

and the first-order condition relative to I_t is

$$\frac{\Psi_{t+1}\left[Z_{t+1}+(1-\delta)Q_{t+1}\right]}{Q_t}=R_{K,t+1}, \tag{15}$$

where Z_{t+1} is the marginal productivity of capital:

$$Z_{t+1}\equiv\alpha A_{t+1}\left(\frac{L_{t+1}}{K_{t+1}}\right)^{1-\alpha}=\alpha\frac{Y_{t+1}}{K_{t+1}}. \tag{16}$$

5.4 Banks

Every period banks make loans to good-producing firms by raising funds both externally and internally. External funds come from households, who can purchase deposits or equity in the bank. These two assets differ in terms of their riskiness: deposits pay a pre-determined rate of interest while equity pays a state-contingent one. In other words, equity is risky in the sense that its rate of return varies with the state of the economy. Deposits, on the other hand, offer a rate of return that may still vary over time but is determined in advance. Deposits and equity are assets for households and liabilities for banks. Financial intermediaries also raise funds internally by using their net worth, i.e. retained earnings.

The balance sheet of the bank implies that the values of the loans made to firms in a given period, Q_tS_t, is equal to the sum of deposits D_t and equity q_tX_t raised from households and the bank's net worth N_t:

$$Q_tS_t=N_t+q_tX_t+D_t. \tag{17}$$

The bank's net worth at t is the gross payoff from loans made at $t-1$ net of gross returns paid to equity and deposits also raised at $t-1$ and other costs. Hence, the net worth can be interpreted as retained earnings.

There are costs associated with raising external funds, which can be interpreted as operating costs of financial intermediation. We assume that the total cost in period t borne by the bank for one unit of deposit raised in $t-1$ is $R_{D,t-1}+\iota$, where $\iota\geq 0$ captures such costs. Along the same lines, the cost in period t borne by the bank for one unit (value) of stock raised in $t-1$ is $R_{X,t}+\tau$, with $\tau > 0$. It is typically assumed in the banking literature that equity is more expensive than deposits – see Myers and Majluf (1984) and Berger, Herring and Szego (1995), citing different tax treatment of interest payments and dividends, transaction costs, asymmetric information and deposit insurance. Hence, $\tau > \iota \geq 0$. Formally, the net worth is given by

$$N_t = R_{k,t}Q_{t-1}S_{t-1} - [R_{X,t} + \tau] X_{t-1}q_{t-1} - [R_{D,t-1} + \iota] D_{t-1} + \mathcal{P}_t, \tag{18}$$

where $\mathcal{P}$ will be described in detail later. To sum up, the bank can raise funds via deposits, equity and net worth, which have different costs. Since equity pays a state-contingent rate of return, it allows better hedging against fluctuations than deposits; the equity cost $\tau > \iota$ makes deposits more attractive than equity from the bank's perspective so that the capital requirement is binding. Since net worth does not entail funding costs, at least at the steady state, and it is a substitute to external funds, the bank would naturally accumulate enough retained earnings to fund all loans internally. To ensure that our equilibrium entails financial intermediation and in line with existing literature, we assume that the bank exits with constant probability $1-\epsilon$ in every period and continues with probability ϵ. When the bank exits, its net worth is transferred to the household in a lump-sum fashion. Low continuation probabilities align the goals of the banks with those of households; high continuation probabilities make banks care more about their value.

Banks are typically regulated in several dimensions. The recent financial crisis and its effects on the financial system has brought bank regulation back to the top of the policy agenda. Here we focus on bank capital adequacy regulation and, in particular, on requirements on bank capital such as Basel II and III. These rules typically require a bank to hold a certain fraction of assets, or risk-weighted assets, as capital (namely, equity). More precisely, Basel II requires that the bank's capital to risk-weighted asset ratio must be at or above 8 percent, where risk-weighted assets are the bank's assets evaluated taking into consideration the risk of different asset classes and consequently assigning them different weights. Basel III requires banks to hold 4.5 percent of common equity and 6 percent of Tier 1 capital of risk-weighted assets. The Federal Reserve Board requires bank holding companies to hold total capital of at least 8 percent of risk-weighted assets, in line with Basel II.

The evidence presented in section 4 shows that most U.S. banks are indeed above the minimum capital requirements dictated by Basel II. Nevertheless, this ratio displays significant variation, both across banks and over time for the same bank. We interpret this evidence as suggesting that mandated capital requirements overall bind for financial institutions but not strictly and not at all times. We capture these features by modeling capital requirements for the bank as a penalty

$$\mathcal{P}_t = \phi \left[\log \left(\frac{X_t q_t + N_t}{\gamma Q_t S_t} \right) - \zeta \left(\frac{X_t q_t + N_t - Xq - N}{Xq + N} \right) \right], \quad \phi, \zeta \geq 0, \qquad (19)$$

which contributes to net worth. γ is the required minimum capital ratio, for example 0.08 for Basel II; Xq is the steady-state value of bank equity. Due to the log term, the bank is penalized when its capital goes below the required 8 percent of total assets and the parameter $\phi \geq 0$ measures the intensity of the penalty in terms of net worth. The second component of the penalty function penalizes capita-to-asset ratios above the steady state. Modeling capital requirements with a penalty function has two advantages. First, it allows for variations in the capital-to-asset ratio that a fixed constraint would instead rule out. Second, it allows us to apply standard perturbation methods.[8]

As suggested earlier, banks exit with constant probability $1 - \epsilon$. Let V_{t-1} be the value of the bank at time $t - 1$. This value satisfies the Bellman equation

$$V_{t-1}(S_{t-1}, X_{t-1}, N_{t-1}) = E_{t-1}\Lambda_{t-1,t} \left\{ (1 - \epsilon)N_t + \epsilon \max_{S_t, X_t} \left[V_t(S_t, X_t, N_t) \right] \right\}. \qquad (20)$$

In every period t the variables S_t and X_t are chosen so as to maximize the value of the bank subject to the flow budget constraint (17) and the law of motion of net worth (18). Using (17) to eliminate deposits from (18) we obtain the following recursive

[8] See Preston and Roca (2007) and Kim, Kollmann and Kim (2010) for applications of the barrier method.

formulation for net worth

$$N_t = \left[R_{K,t} - R_{D,t-1}\right] Q_{t-1}S_{t-1} - \left[R_{X,t} + \tau - R_{D,t-1} - \iota\right] X_{t-1}q_{t-1} + \left[R_{D,t-1} + \iota\right] N_{t-1} + \mathcal{P}_t. \tag{21}$$

We guess that the value of the bank at time t has the simple linear form

$$V_t(S_t, X_t, N_t) = \mu_{s,t}Q_tS_t - \mu_{x,t}q_tX_t + \mu_{n,t}N_t,$$

where $\mu_{s,t}, \mu_{x,t}, \mu_{n,t}$ are undetermined coefficients that we will find later. The first-order conditions relative to S_t and X_t are, respectively,

$$\mu_{s,t}Q_tS_t = \phi\kappa_t, \tag{22}$$

$$\mu_{x,t} = \phi\kappa_t \left[\frac{1}{X_tq_t + N_t} - \frac{\zeta}{Xq + N}\right], \tag{23}$$

and the envelope condition relative to N_{t-1} is

$$V_{N,t-1} = E_{t-1}\Lambda_{t-1,t}\Omega_t \left[R_{D,t-1} + \iota\right], \tag{24}$$

where

$$\Omega_t \equiv \frac{1 - \epsilon + \epsilon\mu_{n,t}}{1 - \mathcal{P}_{N,t}} \quad \text{and} \quad \kappa_t \equiv \frac{\mu_{n,t}}{1 - \mathcal{P}_{N,t}},$$

where $\mathcal{P}_{N,t} \equiv \partial\mathcal{P}_t/\partial N_t$. Substituting (21) into the Bellman equation at time t we can solve for the undetermined coefficients to find

$$\mu_{s,t} = E_t\Lambda_{t,t+1}\Omega_{t+1} \left(R_{K,t+1} - R_{D,t} - \iota\right), \tag{25}$$

$$\mu_{x,t} = E_t\Lambda_{t,t+1}\Omega_{t+1} \left(R_{X,t+1} + \tau - R_{D,t} - \iota\right), \tag{26}$$

$$\mu_{n,t} = E_t\Lambda_{t,t+1}\Omega_{t+1} \left[R_{D,t} + \iota\right]. \tag{27}$$

New banks at t receive a transfer from households equal to a fraction ω of the returns to loans of existing bankers:

$$\omega R_{k,t} Q_{t-1} S_{t-1}, \tag{28}$$

so that the evolution of aggregate net worth can be written as follows

$$N_t = (1-\epsilon)\left\{\left[R_{K,t} - R_{D,t-1}\right] Q_{t-1} S_{t-1} - \left[R_{X,t} + \tau - R_{D,t-1} - \iota\right] q_{t-1} X_{t-1} + R_{D,t-1} N_{t-1} + \mathcal{P}_t\right\} + \epsilon \omega R_{K,t} Q_{t-1} S_{t-1}. \tag{29}$$

5.5 Government

The government purchases the amount G_t of goods produced in the economy and these purchases are financed by lump-sum taxes T_t. Government expenditure are exogenous and stochastic

$$\log G_t = \rho_g \log G_{t-1} + (1-\rho_g) \log G + \varepsilon_g, \tag{30}$$

where G is government purchases at the steady state, $\rho_g \geq 0$ is the coefficient of autocorrelation and ε_g is a government spending shock, which we assume to be distributed normally with zero mean and standard deviation σ_g.

5.6 Equilibrium

Equilibrium requires clearing in the market for goods, assets, loans and labor. For goods, we require that

$$Y_t = C_t + G_t + \left[1 + f\left(\frac{I_t}{I_{t-1}}\right)\right] I_t + \tau X_t q_t + \iota D_t, \tag{31}$$

and for labor we require that supply by households, from (4), equals demand by firms, as defined in (14). Regarding loans, the supply of securities S_t, as specified in (12), must equal demand by banks. The supply of deposits D_t and equity X_t by banks must equal the demand by households.

There are three sources of exogenous fluctuations in our model. The first is a shock to government expenditure, which we have described above. The second is a shock to productivity, which follows the exogenous AR(1) process

$$\log A_t = \rho_a \log A_{t-1} + \varepsilon_a, \tag{32}$$

where $\rho_a \geq 0$ and ε_a has distribution $N(0, \sigma_a^2)$. The third is a capital quality shock, which we assume to also follow an AR(1) process

$$\log \Psi_t = \rho_\Psi \log \Psi_{t-1} + \varepsilon_\Psi, \tag{33}$$

with $\rho_\Psi \geq 0$ and ε_Ψ being the normally distributed disturbance with zero mean and variance σ_Ψ^2.[9]

6 Calibration

For investment, we assume standard adjustment costs

$$f\left(\frac{I_t}{I_{t-1}}\right) \equiv 0.5\chi\left(\frac{I_t}{I_{t-1}} - 1\right)^2.$$

Table 12 summarizes the calibration of our economy. The time unit is meant to be a quarter. We set the coefficient of relative risk aversion σ equal to 2 and the habit parameter h equal to 0.85. The discount factor β implies an annual real interest rate just above 3 percentage points. The inverse elasticity of labor supply φ is set equal to 1/3, as standard in the macro literature and the disutility from work ν is equal to 4. For firms, we set the capital share α equal to 0.3 and capital depreciation δ equal to 2.5 percentage points. The parameter χ measuring investment adjustment costs is set to 2.

Regarding banks, we choose the parameters to come as close as possible to the aggregate summary statistics for banks reported in section 4. We set γ, the bank

[9] Gertler et al. (2011) model the capital quality shock as the product of two processes, one holding in normal times and the other arising occasionally during disasters.

Parameter	Value	Description
β	0.9925	Discount factor of households
σ	2	Coefficient of relative risk aversion
ν	4	Disutility from work
h	0.85	Habit parameter
φ	1/3	Inverse of elasticity of labor supply
χ	2	Firm adjustment costs
α	0.3	Share of capital in production
δ	0.025	Capital depreciation
γ	0.08	Bank capital constraint
ι	0.02	Bank (proportional) cost of deposits
τ	0.02	Bank (proportional) cost of equity
ϵ	0.3	Survival rate of bankers
ω	0.01	Transfer to new bankers
ϕ	0.0025	Penalty parameter
ζ	0.85	Penalty parameter for deviation from steady state
ρ_g	0.87	Serial correlation of government spending shocks
ρ_a	0.8556	Serial correlation of productivity shocks
ρ_Ψ	0.88	Serial correlation of capital quality shocks
σ_g	0.0097	Standard deviation of government spending shocks
σ_a	0.008	Standard deviation of productivity shocks
σ_Ψ	0.002	Standard deviation of capital quality shocks

Table 12: Benchmark Calibration

capital-to-asset minimum required ratio, equal to 8 percentage points. This figure is in line with Basel II and Basel III regulation, although this regulation is in terms of risk weighted assets, and with the empirical evidence reported in Table 5. The survival rate of bankers ϵ is set equal to 0.3 and the transfer to new bankers ω is set equal to 0.01. The survival rate brings a wedge between bankers and consumers. When the survival rate tends to zero, bankers will almost surely become consumers at the end of the period and maximize retained earnings that will be transferred to households and consumed. In this case, Ω is constant and equal to one, so that the banker and the household discount factors are identical. With a positive probability of survival banks care more about the future value of being bankers and less about retained earnings, which become more volatile. Ω becomes counter-cyclical, which in turn makes the banker augmented discount factor $\Lambda\Omega$ more counter-cyclical than that of households. The penalty parameters ϕ and ζ are set equal to 0.0025 and 0.85, respectively. $\zeta < 1$ rewards banks for capital ratios above the required value (except at the steady state) while $\zeta = 0$ penalizes banks for capital ratios above its required value. We set the cost of equity τ equal to 0.01.

For the parameters of the exogenous disturbance processes, we set the standard deviation and autoregressive parameters for the technological progress and government spending using values typically used in the literature. More precisely, we set $\sigma_a = 0.008$ and $\rho_a = 0.8556$; $\sigma_g = 0.0092$ and $\rho_g = 0.87$. There is little empirical evidence and literature on the values to assign to the standard deviation σ_Ψ and autoregressive parameter ρ_Ψ. We choose these values to match the standard deviation of bank assets as reported in table 9.

7 The response to a capital quality shock

Figure 4 reports the impulse responses of our model to a decline in the quality of capital by 2% of the existing stock. All variables are reported in percentage point deviation from steady state and for twenty periods after the shock. We interpret a capital quality shock as the occurrence of losses on loans made by banks to firms.

Capital and its price fall on impact and drive bank assets down. The rate of return on loans is also reduced on impact, which in turn reduces the net interest income of banks. Investment reacts smoothly to the capital quality shock due to the presence of investment adjustment costs and the depressed price of capital. Both the interest rate on deposits and the return on bank stocks fall. Banks reduce their loans to firms because the returns to capital R_K is low and because the capital requirement is binding. Hence banks reduce their demand of deposits and the rate of return R_D falls. The return on bank stocks R_X falls as well as the price of bank stocks q due to the sharp fall in bank income; bank net worth is also reduced. To keep the equity-to-asset ratio from falling below its required level, banks respond to the fall in net worth (retained earnings) by issuing new stocks even though bank stock prices are low. Equity rebounds faster than assets and the equity-to-asset ratio increases. The dynamic response of the capital ratio is consistent with the VAR evidence reported in section 4, which showed that a hump-shaped response of the equity-to-asset ratio to a shock in loan loss provisions (or net charge offs).

Consumers are affected by the capital quality shock in two ways. First, they experience a negative wealth effect due to the loss in value of their portfolio and the sharp fall in returns. Second, their labor income is reduced due to lower labor demand and wages. As a result, household consumption falls. Interestingly, the drop in consumption is deeper and more persistent than that in output. This is because investment must restore capital to its pre-shock level, thereby crowding out consumption.

Figure 5 compares the responses to a capital quality shock in the model with and without bank capital constraints. The blue line is the response in the model with capital constraint, already shown in figure 4; the red line is the response of the model without bank capital constraints. We approximate the model without capital constraints by assigning a very low value to the penalty parameter $\phi = 0.0001$; notice that the model with and without capital constraint share the same deterministic steady state. Without the capital requirement both the net worth and stocks drop sharply in response to a capital quality shock, thereby driving down equity and the equity-to-asset ratio. Banks substitute stocks with deposits as liabilities. The capital

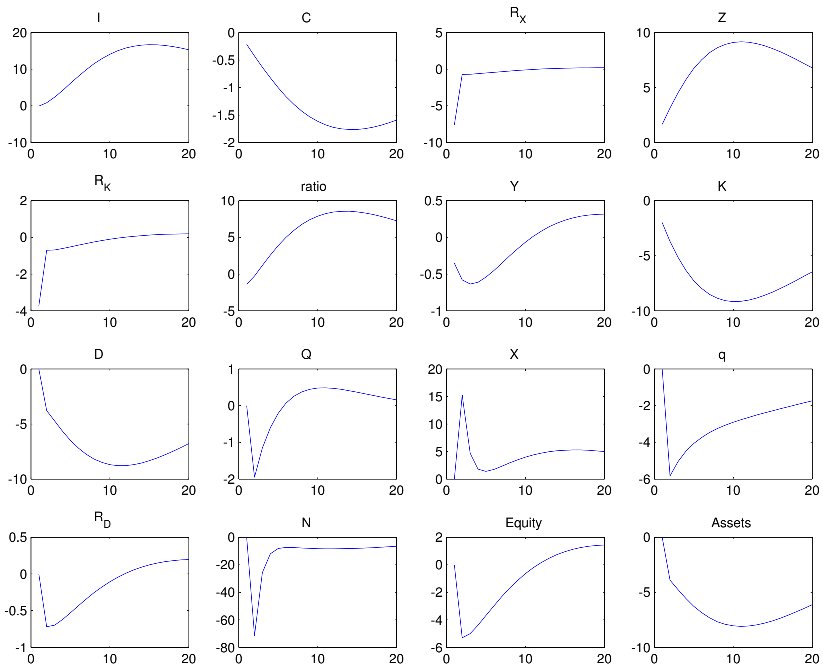


Figure 4: Impulse responses to a capital quality shock

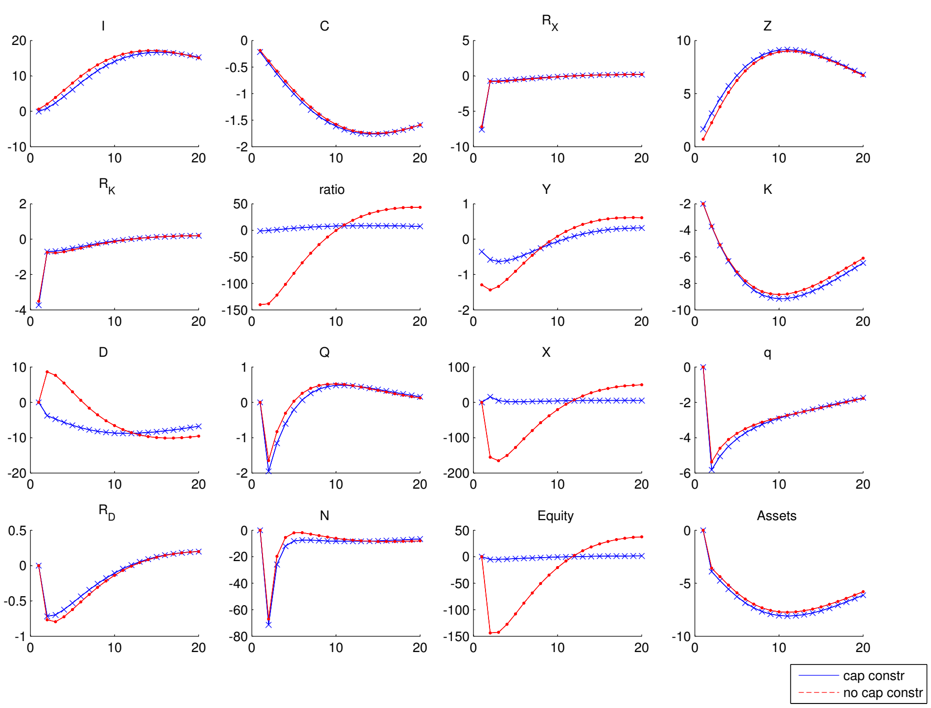


Figure 5: Impulse responses to a capital quality shock with and without bank capital constraints

requirement presses banks to recapitalize at a time when stock prices are low. In the absence of such requirements, banks would reduce their stocks and let equity fall. Notice that bank equity falls by 100% in response to a two percentage points capital quality shock. It is clear that the presence of capital constraints greatly reduces the volatility of bank equity by requiring recapitalization when the balance sheet of banks is under stress. In terms of the effects on the real economy, bank capital requirements lead to a smaller fall in output right after a capital quality shock. Asset prices experience a sharper drop that depresses investment and loans more in the model with bank capital constraints. As a result, labor demand does not fall and the decline in output is less severe.

8 Second Moments

To choose the standard deviation of the stochastic process of capital quality, we first generate the second moments of our model under the benchmark calibration but in the absence of capital quality shocks ($\sigma_\Psi = 0$). The model replicates well the empirical standard deviation of output, consumption and investment (not reported) but the standard deviation of bank variables is about half its empirical counterpart. Then we raise the standard deviation of the capital quality shock to 0.2% to match the standard deviation of bank assets in the data. Table 13 reports the second moments of the data (let-hand side) and the model (right-hand side).

The empirical second moments are calculated over the period 1993Q1 to 2007Q4; all variables are real and per capita. To calculate the standard deviation reported in table 13, first we take the log of the variable, then we apply the HP filter, and then calculate the standard deviation of the cyclical component. For the variables marked with †, we take the HP filter without taking the log and then we calculate the standard deviation of the percentage change from the HP trend. All empirical correlations are statistically significant, with the exception of the correlation of equity with GDP. In computing the theoretical second moments, the parameters of the model take the values shown in table 12. Second moments are calculated using Monte

Table 13: Second moments: empirical and theoretical

Empirical				Model			
Variable	Std	Corr Y	Corr C	Variable	Std	Corr Y	Corr C
GDP	1	1	0.85	Y	1	1	0.43
Cons	0.8	0.85	1	C	0.8	0.43	1
Investment	5.2	0.92	0.69	I	8.1	0.68	-0.22
Assets	3.6	0.56	0.63	$Q \times K$	3.4	0.35	0.94
Deposits	2.7	0.49	0.58	D	3.6	0.36	0.94
Ret. Earnings	3.8	0.34	0.37	N	19	0.73	0.66
Equity	4.1	0.13	0.25	$q \times X + N$	1.45	-0.53	-0.47
Net Income†	27.3	0.21	0.02	NI	37	0.23	0.37
Equity/Asset	2.0	-0.31	-0.4	$ratio$	4.2	-0.41	-0.87
Stock Return†	270	-0.43	-0.52	R_X	257	-0.08	-0.05
3M T-bill	48.5	0.48	0.32	R_D	65	-0.5	-0.2

Standard deviation expressed in percentage points

Carlo simulations with second-order accurate path of the variables. We perform 1000 simulations of 100 quarters each. For each simulation, we compute second moments and then average these figures over the 1000 simulations.

The model-generated standard deviations are roughly in line with the empirical counterparts for output, consumption, investment, assets, and deposits. On the other hand, under the benchmark calibration net income and retained earnings are more volatile in the model than in the data. The lower probability of survival of bankers ϵ would reduce the volatility of net worth to its empirical counterpart but at the cost of reducing the volatility of all bank variables. Intuitively, a lower probability of survival makes bankers maximize current net worth, thereby reducing its standard deviation. In section **??** we perform robustness analysis relative to the parameter ϵ. We speculate however that the reason why net income is more volatile in our model is that banks make extensive use of reserves and provisions to spread the effects of losses and charge offs over time. This makes net income and consequently retained earnings relatively smooth in the data. Our model does not allow for reserves. There is also empirical evidence suggesting that firms (and banks) smooth dividends over time. Dividend smoothing would affect the temporal profile of retained earnings as well as the cyclicality of the return to bank stocks. We plan to incorporate these features in our model in future research.

In the model equity is less volatile while the equity-to-asset ratio is more volatile than in the data. The model predicts a negative correlation between stocks X and retained earnings N in response to a shock to capital quality, as seen in figure 4. When the assets of the bank are hit by a negative shock, net worth inevitably falls but the bank maintains the capital ratio in line with requirements by issuing stocks. As a result equity, which is the sum of net worth and the value of stocks, displays little volatility. This in turn makes the equity-to-asset ratio more volatile because equity responds little at the numerator of the ratio while assets move more at the denominator. The standard deviation of bank stocks X, however, is higher in our model than in the data.[10] This finding suggests that issuing stocks may be costly.

9 Deterministic and Risk-adjusted Steady State

The deterministic steady state does not account the difference in risk between deposits, which pay a pre-determined rate of return, and bank stocks, which pay a state-contingent one. At the deterministic steady state deposits and equity pay the same rate of return

$$R_D = R_X = \frac{1}{\beta}$$

and, up to a first-order approximation, households are indifferent between these two instruments. This is not the case for banks. Since $\tau > 0$ banks prefer to fund themselves via deposits at the deterministic steady state and the bank capital requirement is binding. To capture risk perception and its implications on the portfolio choice of households and financial intermediaries we work with the second-order approximation of our model and construct the risk-adjusted steady state, namely the steady state of the economy that takes into account risk – see Coeurdacier, Rey and Winant (2011). Risk perceptions play an important role in portfolio choices. Equity is risky relative to deposits because its return is state-contingent and more volatile than that of deposits. Moreover the rate of return of deposits is more negatively correlated

[10] The standard deviation of stocks issued by banks quoted in stock market is 8.2%, while our model predicts a multiple of this figure.

with consumption than the rate of return on equity. Hence, equity is a worse hedge to consumption volatility than deposits for households and it must therefore pay a premium for consumers to be willing to hold it. Since the bank capital requirement is binding, the liability side of the bank balance sheet and household portfolio are pinned down. In turn, this determines a unique equilibrium equity premium necessary for households to be willing to invest on bank equity in the amount offered by financial institutions.

Table 14: Steady State

Empirical		Model			
Variable	Mean	Model	Det. SS	Risk-adjusted SS	
				$\sigma_\Psi = 0.002$	$\sigma_\Psi = 0.012$
Stock return	14	R_X	3	3.3	13.7
Equity Premium	10.2	$R_X - R_D$	0	0.45	10.7

Rate of returns in percent and annualized

Our model generates an equity premium for bank stocks at the risk-adjusted steady state that depends on the underlying stochastic processes. The left-hand side of table 15 reports the empirical mean of a number of bank variables over the period 1993Q1 to 2007Q4: the rate of return on bank stocks,[11] the equity premium relative to bonds and retained earnings to assets ratio. The right-hand side of the same table reports the deterministic and risk-adjusted steady-state values of the corresponding variables in our model. When risk is taken into consideration, the model generates an equity premium. Under the benchmark calibration the equity premium on bank stocks is well below its empirical counterpart. The premium goes up with σ_Ψ, the volatility of the capital quality shock.

Table 15 offers further insight into the role of risk in our model. It reports the risk-adjusted steady state of our model for two values of the standard deviation of capital quality shock that we label low risk ($\sigma_\Psi = 0.002$) and high risk ($\sigma_\Psi = 0.01$). Banks hold more equity when they operate in the high-risk environment, both in level and as percentage of their assets. In fact, the equity-to-asset ratio increases from 8 to 8.1 percentage points. Higher equity enables banks to hold more assets;

[11]This is calculated as the return of holding stocks.

this implies more loans and higher capital and output.

Table 15: Risk-adjusted Steady State

Variable	Low Risk	High Risk
$X \times q + N$	0.933	0.946
$Q \times K$	11.670	11.687
$ratio$	0.08	0.081
K	11.670	11.671
Y	2.459	2.461
$R_X - R_D$	0.45	10.7

Rate of returns in percent and annualized
Low Risk: $\sigma_\Psi = 0.002$; High Risk: $\sigma_\Psi = 0.01$

10 Evaluating Basel III regulation

In this section we evaluate two capital regulation changes recently proposed under Basel III: the capital conservation buffer and the counter-cyclical buffer. Basel III requires a mandatory additional capital buffer of 2.5% of RWA. This additional capital conservation buffer should be gradually phased in between 2016 and 2019. In addition to the capital conservation buffer, Basel III also introduced a discretionary counter-cyclical buffer, which would allow national regulators to require up to another 2.5% of capital during periods of high credit growth. In terms of our model, we model the capital conservation buffer as an additional 2.5% equity-to-asset ratio. As for the counter-cyclical buffer, we model it as a change in the minimum required ratio related to credit growth. More precisely, we model the minimum equity-to-asset ratio using the logistic distribution:

$$\tilde{\gamma} = \gamma + \frac{\gamma_1}{1 + \exp(-\gamma_2 \widehat{Q_t S_t})}, \tag{34}$$

where $\gamma = 0.08$ is the minimum level of the ratio, $\gamma_1 = 0.05$ and

$$\widehat{Q_t S_t} \equiv \frac{Q_t S_t}{QS} - 1,$$

namely it is the deviation of credit from its steady-state value. The parameter γ_2 captures the rate of change of the regulated ratio to the deviation of credit from its steady state. We set $\gamma_2 = 20$, although Basel III does not specify such parameter. According to (34), the minimum ratio tends to $\gamma = 0.08$ as the deviation of credit from steady state is negative and large in absolute value; when excess credit is zero, the minimum ratio is $\gamma + \gamma_1/2 = 0.105$, as required by the capital conservation buffer. When credit is above its steady-state value, the minimum ratio increases above 10.5% and it asymptotes 13%.

We evaluate the performance of Basel III proposed regulation by considering its effect in response to shocks, in terms of volatility, and in terms of the risk-adjusted steady state. Figure 6 compares the impulse responses to a -2% capital quality shock under when the minimum capital ratio is constant and equal to 8% (red line) and when the minimum capital ratio specified in (34) (blue line); all other parameter values are as specified in table 12. The impact on the real economy of a capital quality shock is reduced in the presence of the counter-cyclical buffer. The minimum capital ratio falls in response to the fall in asset prices and loans so that banks need to raise less capital, which in turn makes net income and retained earnings fall less. Since bank loans are reduced but less than under a constant minimum capital, the contraction in output is less severe.

The impact of the counter-cyclical buffer on the volatility of the economy is mixed because a number of variables witness a reduction of their standard deviation, but not all. Table 16 reports the standard deviation of the economy with the counter-cyclical buffer and that of the economy with the constant minimum capital ratio. The standard deviations are calculated from with the same shocks. Equity, assets and retained earnings, namely the net worth of banks, become less variable. This is consistent with the response to a capital shock seen earlier. However, investment, the return to stocks and net income display higher volatility.

The risk-adjusted steady state with the counter-cyclical buffer has substantially less capital, output and consumption than the one with a constant equity-to-capital required ratio, even when compared with an economy with a higher (but constant)

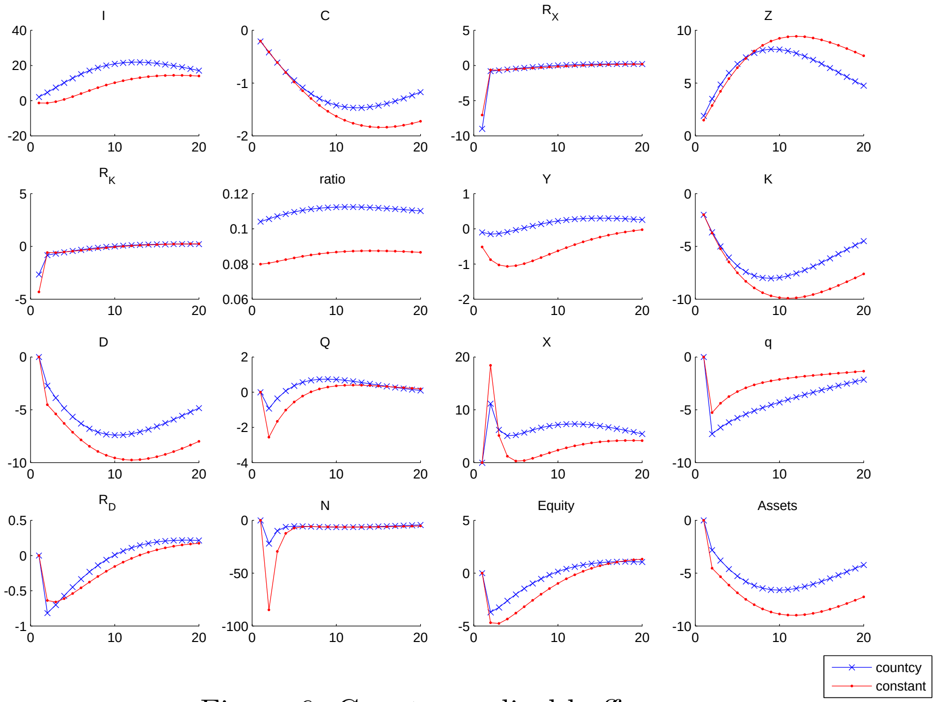


Figure 6: Counter-cyclical buffer

Table 16: Standard deviation

Variable	Constant	Counter-cyclical
GDP	0.9	1
Cons	1	0.8
Investment	7.6	10.7
Assets	4.2	3.8
Deposits	4.6	4.3
Ret. Earnings	18.3	11.7
Equity	3.1	1.9
Net Income†	41.5	47
Equity/Asset	6.1	4.7
Stock Return†	244	264
3M T-bill	64.3	53

Standard deviation expressed in percentage points ratio.

Table 17: Risk-adjusted Steady State and Counter-cyclical Buffer

	Constant $\gamma = 0.105$		Counter-cyclical	
Variable	Low Risk	High Risk	Low Risk	High Risk
$X \times q + N$	1.135	1.154	0.623	0.656
$Q \times K$	10.81	10.82	5.9015	5.574
$ratio$	0.105	0.106	0.106	0.118
K	10.81	10.82	5.9283	5.9
Y	2.39	2.4	1.97	1.94
$R_X - R_D$	0.45	10.7	12	590

Rate of returns in percent and annualized
Low Risk: $\sigma_\Psi = 0.002$; High Risk: $\sigma_\Psi = 0.01$

11 Conclusions

- Model capital shocks with a Poisson process (or a binomial);
- Model reserves
- Model dividend smoothing
- Estimate the model

A Appendix

Table A.1: **Regulatory Capital and Size - Column Percentage**

	[0,25]	[25,50]	[50,75]	[75,100]	Total
Sig-Undercap	1.29	0.66	0.77	1.52	1.06
Undercap	0.59	0.43	0.59	0.18	0.45
Adeqcap	4.30	5.10	4.69	2.00	4.04
Wellcap_0to200	18.59	24.11	29.66	31.38	25.9
Wellcap_200to400	22.63	27.41	27.75	31.23	27.23
Wellcap_400to600	17.96	17.74	15.89	17.70	17.32
Wellcap_600to800	10.82	9.92	7.47	8.39	9.16
Wellcap_over800	23.82	14.63	13.19	7.61	14.86
Total	100	100	100	100	100

Time period: 1993Q1-2012Q1, for banks that exist for at least 50 quarters.

Table A.2: **Regulatory Capital and Mean Capital Ratios**

	$\frac{Tier1}{RWA}$	$\frac{Tier2}{RWA}$	$\frac{Tier1+2}{RWA}$	$\frac{Tier1}{Asset}$	$\frac{Equity}{RWA}$	$\frac{Equity}{Asset}$	$\frac{Equity}{Loan}$
Sig-Undercap	1.18	1.07	2.25	1.25	3.84	2.51	5.22
Undercap	6.05	1.52	7.57	4.63	6.49	4.78	6.94
Adeqcap	7.82	1.44	9.26	6.13	8.00	6.11	8.50
Wellcap_0to200	9.57	1.56	11.13	7.62	9.91	7.64	10.81
Wellcap_200to400	11.42	1.52	12.94	8.55	11.66	8.52	12.78
Wellcap_400to600	13.41	1.49	14.90	9.46	13.71	9.44	15.11
Wellcap_600to800	15.40	1.50	16.90	10.22	15.89	10.34	17.79
Wellcap_over800	18.39	1.41	23.11	11.04	19.00	10.26	19.34
Total	13.10	1.50	14.40	9.06	13.50	9.07	15.15
Start Year	1996q1	1998q1	1998q1	1996q1	1996q1	1993q1	1993q1

Time period: 1993Q1-2012Q1, for banks that exist for at least 50 quarters.

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Table A.3: **Cyclicality and Size Class [0,25]**

	1993Q1-2007Q4			1993Q1-2012Q1		
	Y_{t-1}	Y_t	Y_{t+1}	Y_{t-1}	Y_t	Y_{t+1}
Asset	**0.263**	**0.291**	**0.227**	-0.158	-0.185	-0.184
	(0.044)	(0.024)	(0.081)	(0.173)	(0.107)	(0.111)
Loan	**0.351**	**0.344**	**0.295**	-0.029	-0.122	-0.18
	(0.006)	(0.007)	(0.022)	(0.807)	(0.292)	(0.120)
Liability	**0.346**	**0.380**	**0.308**	-0.119	-0.142	-0.146
	(0.007)	(0.003)	(0.017)	(0.306)	(0.217)	(0.208)
Deposit	-0.085	-0.031	0.041	**-0.295**	**-0.212**	-0.097
	(0.520)	(0.814)	(0.756)	(0.010)	(0.064)	(0.403)
Ret. Earn.	**0.267**	**0.226**	**0.222**	0.164	0.048	-0.041
	(0.041)	(0.083)	(0.088)	(0.156)	(0.681)	(0.723)
Equity	-0.122	-0.136	-0.118	-0.071	-0.114	-0.092
	(0.357)	(0.302)	(0.369)	(0.543)	(0.323)	(0.428)
Stocks	**0.505**	**0.521**	**0.474**	**0.510**	**0.521**	**0.492**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LLP	**-0.353**	**-0.333**	**-0.507**	**-0.481**	**-0.529**	**-0.639**
	(0.006)	(0.009)	(0.000)	(0.000)	(0.000)	(0.000)
NCO	**-0.303**	**-0.238**	**-0.401**	**-0.446**	**-0.440**	**-0.537**
	(0.020)	(0.067)	(0.001)	(0.000)	(0.000)	(0.000)
E/A	**-0.286**	**-0.272**	-0.212	0.07	0.043	0.066
	(0.028)	(0.035)	(0.104)	(0.546)	(0.713)	(0.573)

Time period: 1993Q1-2012Q1, for banks that exist at least 50 quarters.

Table A.4: **Cyclicality and Size Class [25,50]**

	1993Q1-2007Q4			1993Q1-2012Q1		
	Y_{t-1}	Y_t	Y_{t+1}	Y_{t-1}	Y_t	Y_{t+1}
Asset	**0.336**	**0.332**	**0.271**	-0.104	-0.078	-0.043
	(0.009)	(0.010)	(0.036)	(0.372)	(0.497)	(0.711)
Loan	**0.627**	**0.596**	**0.49**	**0.191**	0.082	-0.018
	(0.000)	(0.000)	(0.000)	(0.098)	(0.477)	(0.877)
Liability	**0.427**	**0.419**	**0.337**	-0.04	-0.028	-0.021
	(0.001)	(0.001)	(0.008)	(0.731)	(0.812)	(0.860)
Deposit	-0.041	-0.008	0.038	**-0.413**	**-0.292**	**-0.110**
	(0.757)	(0.950)	(0.772)	(0.000)	(0.010)	(0.342)
Ret. Earn.	**0.331**	**0.326**	**0.441**	**0.438**	**0.487**	**0.588**
	(0.011)	(0.011)	(0.000)	(0.000)	(0.000)	(0.000)
Equity	-0.078	-0.058	0.067	-0.162	-0.05	0.165
	(0.557)	(0.661)	(0.610)	(0.161)	(0.669)	(0.153)
Stocks	**0.454**	**0.528**	**0.521**	0.186	**0.269**	**0.287**
	(0.000)	(0.000)	(0.000)	(0.108)	(0.018)	(0.012)
LLP	**-0.358**	**-0.343**	**-0.458**	**-0.475**	**-0.551**	**-0.661**
	(0.005)	(0.007)	(0.000)	(0.000)	(0.000)	(0.000)
NCO	**-0.301**	**-0.236**	**-0.331**	**-0.438**	**-0.434**	**-0.499**
	(0.021)	(0.070)	(0.010)	(0.000)	(0.000)	(0.000)
E/A	**-0.375**	**-0.329**	**-0.198**	-0.059	0.018	0.166
	(0.003)	(0.010)	(0.130)	(0.612)	(0.875)	(0.152)

Time period: 1993Q1-2012Q1, for banks that exist at least 50 quarters.

Table A.5: **Cyclicality and Size Class [50,75]**

	1993Q1-2007Q4			1993Q1-2012Q1		
	Y_{t-1}	Y_t	Y_{t+1}	Y_{t-1}	Y_t	Y_{t+1}
Asset	**0.543**	**0.581**	**0.540**	0.119	0.112	0.119
	(0.000)	(0.000)	(0.000)	(0.304)	(0.333)	(0.307)
Loan	**0.745**	**0.758**	**0.638**	**0.215**	0.106	-0.013
	(0.000)	(0.000)	(0.000)	(0.062)	(0.360)	(0.911)
Liability	**0.625**	**0.649**	**0.595**	0.161	0.148	0.147
	(0.000)	(0.000)	(0.000)	(0.165)	(0.199)	(0.205)
Deposit	0.003	0.166	**0.284**	**-0.347**	**-0.213**	-0.021
	(0.984)	(0.204)	(0.028)	(0.002)	(0.063)	(0.857)
Ret. Earn.	0.185	**0.376**	**0.461**	**0.519**	**0.508**	**0.409**
	(0.161)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)
Equity	**-0.247**	-0.135	-0.053	0.009	0.078	0.135
	(0.059)	(0.303)	(0.689)	(0.939)	(0.503)	(0.247)
Stocks	**0.301**	0.185	0.063	0.135	0.128	0.133
	(0.021)	(0.157)	(0.630)	(0.246)	(0.268)	(0.254)
LLP	**-0.331**	**-0.373**	**-0.503**	**-0.442**	**-0.541**	**-0.660**
	(0.010)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)
NCO	**-0.318**	**-0.336**	**-0.443**	**-0.436**	**-0.492**	**-0.578**
	(0.014)	(0.009)	(0.000)	(0.000)	(0.000)	(0.000)
E/A	**-0.556**	**-0.507**	**-0.437**	-0.121	-0.044	0.005
	(0.000)	(0.000)	(0.000)	(0.297)	(0.706)	(0.966)

Time period: 1993Q1-2012Q1, for banks that exist at least 50 quarters.

Table A.6: **Cyclicality and Size Class [75,100]**

	1993Q1-2007Q4			1993Q1-2012Q1		
	Y_{t-1}	Y_t	Y_{t+1}	Y_{t-1}	Y_t	Y_{t+1}
Asset	**0.303**	**0.305**	**0.264**	**0.239**	**0.223**	0.174
	(0.020)	(0.018)	(0.041)	(0.038)	(0.051)	(0.133)
Loan	**0.358**	**0.349**	**0.302**	**0.308**	**0.249**	0.158
	(0.005)	(0.006)	(0.019)	(0.007)	(0.029)	(0.174)
Liability	**0.338**	**0.345**	**0.303**	**0.281**	**0.264**	**0.206**
	(0.009)	(0.007)	(0.019)	(0.014)	(0.020)	(0.075)
Deposit	**0.225**	**0.257**	**0.273**	0.062	0.139	**0.203**
	(0.087)	(0.048)	(0.035)	(0.594)	(0.229)	(0.079)
Ret. Earn.	**0.484**	**0.505**	**0.481**	**0.553**	**0.639**	**0.656**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Equity	0.083	0.057	0.036	-0.123	-0.099	-0.028
	(0.533)	(0.663)	(0.787)	(0.288)	(0.391)	(0.808)
Stocks	**0.227**	**0.224**	**0.217**	-0.052	0.079	**0.191**
	(0.084)	(0.085)	(0.095)	(0.654)	(0.495)	(0.099)
LLP	**-0.376**	**-0.411**	**-0.500**	**-0.385**	**-0.508**	**-0.623**
	(0.003)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)
NCO	**-0.475**	**-0.495**	**-0.572**	**-0.562**	**-0.617**	**-0.670**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
E/A	0.004	0.045	0.145	-0.088	-0.026	0.045
	(0.976)	(0.733)	(0.270)	(0.449)	(0.825)	(0.698)

Time period: 1993Q1-2012Q1, for banks that exist at least 50 quarters.

Table A.7: **Cyclicality in the Aggregate Data using CRSP**

	1993Q1-2007Q4			1993Q1-2012Q1		
	Y_{t-1}	Y_t	Y_{t+1}	Y_{t-1}	Y_t	Y_{t+1}
Asset	**0.417**	**0.475**	**0.442**	**0.326**	**0.323**	**0.270**
	(0.001)	(0.000)	(0.000)	(0.004)	(0.004)	(0.019)
Loan	**0.528**	**0.575**	**0.539**	**0.461**	**0.415**	**0.313**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)
Liability	**0.447**	**0.510**	**0.475**	**0.365**	**0.360**	**0.297**
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.010)
Deposit	**0.422**	**0.494**	**0.508**	**0.257**	**0.348**	**0.401**
	(0.001)	(0.000)	(0.000)	(0.026)	(0.002)	0.000
Ret. Earn.	**0.547**	**0.599**	**0.571**	**0.594**	**0.699**	**0.701**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Equity	**0.262**	**0.283**	**0.274**	0.014	0.048	0.12
	(0.045)	(0.028)	(0.034)	(0.907)	(0.681)	(0.304)
Stocks	**0.419**	**0.457**	**0.473**	0.151	**0.287**	**0.393**
	(0.001)	(0.000)	(0.000)	(0.197)	(0.012)	(0.000)
e × q	**0.444**	**0.521**	**0.586**	**0.278**	**0.477**	**0.588**
	(0.000)	(0.000)	(0.000)	(0.016)	(0.000)	(0.000)
q	0.082	0.182	**0.279**	**0.244**	**0.271**	**0.311**
	(0.535)	(0.163)	(0.031)	(0.035)	(0.018)	(0.007)
Equity Premium	**-0.469**	**-0.452**	**-0.484**	**-0.238**	-0.154	**-0.208**
	(0.000)	(0.000)	(0.000)	(0.039)	(0.184)	(0.073)
Return on Stocks	**-0.440**	**-0.427**	**-0.463**	**-0.212**	-0.129	-0.183
	(0.000)	(0.001)	(0.000)	(0.068)	(0.267)	(0.116)
ROAE	**-0.271**	**-0.302**	**-0.246**	**0.195**	**0.225**	**0.285**
	(0.038)	(0.019)	(0.058)	(0.094)	(0.050)	(0.013)
LLP	**-0.315**	**-0.349**	**-0.430**	**-0.320**	**-0.461**	**-0.578**
	(0.015)	(0.006)	(0.001)	(0.005)	(0.000)	(0.000)
NCO	**-0.421**	**-0.433**	**-0.515**	**-0.506**	**-0.575**	**-0.634**
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
E/A	-0.188	-0.153	-0.046	-0.159	-0.067	0.028
	(0.153)	(0.244)	(0.729)	(0.174)	(0.566)	(0.811)

Time period: 1993Q1-2012Q1, for banks that exist at least 50 quarters.

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