The effects of bank capital on lending: What do we know, and what does it mean?

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Motivation

- The effect of changes in bank capital on the extension of bank credit has been one of the most critical financial-to-real linkage questions of the recent crisis.
  - Early in the crisis this question was central to calculating the effects of bank capital losses on bank lending (and activity).
  - Later, this question was key to calculating the effects on bank lending (and activity) of TARP-related capital injections.
- Theory only informs the *sign* of the effect of bank capital on lending, with many possible values for the *size*; specifically,
  - Zero, if banks can accommodate capital losses with no change in assets; or,
  - An amount equal to the leverage ratio, if banks manage assets to maintain a constant leverage ratio.
- The effect of bank capital on credit is ultimately an empirical question.

This paper (1)

- An active literature from the early-1990s developed models well suited to evaluating the effect of bank capital on loan growth. See, for example,
  - Bernanke and Lown (1991);
  - Hancock and Wilcox (1993, 1994); and,
  - Berger and Udell (1994).
- This paper draws on this literature, as well as more recent approaches, to:
  - Examine how bank capital affects bank lending; and,
  - Study the impact of TARP capital injections on U.S. bank lending.
- Our empirical analysis finds:
  - Relatively modest effects of bank capital on lending; and,
  - More notable roles for economic activity and bank's perception of borrower riskiness.

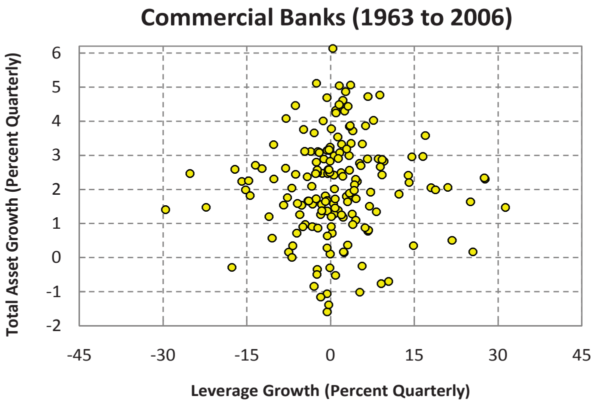
This paper (2)

- Our results suggest considerably smaller effects of TARP injections on lending relative to U.S. Treasury estimates.
  - Analysis for a panel of BHCs (who got $182 billion in TARP funds) suggests a $60 to $273 billion increase in loan volumes.
  - Analysis at the aggregate level for commercial banks (whose top-holders got about $250 billion in TARP funds) suggests a $300 billion increase in loan volumes.
- When discussing the likely effects on lending of capital injections and the anticipated capital raising of the stress tests, U.S. Treasury Secretary Geithner stated that:
  - "A dollar of capital generates between eight and twelve dollars of lending capacity." (See TG-95, April 21, 2009.)
- The U.S. Treasury estimates would therefore suggest a $1.5 to $3 trillion boost to lending stemming from TARP injections.
- Our results also provide an explanation for the notable slowing in loan growth over 2009 despite sizable capital injections.

An alternative – more prominent – view

- The constant leverage view has had a more significant influence on forecasters' and policymakers' perceptions as to the effect of bank capital on lending.
  - This view suggests that – because banks face difficulties raising equity – a \$1 capital loss reduces loan volumes by a dollar amount equal to the the leverage ratio (*i.e.*, about \$8 to \$12).
  - These effects of capital on lending are many times larger than our regression analysis finds.
- Hatzius (2007, 2008) relied on this assumption in considering the restraint on lending from bank capital losses.
- The U.S. Treasury *appears* to have relied on this assumption in estimating the effects of TARP injections on potential lending.
- The recent emphasis towards this view appears to be based on a scatterplot reported by Adrian and Shin (2007), which shows that commercial banks maintain constant leverage.

Total assets and leverage growth, commercial banks



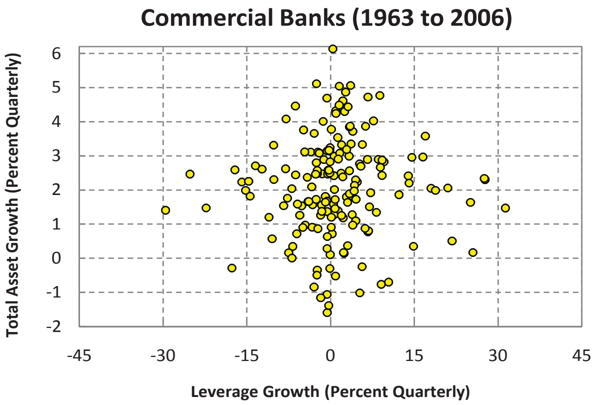
- Commercial banks appear to manage their assets to maintain a constant leverage ratio.
- How is this scatterplot reconciled with our regression results?

Go to: Total assets and leverage growth, all sectors.

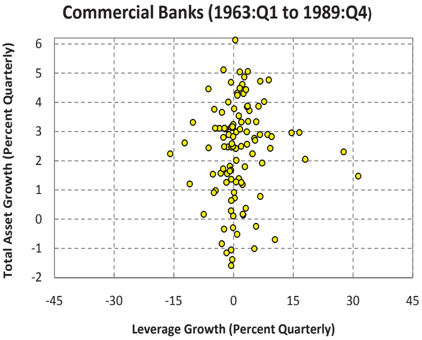
Reconciling our results

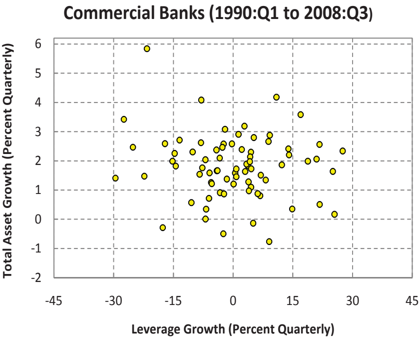
- What accounts for the difference between our results and the figure in Adrian and Shin (2007) is sample period.
- Adrian and Shin consider the sample 1963 to 2006.
- Our analysis starts in the early 1990s, reflecting the significant structural changes in banking stemming from:
  - The adoption of Basel I in the U.S. in the early 1990s; and,
  - The removal of Reg. Q and the episodes of disintermediation prior to the mid-1980s.
- There is *much* less evidence of commercial banks maintaining constant leverage ratios in later sample period.

Across the full sample period ...



Across different sample periods ...





- There is little evidence of banks maintaining constant leverage ratios in the post-1990 sample.

Outline

- Building on the early 1990s literature we first take a panel approach to consider the effect of bank capital on lending.
  - Our panel models are styled on the cross-section models of Bernanke & Lown (1991) and Hancock & Wilcox (1993, 1994).
- A concern with our panel-data analysis is survivor bias.
- Another concern is that it does not capture the general equilibrium channels of the effects of bank capital on lending.
- A vector auto regression model on aggregate data is one way to address such issues.
  - Here we use a variant of Lown & Morgan's (2006) VAR model.
- We then consider some policy questions; specifically,
  - The impact of TARP capital injections on U.S. bank lending; and,
  - The reasons for recent reductions in U.S. bank loan growth despite sizable capital injections.

Our panel regression approaches

- We model the loan growth of a panel of 154 large BHCs as functions of supply and demand factors (similar to Kashyap and Stein), with one of our supply factors being BHC capital:

$$
\begin{aligned}
\%\Delta loan_{i,t} = & \sum_{s=1}^{4} \alpha_s \cdot \%\Delta loan_{i,t-s} + \sum_{s=1}^{4} \gamma_s \cdot \%\Delta gdp_{t-s} + \sum_{s=1}^{4} \delta_s \cdot inf_{t-s} \\
& + \sum_{s=1}^{4} \beta_s \cdot \Delta rff_{t-s} + \sum_{s=1}^{4} \zeta_s \cdot std_{t-s} + \phi \cdot liqu_{i,t-1} + \chi \cdot chg_{i,t-1} \\
& + \psi \cdot \begin{cases} \textit{capital surplus/shortfall } (\widehat{Z}_{i,t}), \ \textit{or} \\ \textit{capital/assets ratio } (k_{i,t-1}) \end{cases} + \epsilon_{i,t}.
\end{aligned}
$$

- We consider two possible ways capital can affect loan growth:
  1. Via the BHC's capital surplus/shortfall from some target level, as calculated in an ancillary equation (Hancock & Wilcox); or
  2. Via the BHC's capital/assets ratio (Bernanke & Lown).

The surplus/shortfall approach (1)

We first derive the target capital-to-assets ratio.

- The target capital-to-assets ratio, $k^*_{i,t}$, is modeled as a linear function $\theta \cdot X_{i,t-1}$ of:
  - Bank-specific variables (such as, bank size, earnings, and risk);
  - Institutional variables (such as, regulatory pressure); and
  - Aggregate variables (such as, stock-market volatility and the aggregate net charge-off rate).
- The actual capital-to-assets ratio, $k_{i,t}$, adjusts slowly to its target: $k_{i,t} = \alpha + (1-\lambda) \cdot k_{i,t-1} + \lambda \cdot \theta \cdot X_{i,t-1} + \epsilon_{i,t}$.

Go to: Main estimation results from this step.

- Each BHC's estimated target capital-to-assets ratio is then: $\hat{k}^*_{i,t} = \hat{\theta} \cdot X_{i,t-1}$.

The surplus/shortfall approach (2)

We then calculate target capital and the capital shortfall/surplus.

- Target capital, $\widehat{K}^*_{i,t}$, is derived based on actual assets, $A_{i,t}$, and the estimated target capital-to-assets ratio, $\hat{k}^*_{i,t}$.
- The capital surplus/shortfall, $\widehat{Z}_{i,t}$, is $(K_{i,t} - \widehat{K}^*_{i,t})/\widehat{K}^*_{i,t}$

The capital surplus/shortfall, $\widehat{Z}_{i,t}$, is then included in the first version of our loan-growth regression:

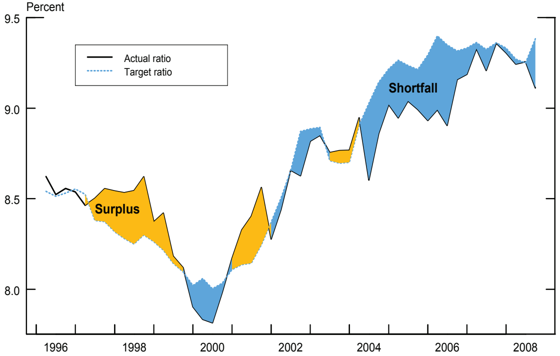
$$\begin{aligned}\%\Delta loan_{i,t} = & \sum_{s=1}^{4} \alpha_s \cdot \%\Delta loan_{i,t-s} + \sum_{s=1}^{4} \gamma_s \cdot \%\Delta gdp_{t-s} + \sum_{s=1}^{4} \delta_s \cdot inf_{t-s} \\ & + \sum_{s=1}^{4} \beta_s \cdot \Delta rff_{t-s} + \sum_{s=1}^{4} \zeta_s \cdot std_{t-s} + \phi \cdot liqu_{i,t-1} + \chi \cdot chg_{i,t-1} \\ & + \psi \cdot \widehat{Z}_{i,t} + \epsilon_{i,t}.\end{aligned}$$

Key results from the surplus/shortfall approach

- We find that a 1 p.p. shortfall in capital implies a 0.3 p.p. restraint in loan growth. This translates to:
  - A $1 shortfall in actual capital from target resulting in a $1.86 reduction in loans over the following year.
- This is a bit bigger than Hancock and Wilcox's (1993, 1994) finding that a $1 shortfall in capital from a bank's target results in a $1.50 reduction in loans over the following year.
- This is notably smaller than (*i.e.*, about one-quarter to one-sixth the size of) the $8 to $12 decrease that would obtain were banks to maintain a constant leverage ratio.
- We find a more notable role for:
  - Demand conditions (proxied by GDP growth); and,
  - Borrower risk (proxied by net charge-offs).

Go to: Estimation results.

Average actual and target capital-to-asset ratios



- Divergence between actual and target ratios are quite persistent.
- Divergence conforms to conventional wisdom; *i.e.*, the build-up of large surpluses in the 1990s.

- The capital surplus/shortfall approach is our preferred method for examining the effect of bank capital on lending.
  - However, it is vulnerable to our mis-specifying target capital.
- We therefore also consider the capital/assets ratio approach.

The capital-to-assets ratio approach

This approach has only one step; the estimation of the loan-growth regression now with the bank capital ratio, $k_{i,t}$:

$$\begin{aligned}\%\Delta loan_{i,t} = &\sum_{s=1}^{4}\alpha_s \cdot \%\Delta loan_{i,t-s} + \sum_{s=1}^{4}\gamma_s \cdot \%\Delta gdp_{t-s} + \sum_{s=1}^{4}\delta_s \cdot inf_{t-s} \\ &+ \sum_{s=1}^{4}\beta_s \cdot \Delta rff_{t-s} + \sum_{s=1}^{4}\zeta_s \cdot std_{t-s} + \phi \cdot liqu_{i,t-1} + \chi \cdot chg_{i,t-1} \\ &+ \psi \cdot k_{i,t-1} + \epsilon_{i,t}.\end{aligned}$$

We consider several measures of the capital-to-assets ratio:

- The equity capital-to-assets ratio;
- The total risk-based capital ratio;
- The tier-one risk-based capital ratio; and,
- The tangible common equity ratio.

Key results from the capital-to-assets ratio approach (1)

- We find that a 1 p.p. decrease in the capital-to-assets ratio restrains annualized loan growth 0.7 p.p. to 1.2 p.p.

- Bernanke's and Lown's (1991) found that a 1 p.p. decrease in the equity capital-to-assets ratio restrains annualized loan growth 2 p.p.; our estimate of 0.7 p.p. is a good bit smaller.

  - Bernanke's and Lown's bank-level analysis was on New Jersey banks, which are much smaller than the BHCs in our sample.

  - Bernanke's and Lown's model only included the capital ratio in their bank-level regressions, which could be capturing the effects of other bank-specific variables.

  - We do obtain a larger estimate of 1.5 p.p. when we perform a cross-section regression over the period 2007:Q3 to 2008:Q3.

Key results from the capital-to-assets ratio approach (2)

- Under the constant leverage assumption, the p.p. reduction in annualized bank lending growth implied by a 1 p.p. decrease in the capital-to-assets ratio is equal to the leverage ratio.
  - Both our results and those of Bernanke and Lown are notably smaller than the constant leverage assumption would imply.
- Our estimation results for other model variables are similar to those found for the surplus/shortfall equation; that is, more notable roles are found for:
  - Demand conditions (proxied by GDP growth); and,
  - Borrower risk (proxied by net charge-offs).

Go to: Estimation results.

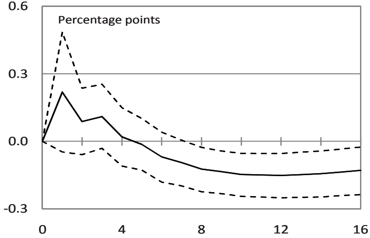
Go to: Addressing endogeneity.

The vector auto regression approach

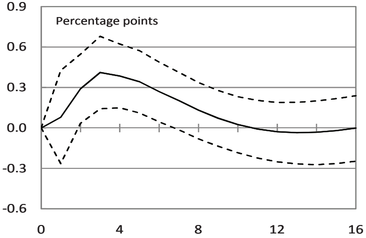
- We estimate a vector auto regression – similar to Lown & Morgan – consisting (in the following order) of:
  - Real GDP growth;
  - GDP price inflation (excluding food and energy);
  - The federal funds rate;
  - The growth rate in *commercial bank and thrift* lending from the FoF accounts;
  - The aggregate capital ratio of the *commercial bank* sector; and,
  - C&I lending standards from the SLOOS.
- We examine the response of loan growth to a capital ratio shock (for comparison with the panel results).
  - These shocks represent the component of changes in the capital ratio that are exogenous to other variables.

Response to a capital ratio shock (1)

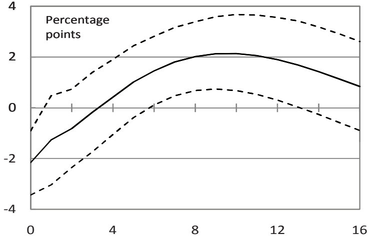
Response of output growth



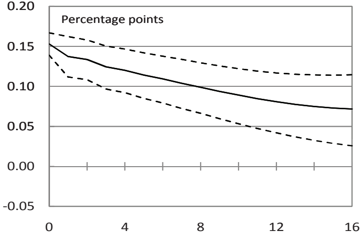
Response of loan growth



Response of standards

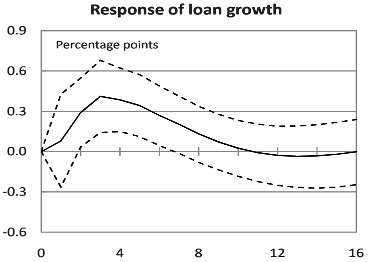


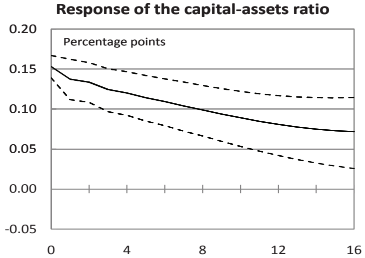
Response of the capital-assets ratio



Go to: Exploration of the output growth response.

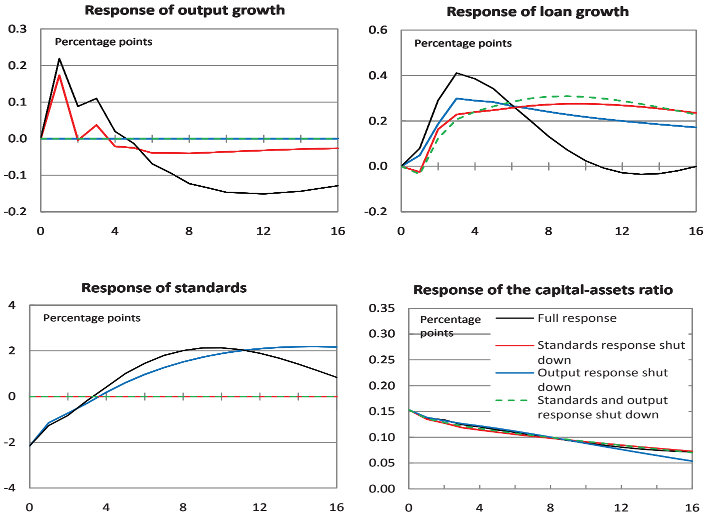
Response to a capital ratio shock (2)





- A 1 p.p. increase in the capital ratio $\Rightarrow$ a 2-1/2 p.p. boost to lending in the first year following the impetus.
  - This is four times larger than the effect found in the panel regressions.
- A larger effect in the VAR is not that surprising.
  - The VAR model is not susceptible to survivor bias.
  - Small banks are present in the VAR model's data.
  - The VAR model has endogenous responses of several variables.
- We can shut down the endogenous responses of standards and GDP growth (individually and together).

Response to a capital ratio shock (3)



- Without the standards and output responses a 1 p.p. increase in the capital ratio boosts loan growth 1-1/4 p.p.

Summary of regression results

- Our results indicate that capital-to-asset ratios affect lending much less than the constant leverage view would suggest.
- The constant leverage view suggests that the p.p. reduction in annualized lending growth implied by a 1 p.p. decrease in the capital-to-assets ratio is equal to the leverage ratio.
  - In our panel regressions: A $\downarrow$ 1 p.p. in the K/A ratio $\Rightarrow$ a $\downarrow$ 0.7 p.p. to 1.2 p.p. in loan growth.
  - In our VAR model (with endogenous feedback): A $\downarrow$ 1 p.p. in the K/A ratio $\Rightarrow$ a $\downarrow$ 2-1/2 p.p. in loan growth.
  - In our VAR model (without endogenous feedback): A $\downarrow$ 1 p.p. in the K/A ratio $\Rightarrow$ a $\downarrow$ 1-1/4 p.p. in loan growth.
- The constant leverage view suggests that the dollar reduction in lending implied by a $1 shortfall of capital from target is equal to the leverage ratio.
  - Our panel regressions suggest that a $1 capital shortfall results in a $1.86 reduction in lending.

The estimated impact of TARP capital injections (1)

The BHCs in our panel received \$182 billion in TARP funds. These TARP injections generated:

- A $\uparrow$14 p.p. in the capital surplus, thereby implying:
  - A $\uparrow$3.5 p.p. in annualized loan growth; and,
  - A $\uparrow$\$273 billion in the volume of loans.
- A $\uparrow$1.4 p.p. in the equity capital-to-assets ratio, thereby implying:
  - A $\uparrow$1.0 p.p. in annualized loan growth; and,
  - A $\uparrow$\$60 billion in the volume of loans.
- A $\uparrow$1.7 p.p. in the risk-based capital ratio, thereby implying:
  - A $\uparrow$1.4 p.p. in annualized loan growth; and,
  - A $\uparrow$\$86 billion in the volume of loans.

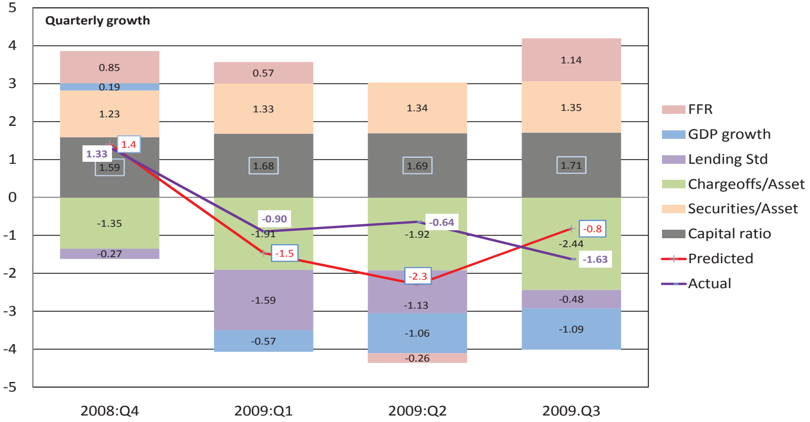
The estimated impact of TARP capital injections (2)

In the VAR model the \$250 billion in TARP funds injected into the banking system generated a $\uparrow$1.4 p.p. in the equity capital-to-assets ratio, thereby implying:

- A $\uparrow$3.7 p.p. annualized loan growth in the first year following the injection; and,
- An eventual $\uparrow$5 percent or $\uparrow$\$300 billion in loan volumes.

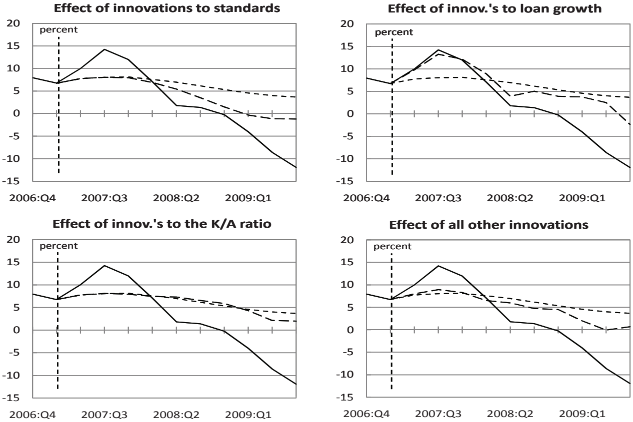
The panel and VAR estimates are small relative to the \$1.5 trillion to \$3 trillion increase in lending capacity suggested by the Treasury.

Decomposition of recent fluctuations in lending growth (1)



- The slowdown in BHC lending growth is:
  - Mostly accounted for by reduced demand, increased bank risk and tighter lending standards.
- These factors offset the positive impact of K/A ratio.

Decomposition of recent fluctuations in lending growth (2)



- The slowdown in commercial bank lending growth is:
  - Mostly accounted for by demand, standards, and own-variable innovations;
  - About one-fifth accounted for by K/A ratio innovations.

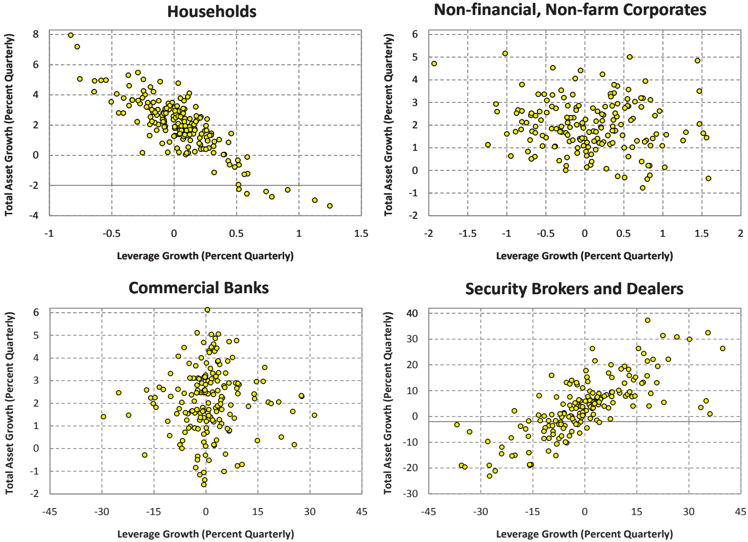
Summing up (1)

- This paper applies a number of different methods to examine how bank capital influences the extension of bank credit.
  - Our analysis based on panel data finds relatively modest effects of BHC capital on lending.
  - Macroeconomic time series and aggregate commercial bank balance sheet data finds larger – but still modest – effects of capital ratio shocks on loan growth.
- Our results are in contrast to the constant leverage view, which predicts changes in loan growth on the order six to fifteen times larger than our regression analysis finds.
- Our empirical results find more important roles for other factors such as economic activity and banks' perception of borrower riskiness.

Summing up (2)

- Our results provide one explanation for the notable slowing in loan growth over 2009 despite sizable capital injections.
  - Banks and BHCs give little consideration to their capital position when deciding whether to lend relative to loan demand and risk.
- Our results could also mean that existing measures of bank capital do not capture the "true" capital position of banks
  - This interpretation calls into question whether existing risk-based regulatory capital measures are valid and suggests that such measures need to be improved.

Total assets and leverage growth, all sectors



Go to: Total assets and leverage growth, commercial banks.

Results from the ancillary regression

- We find that BHCs with:
  - Greater size have higher capital ratios (***);
  - Greater portfolio diversification across different loan types and securities have lower capital ratios (***);
  - Higher individual (insig.) and aggregate net charge-off rates (***) have higher capital ratios;
  - Higher profits have higher capital ratios (insig.); and,
  - Greater regulatory pressure have lower capital ratios (insig.).

  In addition, higher stock market volatility (***) is associated with lower capital ratios (likely reflecting cyclical fluctuations).
- Although some coefficient signs differ from what might be expected, the implied target capital paths seem plausible and conforms to conventional wisdom.

Go to: Estimation results.   Go to: The surplus/shortfall approach (1).

Determinants of BHC capital-to-asset ratio targets

Dependent variable: BHC capital-to-asset ratio

	Model 1	Model 2
	Estimate	Estimate
Lagged capital ratio	0.9108***	0.9189***
Size	0.0931***	0.0778***
ROA	0.0356	0.0373*
Aggregate Volatility	-0.0053***	-0.0035***
C&I loan share	-0.0097***	
Real Estate loan share	-0.0065***	
Consumer Loan share	0.0001	
Securities share	-0.0059***	
Regulatory Pressure	-0.0260	-0.0159
Sector Chargeoff/Loan	0.1074**	0.0781**
Chargeoffs/Asset	0.0229	0.0094
R^2	0.852	0.870
N	8706	10512

Go to: Results from the ancillary regression. Go to: The surplus/shortfall approach (1).

Impact of capital surplus on BHC loan growth

Dependent variable: BHC Total loan growth

	Total Loans	C&I Loans
	Estimate	Estimate
Loan Growth Lags (sum)	0.1598***	0.0731
Surplus capital	0.0523***	0.0602***
Securities/Asset	0.0668***	0.0559**
Net Chargeoffs/Asset	-1.6177***	-1.6410***
Lending Standards (sum)	-0.0181***	-0.0274***
GDP Growth Lags (sum)	0.8562**	2.1685***
Fed Funds Lags (sum)	-0.4534	-0.0059
Inflation Lags (sum)	-0.1918	-1.7849
R^2	0.215	0.098
N	7793	7760

Go to: Key results from the surplus/shortfall approach.

Impact of capital-to-assets ratios on BHC loan growth

Dependent variable: BHC Total loan growth

	Equity to asset ratio	Risk-based Tier 1 ratio	TCE ratio
Loan growth lags (sum)	0.1648***	0.1571***	0.1743***
Capital ratio	0.1405***	0.1674***	0.2521***
Securities/asset	0.0556***	0.0421***	0.0498***
Net Chargeoffs/asset	-1.6835***	-1.8346***	-1.6832***
Lend. standards (sum)	-0.0135**	-0.0130***	-0.0131***
GDP growth lags (sum)	0.8628***	1.0684***	0.8508***
Fed. funds lags (sum)	-0.1164	-0.5696*	-0.1792
Inflation lags (sum)	-1.1988***	-0.3482	-0.7072
Within R^2	0.186	0.197	0.190
N	8549	6658	8549

Go to: Key results from the capital-to-assets ratio approach.

Addressing endogeneity in the panel regressions (1)

- We interpret ψ as reflecting the size of the increase in loan growth implied by a higher capital surplus or capital ratio.
- Doing this requires us to rule out other reasons for a relationship between BHC capital and loan growth.
- A positive correlation between BHC capital and loan growth may arise because both are correlated with economic activity.
  - Adding a direct measure of economic activity to the regression should absorb the predictive power of capital arising from this relationship.

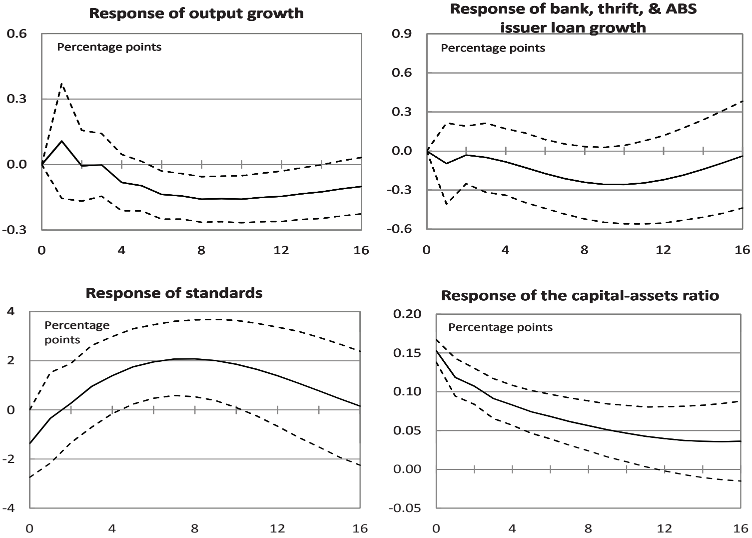
Go to: The vector auto regression approach.

Addressing endogeneity in the panel regressions (2)

- A positive correlation between capital and loan growth may also arise because BHCs build up capital in anticipation of an expansion in lending.
- If target capital is modeled correctly, the parameter ψ in the surplus/shortfall regression should not be affected by this relationship (as *both* target and actual capital would change).
- The parameter ψ in the capital-to-assets ratio regressions is potentially affected by this alternate relationship.
  - However, the bias is in the upward direction and our goal is to examine whether the constant leverage assumption overstates the effect of capital on loan growth.
  - Adding the dividend-to-net-income ratio to the regression appears to absorb some of this effect and lowers ψ slightly.

Go to: The vector auto regression approach.

Exploration of the output growth response



Go to: Response to a capital ratio shock (1).