Macroeconomic Implications of 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; b) bank assets and deposits are pro-cyclical while equity is acyclical; c) an increase in loan loss provisions reduces output, raises the corporate bond spread and the bank equity-to-asset ratio. In our model financial intermediaries are subject to an equity constraint along the lines of Basel II which specifies a constant minimum equity-to-asset ratio requirement. The 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. We also model Basel III regulation that specifies a capital conservation (in addition to the eight percent required by Basel II) and a counter-cyclical buffer for equity-to-asset ratios. The increase in the capital ratio mandated by Basel III is achieved primarily by reducing assets; capital is raised slightly by increasing internal funding and reducing bank equity. Lower financial intermediation leads to lower output. Under Basel III bank balance sheets are less volatile, which makes banks more resilient to crises. Since the minimum capital ratio falls in response to a fall in asset prices and loans, banks raise less capital but still reduce loans as much as under Basel II. Hence, Basel III fails to de-amplify the output effects of shocks to bank assets.

Keywords: Macro & Finance; Capital Adequacy; Financial Regulation
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1 Introduction

Financial crisis of 2007-09 was characterized by huge pressure on financial firms and disruption of financial markets. Strong, global policy response averted the failure of systematically important financial institutions and stabilized global financial markets. One action taken by policy makers was capital injections to the bank balance sheets, and therefore assessing the capital needs of banks during the financial crisis was crucial. These events have brought regulation and oversight of financial firms and the effect of regulation on the economy back on the policy agenda.

In this paper, 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 regulation, 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 requirements.

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 and use bank-level data. We 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 pro-cyclical whereas equity is acyclical and equity-to-asset ratio is counter-cyclical.

Next, we examine various bank capital ratios which are subject to regulation. 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 study the shocks to

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

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 of 15 largest BHCs which constitute about 76% of the total bank assets in our data sample, and almost about 2% of the total number of 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 is in line with counter-cyclical equity-to-asset ratios.

In the theoretical part, we develop a macroeconomic 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 of a bank equity constraint such that equity should be at least 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 our model to analyze the effects of a crisis, which we capture with a reduction in banks' assets – a decline in capital quality. A decline in banks' assets generates a fall in asset prices and bank loans. The rate of return on loans falls sharply and banks' stock prices are reduced as well. As a result banks face losses and their net worth declines. Meanwhile, banks must maintain the minimum capital requirement, therefore they have to issue new stocks to balance the fall in the net worth. Overall, equity decreases less than assets, and equity-to-asset ratio increases. The decline in bank loans implies a decline in capital and investment and hence a lower level of output in the economy. The increase in the bank capital ratio and the decline in output as a result of a disruption on the asset side of the banks' balance sheets is in line with the VAR evidence we present in the empirical part.

As a next step, we modify the bank equity constraint in line with Basel III regulation, which introduced a capital conservation buffer and a counter-cyclical buffer. The capital conservation buffer requires that, in normal times, banks hold a capital ratio of at least 10.5 percentage points, up from 8 percentage points mandated by Basel II. We find that banks increase their capital ratios primarily by reducing loans, namely by reducing the denominator of the regulated ratio. Lower financial intermediation causes output to fall. Bank capital is raised slightly and the improvement stems from higher internal funding at the expense of lower bank equity. As for the counter-cyclical buffer, under Basel III the capital ratio can fall to 8% when credit growth and economic conditions worsen and it can go up to 13% when credit growth is high. Since banks need to recapitalize less when stock prices are low, the volatility of net income and retained earnings is reduced. As a result, all balance sheet components as well as the economy become less volatile. Our results therefore suggest that banks become more resilient under Basel III regulation. By requiring a lower capital ratio during a crisis, Basel III regulation aims to avert a credit tightening and a fire sale of assets as experienced in the recent financial crisis. Our model suggests that a counter-cyclical capital ratio fails to reduce the impact on the economy of a shock to banks' assets. The decline in asset prices, bank loans and output is similar under Basel II and Basel III regulations. Banks let their capital fall in a crisis, taking advantage of a lower minimum capital ratio, but still cut loans proportionally as much as they would do under Basel II.

The rest of the paper is organized as follows. Section 2 discusses the related literature; section 3 documents bank capital regulation and presents the empirical evidence. Section 4 describes the model and sections 5 to 8 present the results. In section 9 we evaluate Basel III regulation and in section 10 we carry out some robustness exercises. Section 11 concludes.

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 to a 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 pro-cyclical 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 pro-cyclical 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 mostly partial equilibrium models. Only a few dynamic stochastic general equilibrium (DSGE) models have introduced financial intermediation 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 banks' lending behavior depends on how well they 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.

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 in their model banks operate for just a period and they do not retain earnings which contributes to equity of the bank.

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 repu-

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

tation 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 Regulation and Empirical Evidence

3.1 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 3% leverage ratio, which is Tier 1 capital divided by average total assets, was also introduced. Table 1 summarizes the Basel II accord.

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

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	$\geq$ 3%

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
U.S.: Leverage ratio	$\geq$ 3% (6%)
Capital Conservation Buffer	
Common equity Tier 1	additional 2.5% of RWA
Counter-cyclical Buffer	
Common equity Tier 1	additional 2.5% of RWA

3.2 Empirical Evidence

In our analysis we use quarterly data for U.S. BHCs between 1993Q1 and 2012Q1. Our data set starts with the first quarter of 1993, because the implementation deadline for Basel I rules was December 1992. 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 because 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 Table A.1 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%.

- *more than 18%* if the BHC's capital ratio exceeds the regulatory standard for "well capitalized" by more than 800 bps,
- *16% - 18%* if the BHC's capital ratio is 600-800 bps above the "well capitalized" threshold,
- *14% - 16%* if the BHC's capital ratio is 400-600 bps above the "well capitalized" threshold,
- *12% - 14%* if the BHC's capital ratio is 200-400 bps above the "well capitalized" threshold,
- *10% - 12%* if the BHC's capital ratio is up to 200 bps above the "well capitalized" threshold,
- *8% - 10%* if the BHC's capital ratio lies between the adequate and well-capitalized thresholds,
- *7% - 8%* 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.

- *less than 7%* 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. Table 3 shows the number of banks for each size and capital group. Table 4 shows the size distribution of banks for a given capital group. Tables 3 and 4 indicate that the majority of the banks were well-capitalized, and they hold more than the regulatory requirement. 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 - Number of Banks**

	[0,25]	[25,50]	[50,75]	[75,100]	Total
less than 7%	143	73	86	163	465
7% - 8%	65	48	65	19	197
8% - 10%	476	566	521	215	1,778
10% - 12%	2,059	2,677	3,295	3,376	11,407
12% - 14%	2,506	3,044	3,083	3,360	11,993
14% - 16%	1,989	1,970	1,766	1,904	7,629
16% - 18%	1,198	1,102	830	903	4,033
more than 18%	2,638	1,625	1,465	819	6,547
Total	11,074	11,105	11,111	10,759	44,049

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

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

	[0,25]	[25,50]	[50,75]	[75,100]	Total
less than 7%	30.75	15.70	18.49	**35.05**	100
7% - 8%	**32.99**	24.37	**32.99**	9.64	100
8% - 10%	26.77	**31.83**	29.30	12.09	100
10% - 12%	18.05	23.47	28.89	**29.60**	100
12% - 14%	20.90	25.38	25.71	**28.02**	100
14% - 16%	**26.07**	25.82	23.15	24.96	100
16% - 18%	**29.70**	27.32	20.58	22.39	100
more than 18%	**40.29**	24.82	22.38	12.51	100
Total	25.14	25.21	25.22	24.43	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 3 shows that most of the small banks which are at the bottom 25% of the size distribution are very well capitalized.[4] 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

[4]Column percentage are in Table A.2 in Appendix A

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. This implies, smaller banks hold relatively more Tier 1 capital, which is a better quality of capital, compared to larger banks, and larger banks hold relatively more Tier 2 capital, which is not as good quality as Tier 1 capital. 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. Similar to the *Tier 1+Tier 2* regulatory ratio as the bank size gets larger this ratio gets smaller. 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. This is probably because the largest banks have a larger share of trading assets on their balance sheets compared to smaller banks, and loans constitute a smaller percentage of their assets.

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.

In Table 6, we examine the cyclicality of bank balance sheet variables. 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.[5] 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 pro-cyclical, such as assets, loans, liabilities, deposits, stocks (preferred stock plus common stock) and retained earnings,[6] as expected. Loan loss provisions *(LLP)* and net charge offs *(NCO)* are counter-cyclical. 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 pro-cyclical, and share prices are positively correlated only with future GDP. Equity premium and return on bank stocks are counter-cyclical. 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 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.

[5] 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.4-A.7.

[6] Retained Earnings$_t$=Retained Earnings$_{t-1}$+Net Income$_t$ -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.

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

	GDP	Cons.	Inv.	Asset	Loan	Liab.	Deposit	R.E.	Equity	Stock	LLP	NCO	E/A	ROAE	ROL	ROA	NIMA
GDP	1																
Cons.	**0.859**	1															
	0.000																
Inv.	**0.921**	**0.698**	1														
	0.000	*0.000*															
Asset	**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*												
Deposit	**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.	**0.447**	**0.514**	**0.514**	**0.430**	**0.578**	**0.425**	**0.586**	1									
Earn.	*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*									
Stock	**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.

As a next step, 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. Following Covas, Rump and Zakrajsek (2012) our sample consists only of the largest 15 BHCs which are listed on Table 8.[8]

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.

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

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

We estimate the model over the 1993Q1-2012Q1 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.

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

[8]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.

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 1: Variables used in VAR estimation

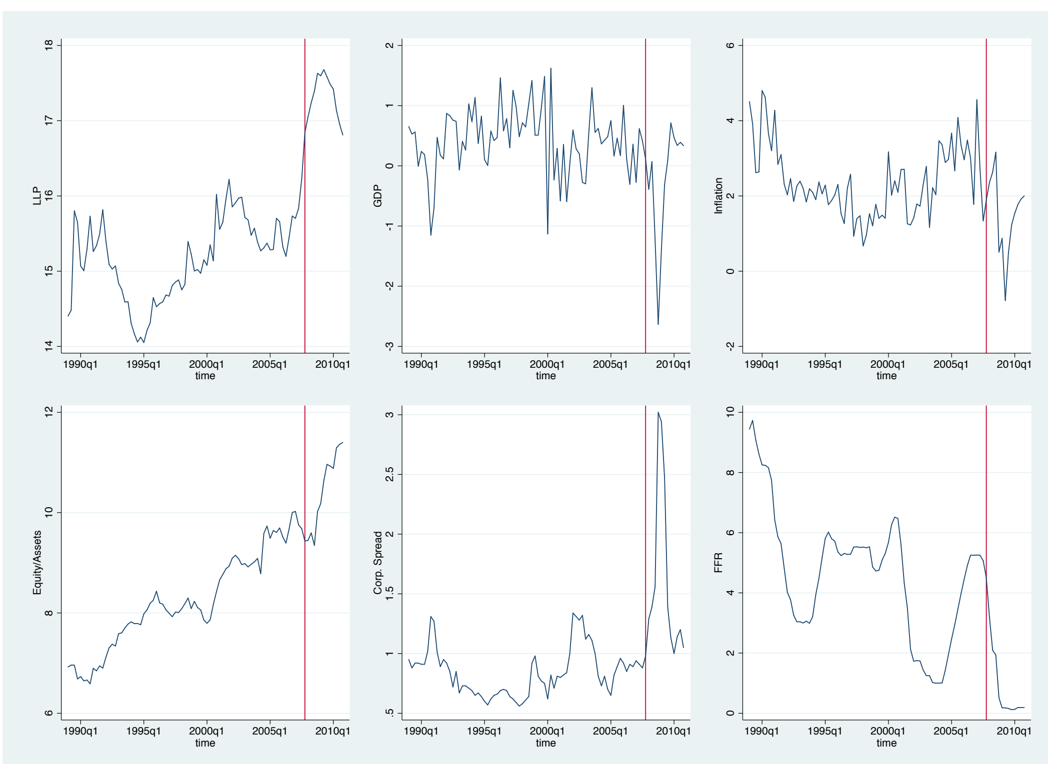
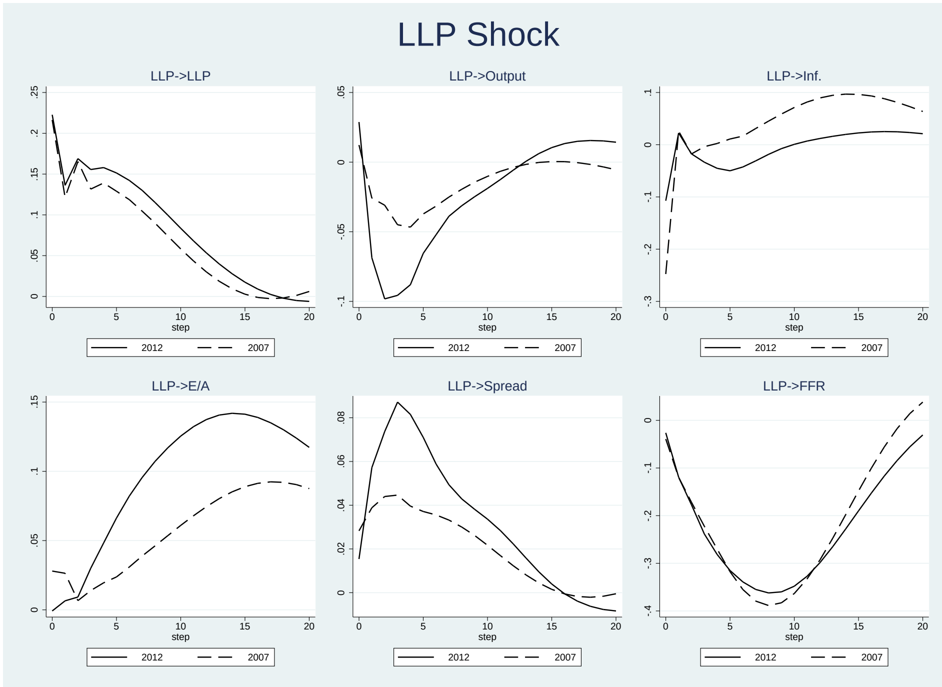


Figure 2: Response to a Shock in Loan Loss Provisions



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 error variance decomposition (FEVD) 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 about 6% of the variation in output, and equity to asset ratio explain about 3% of the output fluctuations.

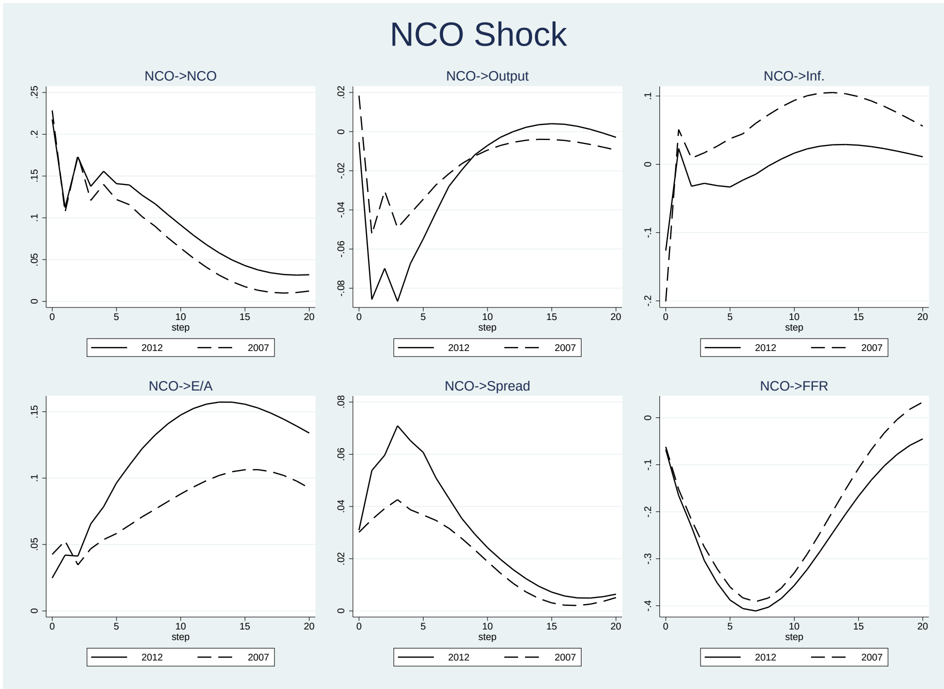
Table 10: **FEVD for Output Growth - LLP**

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

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



the VAR respond to the net charge-off shock similar to the loan loss provision shock. Table 11 shows the forecast variance error decomposition for output growth at various horizons. We see that after four quarters, 82% of the 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: **FEVD 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

4 The Model

4.1 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

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

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

Households' 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.

4.2 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.

4.3 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_tS_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 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:

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

4.4 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, $Q_t S_t$, is equal to the sum of deposits D_t and equity $q_t X_t$ raised from households and the bank's net worth N_t:

$$Q_t S_t = N_t + q_t X_t + D_t. \tag{17}$$

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

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

where the gross rate of return on equity at $t+1$ is:

$$\frac{\Psi_{t+1}\left[Z_{t+1} + (1-\delta) q_{t+1}\right]}{q_t} = R_{X,t+1}, \tag{19}$$

and $\mathcal{P}$ 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 3 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

$$\mathcal{P}_t = \phi \left[\log \left(\frac{X_t q_t + N_t}{\gamma Q_t S_t} \right) - \zeta \left(\frac{X_t q_t + N_t - Xq - N}{Xq + N} \right) \right], \quad \phi, \zeta \geq 0, \tag{20}$$

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; N is the steady-state net worth so that $Xq + N$ is bank capital at the steady state. 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 capital-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.[9] The penalty captures the cost borne by banks for having low capital-to-asset ratios, such as restrictions on discretionary bonus payments and capital distributions, increased monitoring, higher funding costs, etc.

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

$$V_t(S_t, X_t, N_t) = \max_{S_t, X_t} E_t \Lambda_{t,t+1} \left\{ (1 - \epsilon) N_t + \epsilon \left[V_{t+1}(S_{t+1}, X_{t+1}, N_{t+1}) \right] \right\}. \tag{21}$$

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 formulation for net worth

$$N_{t+1} = \left[R_{K,t+1} - R_{D,t} - \iota \right] Q_t S_t - \left[R_{X,t+1} + \tau - R_{D,t} - \iota \right] X_t q_t + \left[R_{D,t} + \iota \right] N_t + \mathcal{P}_t. \tag{22}$$

The first-order conditions relative to S_t and X_t are, respectively,

$$\mu_{s,t} Q_t S_t = \phi E_t \Lambda_{t,t+1} \Omega_{t+1}, \tag{23}$$

$$\mu_{x,t} = \phi E_t \Lambda_{t,t+1} \Omega_{t+1} \left[\frac{1}{X_t q_t + N_t} - \frac{\zeta}{Xq + N} \right], \tag{24}$$

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

$$V_{N,t} = 1 - \epsilon + \epsilon E_t \Lambda_{t,t+1} V_{N,t+1} \left[R_{D,t} + \iota + \mathcal{P}_{N,t} \right], \tag{25}$$

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

where we have defined $\mathcal{P}_{N,t}, \Omega_{t+1}, \mu_{s,t}, \mu_{x,t}$, and $\mu_{n,t}$ as follows

$$\begin{aligned}
\mathcal{P}_{N,t} &\equiv \partial \mathcal{P}_t / \partial N_t, && (26)\\
\Omega_{t+1} &\equiv V_{N,t+1}, && (27)\\
\mu_{s,t} &\equiv E_t \Lambda_{t,t+1} \Omega_{t+1} \left(R_{K,t+1} - R_{D,t} - \iota \right), && (28)\\
\mu_{x,t} &\equiv E_t \Lambda_{t,t+1} \Omega_{t+1} \left(R_{X,t+1} + \tau - R_{D,t} - \iota \right), && (29)\\
\mu_{n,t} &\equiv E_t \Lambda_{t,t+1} \Omega_{t+1} \left[R_{D,t} + \iota + \mathcal{P}_{N,t} \right]. && (30)
\end{aligned}$$

As a result,

$$\Omega_t = 1 - \epsilon + \epsilon \mu_{n,t}. \tag{31}$$

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

$$\omega R_{k,t} Q_{t-1} S_{t-1}, \tag{32}$$

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

$$N_t = \epsilon \left\{ \left[R_{K,t} - R_{D,t-1} \right] Q_{t-1} S_{t-1} - \left[R_{X,t} + \tau - R_{D,t-1} - \iota \right] q_{t-1} X_{t-1} + R_{D,t-1} N_{t-1} + \mathcal{P}_t \right\} + (1-\epsilon) \omega R_{K,t} Q_{t-1} S_{t-1}. \tag{33}$$

4.5 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

$$\log G_t = \rho_g \log G_{t-1} + (1 - \rho_g) \log G + \varepsilon_g, \tag{34}$$

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.

4.6 Equilibrium

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

$$Y_t = C_t + G_t + \left[1 + f\left(\frac{I_t}{I_{t-1}} \right) \right] I_t. \tag{35}$$

Hence, financial intermediation costs are rebated back to consumers in a lump-sum fashion.[10] 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

$$\log A_t = \rho_a \log A_{t-1} + \varepsilon_a, \tag{36}$$

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

$$\log \Psi_t = \rho_\Psi \log \Psi_{t-1} + \varepsilon_\Psi, \tag{37}$$

with $\rho_\Psi \geq 0$ and ε_Ψ being the normally distributed disturbance with zero mean and variance σ_Ψ^2.[11]

5 Calibration

For investment, we assume standard adjustment costs

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

We also specify an adjustment cost for equity of the following form

$$0.5\lambda_0\left(\frac{e_t}{e} - 1\right)^2, \quad \lambda_0 \geq 0$$

where e is the number of stocks at the deterministic steady state. This cost is present only outside the steady state and it captures the fact that issuing and retiring equity is costly. In response to a fall in asset values, the bank will be reluctant to respond (and keep the regulated ratio from falling) by issuing only equity.

Table 12 summarizes the calibration of our economy. The time unit is meant to be a quarter.

[10] This reduces the output effect of shocks. We have also looked at the case where transactions costs $\tau X_t q_t + \iota D_t$ are wasted and our results are not affected.

[11] 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.

Table 12: **Benchmark Calibration**

Parameter	Value	Description
β	0.9925	Discount factor of households
σ	2	Coefficient of relative risk aversion
ν	4	Disutility from work
h	0.75	Habit parameter
φ	1/5	Inverse of elasticity of labor supply
χ	0.8	Firm adjustment costs
α	0.3	Share of capital in production
δ	0.025	Capital depreciation
γ	0.08	Bank capital constraint
ι	0	Bank (proportional) cost of deposits
τ	0.035	Bank (proportional) cost of equity
ϵ	0.75	Survival rate of bankers
ω	0.03	Transfer to new bankers
ϕ	0.065	Penalty parameter
ζ	0.2	Penalty parameter for deviation from steady state
λ_0	0.003	Bank (quadratic) cost of equity
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	0.0077	Standard deviation of government spending shocks
σ_a	0.0064	Standard deviation of productivity shocks
σ_Ψ	0.0017	Standard deviation of capital quality shocks

We set the coefficient of relative risk aversion σ equal to 2 and the habit parameter h equal to 0.75. 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 0.8. Regarding banks, we choose the parameters to come as close as possible to the aggregate summary statistics for banks reported in section 3. We set γ, the bank 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 0.75 and the transfer to new bankers ω is set equal to 0.03. 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 0.065 and 0.2, respectively. $\zeta = 1$ penalizes banks for capital ratios different from the required value, both larger and smaller; $0 < \zeta < 1$ rewards banks for capital ratios above (but not too far above) the required value (except at the steady state) while $\zeta = 0$ penalizes banks for capital ratios below its required value. We set the cost of equity τ equal to 0.035 and the cost of deposits ι equal to zero. The adjustment cost of equity, λ_0, is set equal to 0.003.

For the parameters of the exogenous disturbance processes, we set the standard deviation and autoregressive parameters for the technological progress and government spending so as to match the standard deviation of output. More precisely, we set $\sigma_a = 0.0064$ and $\rho_a = 0.8556$; $\sigma_g = 0.0077$ and $\rho_g = 0.87$, which are close to the values typically used in the literature. 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 roughly match the standard deviation of bank assets as reported in table 9.

6 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 forty 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 they want to avoid the capital ratio from falling below the required level. In other words, banks de-leverage and reduce financial intermediation. As a result, 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 3, 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

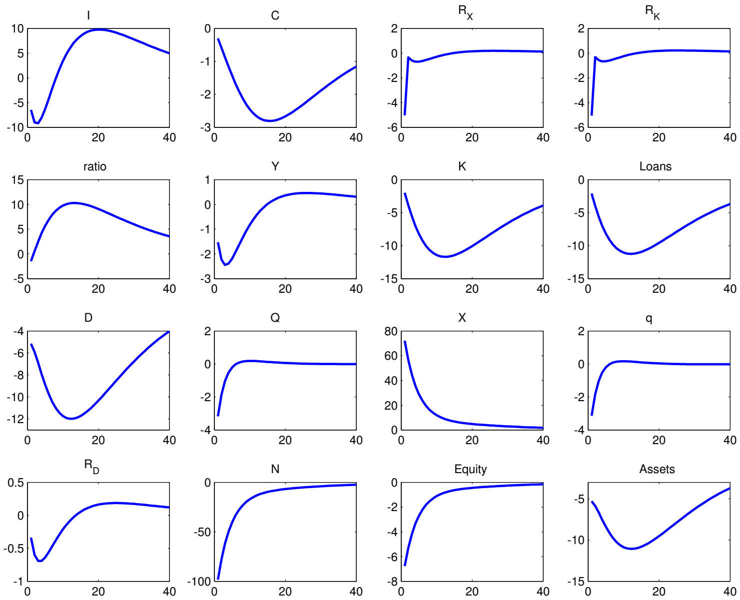


Figure 4: Impulse responses to a capital quality shock

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 reports the impulse responses to a capital quality shock with and without capital requirements for banks, which we model by bringing the penalty parameter close to zero. In the absence of capital requirements, the bank would reduce, rather than increase, its equity X because stock prices are low. As a result, the capital-to-asset ratio falls. In terms of output, capital requirements for banks slightly amplify the impact of the shock.

7 Deterministic and Risk-adjusted Steady State

The penalty function (20) affects the steady state of our model. Intuitively, the penalty raises the marginal benefit of bank equity and reduces the marginal benefit of loans. Equity is at the numerator of the regulated ratio and its increase reduces the penalty; on the other hand, loans reduce the ratio and thereby increase the penalty. In fact, reducing the parameter ϕ and increasing the parameter ζ implies lower stocks and higher deposits at the steady state; along the same lines, higher values of the proportional cost of equity τ also reduce stocks at the steady state – see table 13. The bold line in table 13 reports the benchmark calibration

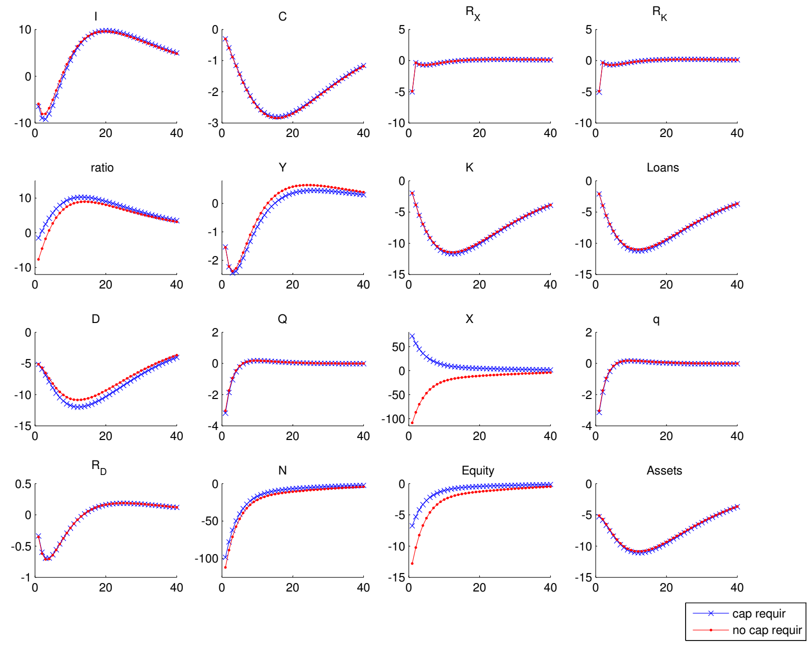


Figure 5: Impulse responses to a capital quality shock with and without capital requirements

and deterministic steady state of our model.

Table 13: **Bank Choice of Equity versus Deposits**

Parameter Value			Variables		
ϕ	ζ	τ	X	D	$ratio$
0.065	**0.2**	**0.035**	**0.7265**	**16.4926**	**0.0821**
0.024	0.2	0.035	0.0037	19.3718	0.0316
0.065	0	0.035	1.3221	15.8018	0.1206
0.065	0.2	0.02	1.3624	15.7304	0.1246

The deterministic steady state does not account for 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. The presence of costs and the minimum capital requirement pins down the liability composition of banks, as shown in table 13. To capture risk perception and its implications on the portfolio choice of both households and financial intermediaries we work with the second-order approximation of the 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). To this end we implement an iterative procedure: a) we log-linearize the model around the non-stochastic steady state; b) we then use the second moments to adjust the steady state for risk; c) we evaluate the moments around the first-stage risk-adjusted steady state and compute the residuals of our approximation; d) we keep iterating until the residuals are zero.[12]

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 on deposits has a lower correlation with consumption than the 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 and the cost structure of banks pin down the liability side of their balance sheet, the household's portfolio is also 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.

The left-hand side of table 14 reports the empirical mean of the rate of return on bank stocks,[13] and the equity premium relative to bonds over the period 1993Q1 to 2007Q4. The right-hand side of table 14 reports the deterministic and risk-adjusted steady-state values of the corresponding variables in our model. The parameter values are those specified in table 12; for the standard deviation of the exogenous shocks, we consider scenarios. The first column under risk-adjusted steady state shows R_X and the equity premium with the standard deviations of our benchmark calibration: the equity premium is small and equal to 0.07%. In the second column the standard deviations of the shocks are ten times larger and the equity premium rises to 8.42%. Column 3 and 4 shed light on the source of the equity premium as they consider in isolation capital quality shocks (column 3) and technology and government spending shocks (column 4). The equity premium is driven by the volatility of capital quality shocks. In fact, high volatility of ϵ_a, ϵ_g in the absence of shocks to bank assets generate a bank equity premium of 0.55%; on the other hand, high volatility of ϵ_Ψ alone generates an equity premium of 6.70%.

Two mechanisms generate and affect the equity premium in our model. The first is the standard equity premium motive stemming from the fact that stocks are a bad hedge for households against fluctuations, at least relative to bank deposits. From the household first-order conditions (5) and (6) we obtain

$$\frac{E_t R_{X,t+1}}{R_{D,t}} = 1 - Cov_t\left(\frac{\beta\lambda_{t+1}}{\lambda_t}, R_{X,t+1}\right). \tag{38}$$

[12]For further details, see Juillard (2011).
[13]This is calculated as the return of holding stocks.

Table 14: **Steady State**

Empirical		Model					
Variable	Mean	Model	Det. SS	Risk-adjusted SS			
				$\sigma_\Psi = 0.17$	$\sigma_\Psi = 1.7$	$\sigma_\Psi = 1.7$	$\sigma_\Psi = 0$
				$\sigma_a = 0.64$	$\sigma_a = 6.4$	$\sigma_a = 0$	$\sigma_a = 6.4$
				$\sigma_g = 0.77$	$\sigma_g = 7.7$	$\sigma_g = 0$	$\sigma_g = 7.7$
Stock return	14	R_X	3.07	3.10	8.24	9.18	1.55
Equity Premium	10.2	$R_X - R_D$	0	0.07	8.42	6.70	0.55

Rate of returns in percent and annualized; Standard deviations in percent

A negative covariance between the stochastic discount factor and stock returns means that bank stocks pay a high return when consumption is already high. Hence agents demand a premium on equity relative to deposits. In our model the covariance is indeed negative; in the simulation reported later the correlation between $R_{X,t+1}$ and the stochastic discount factor is -0.3844. The second mechanism arises from the portfolio choice of banks and it is more novel. We can rearrange the first-order condition of banks relative to X_t, (24) as follows:

$$E_t(\Lambda_{t,t+1}\Omega_{t+1})E_t(R_{X,t+1} + \tau - R_{D,t} - \iota) + Cov_t(\Lambda_{t,t+1}\Omega_{t+1}, R_{X,t+1} + \tau - R_{D,t} - \iota) = \qquad (39)$$

$$\phi \left[\frac{1}{X_t q_t + N_t} - \frac{\zeta}{Xq + N} \right] E_t(\Lambda_{t,t+1}\Omega_{t+1}),$$

where $\Lambda_{t,t+1}\Omega_{t+1}$ is the augmented discount factor in Gertler, Kyotaki and Queralto's jargon, i.e. it is the discount factor used by banks. A negative covariance between the augmented discount factor and the spread $(R_{X,t+1} + \tau - R_{D,t} - \iota)$ raises the equity premium. Intuitively, the left-hand side of (39) represents the expected present value of the marginal cost of stocks relative to deposits for the bank while the right-hand side represents the marginal benefit. Because the augmented discount factor is negatively correlated with bank's net worth and output, a negative covariance means that the bank's excess marginal cost of stocks is high when the net worth is also high. The bank is happy to pay high returns on equity when economic conditions are good and retained earnings are high. Hence, stocks are a good hedge for banks and therefore they offer an equity premium relative to deposits. In our simulation the correlation between the augmented discount factor and the excess cost of stocks relative to deposits is -0.3354 – see table 16). As suggested by table 14, another important factor in determining the equity premium in our model is the volatility of capital quality shocks relative to technology and government spending shocks. When only capital quality shocks are present, the net worth and the augmented discount factor are positively correlated so that a high spread must be paid when net worth is low. Since the bank does not like to pay high stock returns when its net worth is low, it offers a lower equity premium.

Table 15 offers further insight into the role of risk in our model. It reports the risk-adjusted steady state of our model in low- and high-risk economies. For the low-risk economy we choose the benchmark standard deviations specified in table 12; for the high-risk economy, we leave σ_a, σ_g unchanged but raise σ_Ψ to 0.0207; with this value the model generates an equity premium of 10.1 percentage points, in line with the empirical evidence. Banks hold more capital 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 8.2 to 8.3 percentage points. Higher equity enables banks to hold more assets; this implies more loans and higher capital and output. Banks increase capital by raising net worth, i.e. retained earnings, but reducing equity Xq. Bank stocks need to pay a higher average rate of return R_X when risk is higher; as a result banks issue fewer stocks X and the price q increases. Leverage, which we define as assets relative to net worth, decreases with risk. Hence, our model predicts that riskier environments are characterized by increased financial intermediation and loans, higher capital ratios and lower leverage.

Table 15: **Risk-adjusted Steady State**

Variable	Low Risk	High Risk
$X \times q + N$	1.476	1.502
$Q \times K$	17.969	18.069
Q	1	1.005
S	17.969	17.983
X	0.726	0.687
q	1.111	1.136
N	0.669	0.723
$ratio$	0.082	0.0831
Y	2.167	2.180
$R_X - R_D$	0.07	10.1

Rate of returns in percent and annualized. Low Risk: $\sigma_\Psi = 0.0017$; High Risk: $\sigma_\Psi = 0.0207$

Figure 6 compares the impulse responses to a capital quality shock in the low- and high-risk environments. Both net worth and stocks drop sharply in response to a capital quality shock, thereby driving down equity. The change in assets are similar in both environments. Equity, however, rebounds faster and even grows in the high-risk environment, so that the capital ratio displays a stronger increase. The reason is that banks issue more stocks with high risk. At the high-risk steady state, the equity premium is large and the stock price is high; hence, the fall in the return from loans R_K brings down the equity return relatively more in the low-risk economy. Stock prices in fact fall in the low-risk economy but increase in the high-risk one. The stronger increase of equity-to-assets ratio leads to a greater decline in investment and output in the high-risk environment. The spread, namely $E_t R_{K,t+1} - R_{D,t}$, increases following the crisis

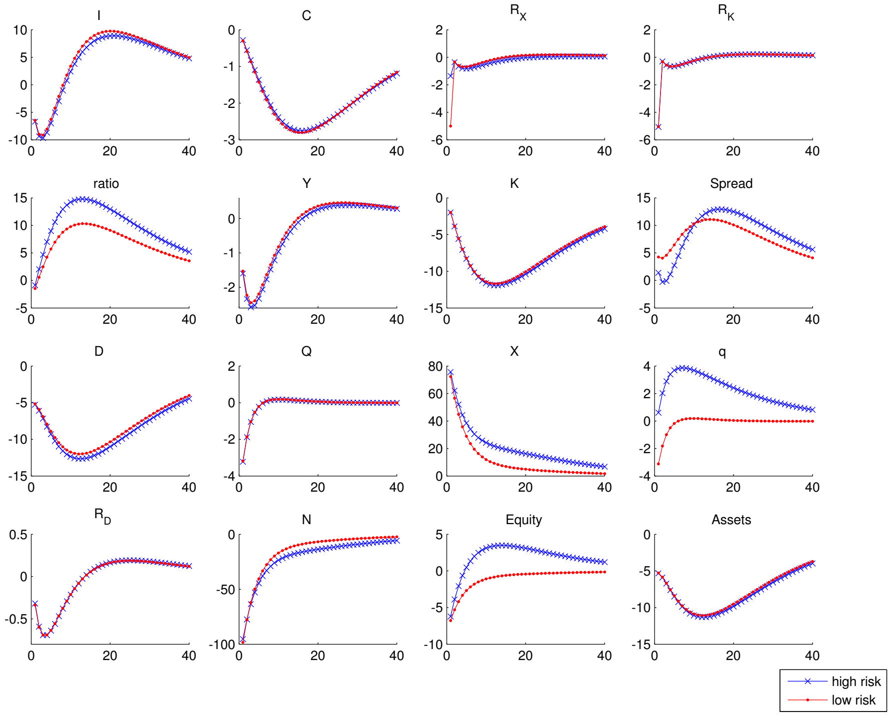


Figure 6: Impulse responses to a capital quality shock with low and high risk

and is more persistent with high risk.

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 0.19% to match the standard deviation of bank assets in the data. Table 16 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 16, 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 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

Table 16: **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	1.27	1	0.41
Cons	0.8	0.85	1	C	0.93	0.41	1
Investment	5.2	0.92	0.69	I	5.58	0.85	0.05
Assets	3.6	0.56	0.63	$Q \times K$	3.5	0.38	0.96
Deposits	2.7	0.49	0.58	D	3.69	0.38	0.97
Ret. Earnings	3.8	0.34	0.37	N	21.39	0.82	0.42
Equity	4.1	0.13	0.25	$q \times X + N$	1.48	0.82	0.42
Equity/Asset	2.0	-0.31	-0.4	$ratio$	2.98	-0.12	-0.91
Stock Return	270	-0.43	-0.52	R_X	123.82	0.08	-0.01
3M T-bill	48.5	0.48	0.32	R_D	46.7	-0.37	-0.21
				$Corr_t(\Lambda_{t,t+1}, R_{X,t+1}) = -0.3844$			
				$Corr_t(\Lambda_{t,t+1}\Omega_{t+1}, R_{X,t+1} - R_{D,t}) = -0.3354$			
				$Corr_t(\Lambda_{t,t+1}\Omega_{t+1}, N_{t+1}) = -0.2911$			

Standard deviation expressed in percentage points

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 retained earnings are more volatile in the model than in the data. Reducing the 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. 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 slightly 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.[14] This finding suggests that issuing stocks may be more costly than assumed in our paper.

9 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:

$$\tilde{\gamma} = \gamma + \frac{\gamma_1}{1 + \gamma_3 \exp(-\gamma_2 \widehat{Q_t S_t})}, \tag{40}$$

where

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

is the deviation of credit from its steady-state value. The parameters of equation (40) are chosen so that: a) the capital ratio is equal to 10.5% at the steady state; b) it varies between 8% and 13% for reasonable values of credit growth. This implies setting $\gamma = 0.0755$, $\gamma_1 = 0.0589$ and $\gamma_3 = 1$. The parameter γ_2 captures the rate at which the minimum capital requirement is reduced when bank assets fall and vice versa when bank assets grow. We set $\gamma_2 = 3$ in our benchmark calibration and discuss later the effects of changing this value.

We evaluate the performance of proposed Basel III regulation in several ways. First, we evaluate its impact on the second moments of the economy. Table 17 reports the second moments of the model under the constant 8 percentage points minimum capital-to-asset ratio (as in Basel II) and the counter-cyclical capital-to-asset ratio (40) (as in Basel III). The second moments are calculated using the same underlying shocks. Basel III significantly reduces the volatility of bank variables such as net income, net worth, assets, equity and the equity-to-asset ratio. The reason is straightforward: thanks to the counter-cyclical minimum capital

[14] The standard deviation of stocks issued by banks quoted in stock market is 8.2%, while our model generates 15%.

requirement, banks need to raise less equity during a downturn. This makes bank equity less volatile and cuts the volatility of net income by more than half. Since net income is less volatile, retained earnings are also less volatile. By allowing banks to recapitalize less during period of stress, profits are stabilized. Retained earnings and the spread become less negatively correlated, thereby reducing the equity premium paid by banks. In fact, the equity premium falls substantially under Basel III regulation, as illustrated in Table 18. Improved bank stability under Basel III leads to slightly lower volatility of output and consumption.

Table 17: **Second moments: Basel II and III**

	Basel II			Basel III		
Variable	Std	Corr Y	Corr C	Std	Corr Y	Corr C
Y	1.27	1	0.41	1.24	1	0.43
C	0.93	0.41	1	0.92	0.43	1
I	5.58	0.85	0.05	5.7	0.84	0.05
$Q \times S$	3.5	0.38	0.96	3.44	0.42	0.97
D	3.69	0.38	0.97	3.70	0.39	0.97
N	21.39	0.82	0.42	19.22	0.82	0.42
$q \times X + N$	1.48	0.82	0.42	1.43	0.82	0.53
$ratio$	2.98	-0.12	-0.91	2.8	-0.15	-0.92
R_X	123.82	0.08	-0.01	124	0.08	-0.01
R_D	46.7	-0.37	-0.21	46.44	-0.38	-0.22
$NetIncome$	445.55	0.22	0.08	205.38	0.25	0.08
$Corr_t(\Lambda_{t,t+1}, R_{X,t+1})$		-0.3844			-0.3769	
$Corr_t(\Lambda_{t,t+1}\Omega_{t+1}, R_{X,t+1} - R_{D,t})$		-0.3354			-0.0578	
$Corr_t(\Lambda_{t,t+1}\Omega_{t+1}, N_{t+1})$		-0.2911			-0.2039	

Standard deviation expressed in percentage points

Basel III regulation mandates a higher capital ratio than Basel II, at least in tranquil times (10.5 against 8 percent of risk-weighted assets). Keeping the penalty parameters ϕ, ζ and the equity cost τ unchanged, we find that banks will increase their capital ratios relative to Basel II, but not enough to reach the required level at the steady state, either risk-adjusted or deterministic. In fact, the capital ratio improves by hundred basis points from 8.2 to 9.2 percentage points in the low-risk economy (from 8.3 to 9.3 percentage points in the high-risk economy) – see Table 18. Intuitively, the cost equity is such that banks trade off capital for penalty. Bank capital increases from Basel II to III by around 4%; this rise stems from an increase in internal funding (net worth) and a decrease in bank equity X, which triggers higher stock prices q at the steady state. More importantly, the improvement in the capital ratio stems mainly from a large reduction in bank assets. Banks decide to achieve higher capital ratios by curtailing lending and thereby raising the denominator of the capital ratio.; in fact the fall in assets is entirely due to a reduction in loans rather than lower loan prices. Not surprisingly, steady-state output falls by anywhere between 2.7 to 2.5 percentage points under Basel III. The reason is straightforward: unless the penalty for being under-capitalized is higher, banks will not raise sufficiently their capital ratios under Basel III and they will achieve higher ratios primarily by cutting lending. This result lends support to the view and fears that the Basel III banking reform package will lead to substantial disintermediation by banks.

Table 18: **Risk-adjusted Steady State: Basel II and III**

	Basel II		Basel III	
Variable	Low Risk	High Risk	Low Risk	High Risk
$X \times q + N$	1.476	1.502	1.531	1.533
$Q \times K$	17.969	18.069	16.585	16.750
X	0.726	0.687	0.725	0.662
q	1.111	1.136	1.171	1.177
N	0.669	0.723	0.6813	0.796
$ratio$	0.082	0.0831	0.0923	0.0933
Y	2.167	2.180	2.108	2.126
$R_X - R_D$	0.07	10.1	0.02	3.61

Low Risk: $\sigma_\Psi = 0.0017$; High Risk: $\sigma_\Psi = 0.0207$;$\gamma = 0.0755$, $\gamma_1 = 0.0589$, $\gamma_2 = 3$ and $\gamma_3 = 1$

Figure 7 compares the impulse responses to a -2% capital quality shock under Basel II and III in the high-risk economy; the responses are around the risk-adjusted steady state. The response of stocks X is weaker under Basel III, starting already from a lower steady-state value, implying that banks recapitalize less in response to the shock. As a result, retained earnings N fall less. Interestingly, on impact the capital ratio behaves similarly under the two regulations; the effect of the counter-cyclical minimum capital ratio is evident in the medium run, as the capital ratio displays a more moderate increase. The stock price q drops on impact under Basel III in order to sufficiently reduce the return on equity R_X, whose risk-adjusted steady-state value is significantly lower in the presence of the counter-cyclical buffer. This forces banks to issue more stocks. Looking at bank variables, it is clear that Basel III regulation makes banks less vulnerable and more stable in response to unanticipated losses on their assets. In terms of implications for the macro-economy, however, the response of assets, loans and output under Basel III and II are practically identical. Keeping in mind that the steady-state levels of assets, loans, and output are lower under Basel III, the presence of a counter-cyclical minimum capital ratio fails to de-amplify the effects of the shock. The percentage point fall in loans, assets and output is the same. Since the required capital ratio falls in response to a capital quality shock under Basel III, in principle banks could cut loans by less and let their capital ratio fall. Our model predicts that Basel III regulation will not alter banks' incentive to reduce lending in response to a crisis. Hence, the Basel III reform makes banks more resilient to crises, but it does not affect the dynamic response of the denominator of the regulated ratio.

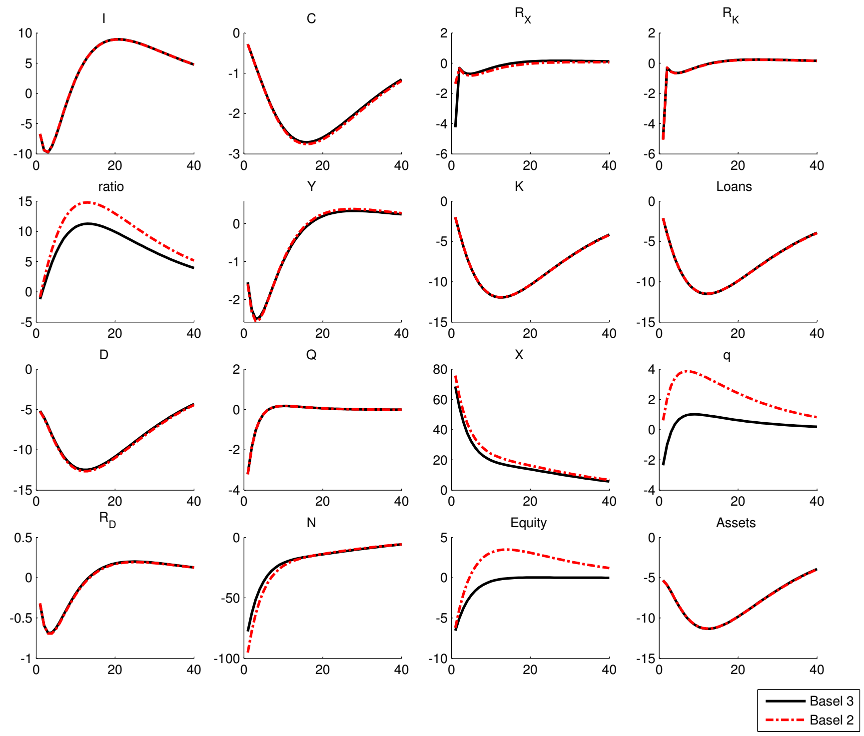


Figure 7: Impulse responses to a capital quality shock with high risk

10 Robustness

10.1 Penalty

As a first robustness exercise, we raise the value of the penalty ϕ from 0.065 (benchmark) to 0.0715 and then to 0.078, an increase of 10 and 20 percent, respectively. As ϕ increases the penalty becomes larger and it is costlier to have capital-to-asset ratios below the mandated level. In response to higher ϕ banks raise the steady-state capital ratios. For $\phi = 0.0715$ the risk-adjusted ratio is 9% and 9.06% (for low- and high-risk economies, respectively0 under Basel II and 10.21% and 10.3% under Basel III. These results suggest that banks will increase their capital ratios if the punishment (in terms of restrictions on discretionary bonus payments and capital distributions, increased monitoring, higher funding costs, etc.) of not doing so are high enough. However, the result that higher capital ratios are achieved by curtailing loans, i.e. reducing the denominator of the regulated ratio, not only remains but is even amplified as ϕ gets larger. Moving from Basel II to III implies a fall in assets by 8.7% for $\phi = 0.0715$ and by 9.7% for $\phi = 0.078$; the fall in output also increases by 2.7% to 3.06% and 3.41%. In line with our findings above, bank capital increases slightly, this increasing stemming from higher retained earnings and lower bank equity.

10.2 Role of γ_2

Here we analyze the effect of a higher value for the parameter γ_2, which captures the response of the minimum capital ratio to credit growth. With $\gamma_2 = 10$, a 25% reduction in credit brings the minimum capital ratio exactly at 8% while a 25% growth in credit raises the minimum capital to 13%. First we evaluate the cyclical properties of the economy. Table 19 compares the second moments of the model under Basel II and Basel III with $\gamma_2 = 3$ and 10; the second moments are calculated using the same underlying shocks. Since banks' need to tap into the equity market in time of stress is even lower, net income and retained earnings become less volatile. However, all other bank variables as well as output, consumption and investment become more volatile. Hence, there is a tradeoff in increasing the response of the minimum capital ratio to credit growth: on one hand, banks' net income becomes more stable; on the other hand, banks' balance sheet and the macro-economy become more volatile.

Table 19: **Second moments: robustness to γ_2**

	Basel III, $\gamma_2 = 3$			Basel III, $\gamma_2 = 10$		
Variable	Std	Corr Y	Corr C	Std	Corr Y	Corr C
Y	1.24	1	0.43	1.47	1	0.53
C	0.92	0.43	1	0.97	0.53	1
I	5.7	0.84	0.05	7.50	0.87	0.20
$Q \times S$	3.44	0.42	0.97	4.10	0.55	0.96
D	3.70	0.39	0.97	4.43	0.514	0.96
N	19.22	0.82	0.42	14.45	0.71	0.17
$q \times X + N$	1.43	0.82	0.53	2.30	0.80	0.49
$ratio$	2.8	-0.15	-0.92	3.32	-0.16	-0.84
R_X	124	0.08	-0.01	116.92	0.08	-0.03
R_D	46.44	-0.38	-0.22	46.11	-0.29	-0.18
$NetIncome$	205.38	0.25	0.08	77.15	0.19	-0.004
$Corr_t(\Lambda_{t,t+1}, R_{X,t+1})$	-0.3769			-0.4165		
$Corr_t(\Lambda_{t,t+1}\Omega_{t+1}, R_{X,t+1} - R_{D,t})$	-0.1464			-0.1954		
$Corr_t(\Lambda_{t,t+1}\Omega_{t+1}, N_{t+1})$	-0.2039			-0.3866		

Standard deviation expressed in percentage points

Figure 8 displays the impulse responses of our model under Basel 3 for γ_2 equal to 3 and 10. The higher value of γ_2 enables banks to reduce the capital ratio in response to a capital shock; because banks do not need to recapitalize when stock prices are low, the negative effect on net worth is smaller. However the spread, namely $E_t[R_{X,t+1} + \tau - R_{D,t} - \iota]$, goes up more so that loans and economic activity suffer more under $\gamma_2 = 10$.

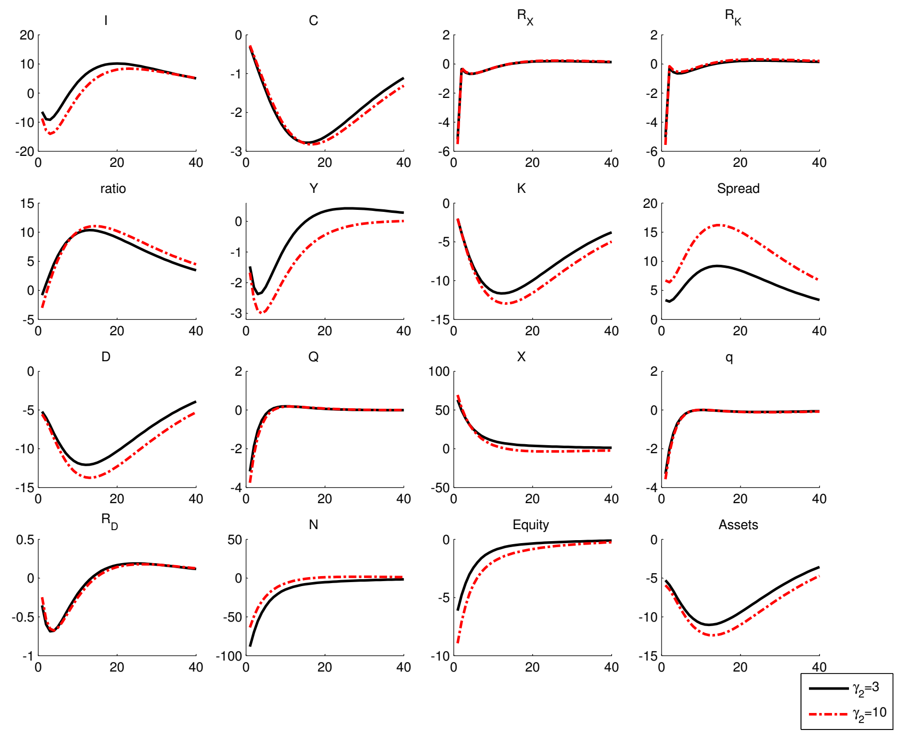


Figure 8: Impulse responses to a capital quality shock with low risk: $\gamma_2 = 3$ and $\gamma_2 = 10$

11 Conclusions

In this paper we analyze how the presence of bank capital requirements affects the composition of banks' balance sheets and how, in turn, this propagates to the real economy. First, in the empirical part of our paper we document that banks actively manage their capital ratios and hold capital that are well above the regulatory minimum requirement. We also show that cyclicality properties of the banking sector are driven by the large BHCs: bank assets and deposits are pro-cyclical while equity is acyclical, and bank capital-to-asset ratio is counter-cyclical. Our VAR analysis demonstrates that an increase in loan loss provisions reduces output, raises the corporate bond spread and the bank equity-to-asset ratio.

In the theoretical part, we develop a macroeconomic model where financial intermediaries are subject to an equity constraint along the lines of Basel II or Basel III. 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.

We use the model to evaluate the effects of proposed Basel III regulation that species a capital conservation and a counter-cyclical buffer for banks' equity-to-asset ratios. Our model predicts that the increase in the capital ratio mandated by Basel III is achieved primarily by a reduction in the denominator of the ratio, i.e. banks reduce their lending to the economy in order to achieve a higher capital-to-asset ratio. In terms of the numerator, the increase in bank capital is obtained by raising retained earnings at the expenses of bank equity, which actually falls going from Basel II to III. On the positive side, Basel III makes banks more resilient to shocks by reducing significantly the volatility of bank variables; as a consequence, the volatility of output and consumption is also reduced.

In future research we would like to extend our model by incorporating different asset classes into bank balance sheets to take into account various risk weights. Investigating how the pricing of different asset classes further influences the propagation of capital shocks will allow us to get a better picture of the current bank regulation. Also, in this version of the paper capital quality shock is modeled as an AR process, however in reality these shocks do not happen very frequently. So, modeling the capital shock with a Poisson process or a binomial distribution, might also improve the second order properties of our model.

We would also like to estimate the model because the empirical literature on financial intermediation and banking does not provide much guidance regarding the parameters used in DSGE models. Clearly, this is a drawback of current macro macro models and is a priority for future research.

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A Appendix

Table A.1: **Variable Definitions**

Variable	FR Y-9C Data Item	Explanation
Asset	BHCK2170	Total assets
Loan	BHCK2122 + BHCK2123	Total loans and leases
Liability	BHCK2948	Total liabilities and minority interest
Deposit	BHCK3517 + BHCK3404	Quarterly averages of interest-bearing deposits + Quarterly average of interest-bearing deposits in foreign offices, edge and agreement subsidiaries, and IBFs
Retained Earning	BHCK3247	Retained earnings
Equity	BHCK3210	Total equity capital
Stocks	BHCK3230 + BHCK3240	Common stock (par value) + Surplus (exclude all surplus related to preferred stock)
Net Interest Income	BHCK4074	Net interest income (Interest income - Interest expense)
Net Income	BHCK4340	Net Income
Average Asset	BHCK3368	Quarterly average of total assets
Average Equity	BHCK3519	Quarterly average of equity capital
Return on Average Asset	BHCK4340 / BHCK3368	
Return on Average Equity	BHCK4340 / BHCK3519	
Net Interest Margin	BHCK4074 / BHCK2170	
Loan Loss Provision	BHCK4230	Provision for loan and lease losses
Net Charge Off	BHCK4635 - BHCK4605	Charge-offs on allowance for loan and lease losses - Recoveries on allowance for loan and lease losses
Tier 1	BHCK8274	Tier 1 capital allowable under the risk-based capital guidelines
Tier 2	BHCK8275	Tier 2 capital allowable under the risk-based capital guidelines
RWA	BHCKA223	Risk-weighted assets (net of allowances and other deductions)
Regulatory Avg. Total Asset	BHCKA224	Average total assets (net of deductions)
Leverage Ratio	BHCK8274 / BHCKA224	

Table A.2: **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.3: **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.

Table A.4: **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.5: **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.6: **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.7: **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.8: **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.