Estimating the Impact of Shocks to Bank Capital in the Euro Area

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The views expressed do not necessarily represent the views of the EIB or ECB.

Motivation

The global financial crisis revealed a need for macroprudential policy tools to mitigate the build-up of risk in the financial system.

- As a consequence, macroprudential policy has been ramped up in many jurisdictions (including capital-based instruments, such as the CCB).
- In this context, the question is whether and to what extent changes in the capital buffers will affect bank lending, lending spreads and the broader macro-economy.
- Answering this question is not straightforward, as capital ratios are endogenous.
- Furthermore, the empirical evidence with the macroprudential use of such buffers is very thin, in particular in the euro area.
- As a consequence, the literature on the impact of shocks to bank capital can offer useful insights in order to assess the impact of macroprudential buffers on the banking sector and the economy at large.

What we do

We contribute to the empirical literature on the impact of shocks to bank capital in the euro area by estimating a Bayesian VAR model identified with sign restrictions.

- Starting point: standard workhorse VAR used extensively in monetary policy analysis extended to include aggregate banking sector variables.
- Relatively short estimation sample: model estimated with Bayesian techniques and DSGE priors (Del Negro and Schorfheide, 2004).
- The canonical DSGE model with a financial sector by Gertler and Karadi (2011) is used to generate moments for the Normal Inverse-Wishart prior of the VAR coefficients and variance-covariance matrix.
- The structural model is identified with sign restrictions (Rubio-Ramirez et al., 2010).
- We identify two shocks: demand shock and a shock to bank capital.

Results

1. Impulse-response analysis shows that in response to a shock in bank capital, banks boost capital ratios by reducing their relative exposure to riskier assets and by adjusting lending to a larger extent that they increase the level of capital and reserves per se.

2. Historical shock decomposition analysis shows that bank capital shocks have contributed to increase capital ratios since the crisis, hence impairing bank lending growth and contributing to widened bank lending spreads.

3. Counterfactual analysis shows that higher capital ratios pre-crisis would have helped dampening the euro area credit and business cycle.

Literature Review

Challenges related to Endogeneity Issues

- Identifying the impact of changes in bank capital on lending and the economy is challenging because bank capital is endogenous to bank lending and the macroeconomic environment

- Approaches in the Literature:
  1. **Isolate shocks originating outside banks on bank capital** (Bernanke and Lown (1991), Hancock et al. (1995), Peek and Rosengren (1997), Watanabe (2007), Mora and Logan (2012), Maurin and Toivanen (2012))
  2. **Isolate regulatory shocks to bank capital** (Peek and Rosengren (1997), Woo (2003), Francis and Osborne (2009), Aiyar et al. (2012), Bridges et al. (2014), Jimenez et al. (2016), Mesonnier and Monks (2014))
  3. **SVARs and GVARs** (Lown and Morgan (2006), Berrospide and Edge (2010), Noss and Toffano (2014), Meeks (2014), Groß et al. (2015))

Literature Review

Advantages of the methodology

- It does not require time varying, bank-by-bank regulatory capital requirements, which are only available in the euro area since 2015.
- This methodology allows also studying the dynamic interaction among banking variables and between these and macroeconomic variables, which has been largely neglected in the approaches mentioned before.
- Finally, this approach does not require identifying specific one-off events, which are difficult to generalise.

Econometric Model

The impact of bank capital shocks on the euro area economy is estimated based on the following VAR(p) model:

$$Y_t = C + B_1 Y_{t-1} + B_2 Y_{t-2} + \ldots + B_p Y_{t-p} + \vartheta_t \quad (2.1)$$

Where Y_t is an N-dimensional vector of endogenous variables at time t ($N = 9$), C denotes a vector of constants, B_p denotes the matrix of coefficients associated with the pth lag of Y_t and ϑ_t is a vector of residuals (reduced-form shocks) with the following properties:

$$\begin{aligned} \mathbb{E}[\vartheta_t \vartheta_s'] &= \Sigma \quad \text{if } t = s \\ \mathbb{E}[\vartheta_t \vartheta_s'] &= 0 \quad \text{if } t \neq s \\ \mathbb{E}[\vartheta_t] &= 0 \end{aligned}$$

Econometric Model

Equation (2.1) can be rewritten as a system of multivariate regressions, as follows:

$$Y = XB + V \tag{2.2}$$

We assume that the prior for the coefficient matrix B, conditional on Σ, is multivariate-normal:

$$p(B|\Sigma) \sim \mathcal{N}\left(\bar{B}_0, H\right) \tag{2.3}$$

where $H = \Sigma \otimes \bar{H}$ and $\bar{B}_0$ is a $(N(Np+1)) \times 1$ vector with the coefficient's prior mean. The conjugate prior for the VAR covariance matrix is an inverse Wishart distribution with prior scale matrix $\bar{S}$ and prior degrees of freedom α:

$$p(\Sigma) \sim \mathcal{IW}\left(\bar{S}, \alpha\right). \tag{2.4}$$

Econometric Model

DSGE-based Prior (Del Negro and Schorfheide (2004))

Basic Idea: use theoretical autocovariances Γ from a DSGE model to construct the moments for the normal and the inverse-Wishart distribution.

$$B^*(\theta) = \Gamma_{XX}^{-1}(\theta)\Gamma_{XY}(\theta) \quad (2.5)$$

$$\Sigma^*(\theta) = \Gamma_{YY}(\theta) - \Gamma_{YX}(\theta)\Gamma_{XX}^{-1}(\theta)\Gamma_{XY}(\theta) \quad (2.6)$$

Then, conditional on the parameter vector of the DSGE model and on the weight of the DSGE prior τ, the DSGE-based normal and inverse-Wishart distributions are given by:

$$vec(B)|\Sigma, \theta, \tau \sim \mathcal{N}\left(vec(B^*(\theta)), \Sigma \otimes [\tau T \Gamma_{XX}]^{-1}\right) \quad (2.7)$$

$$\Sigma|\theta, \tau \sim \mathcal{IW}\left(\tau T \Sigma^*(\theta), \tau T - Np - N\right) \quad (2.8)$$

The DSGE-prior weight τ can either be estimated or it can be calibrated. This hyperparameter measures the weight of the prior relative to the sample.

Details

DSGE model

Gertler and Karadi, (2011)

We derive the theoretical autocovariances from the Gertler-Karadi model.

- Standard quantitative macro-financial model in the literature.
- Out of our set of nine variables, there are six variables that have a close theoretical counterpart in Gertler and Karadi (2011).
- By contrast, in their model there is no theoretical counterpart for mortgage loans, mortgage spreads and capital and reserves.
- We include these three series in a VAR(p) reduced form.

Details

Variables included in the VAR

- **Policy interest rate**: Eonia (ECB)
- **Economic activity**: Y-o-Y growth rate of euro area real GDP (Eurostat)
- **Inflation**: Y-o-Y growth rate core HICP (Eurostat)
- **Bank lending volumes**: Y-o-Y growth rate bank lending to non-financial corporations and to households for house purchase (BSI)
- **Bank lending spreads**: difference between bank lending rates and Eonia (MIR)
- **Risk-weighted banks capital ratios**: median core tier 1 capital ratio of 51 listed banks (Datastream, back-cast with BSI prior to 2005Q1)
- **Bank capital accumulation**: Y-o-Y growth rate in capital and reserves (BSI)

Variables included in the VAR

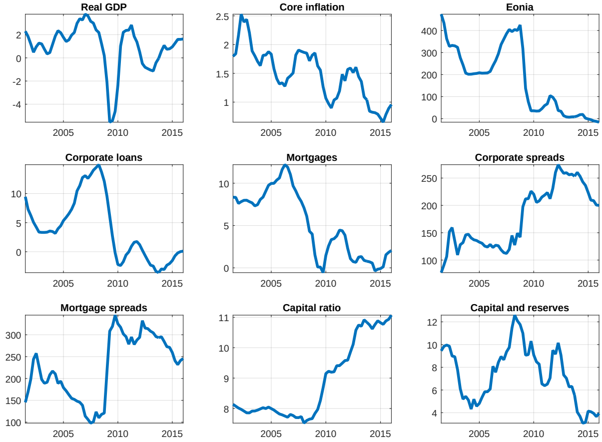

Figure 1: Variables included in the VAR

Identification Scheme

Demand versus Capital Shocks

We want to identify two shocks:

1. Demand Shock
2. Capital Shock

The shocks are identified with sign restrictions rather than via recursive identification.

All the restrictions are imposed on impact. Exception: inflation (one quarter lag; Angeloni et al., 2003).

Identification Scheme

Sign Restrictions

	Demand Shock	Bank Capital Shock
Real GDP	+	−
Core Inflation	+	−
Eonia Rate		
Corporate Loans	+	−
Mortgage Loans	+	−
Corporate Spread		+
Mortgage Spread		+
Capital Ratio		+
Capital & Reserves	+	+

Table 1: Sign restrictions enabling the identification of shocks to bank capital and demand

Details

Expected results

Estimating the impact of shocks to bank capital

We illustrate the impact of bank capital adjustment on the euro area economy based on three sets of results:

- First, we present the **estimated impulse response functions**.
- Second, we estimate the **historical contribution** of the two shocks to the evolution of the observables.
- Finally, we develop a **scenario** in which the capital ratio would have started to rise prior to the crisis and compute the associated response of the remaining variables in the VAR.

Impulse Response Analysis: Demand Shock

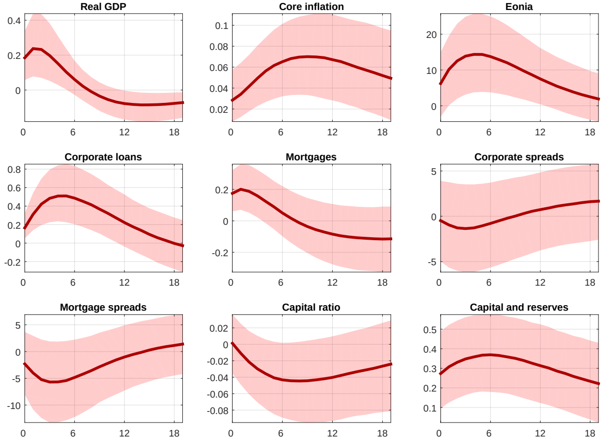

Figure 2: IRFs of endogenous variables to Demand Shock

Impulse Response Analysis: Capital Shock

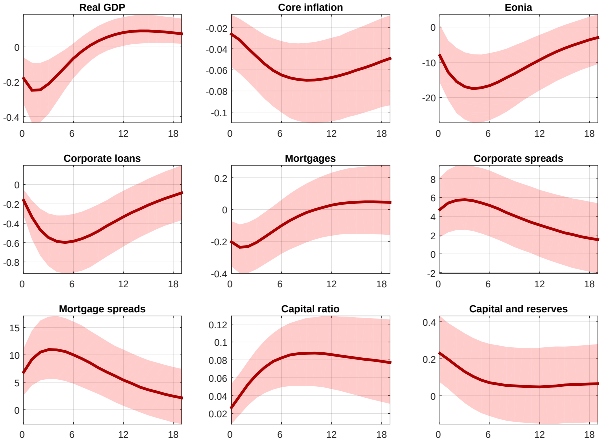

Figure 3: IRFs of endogenous variables to Capital Shock

Historical Decomposition

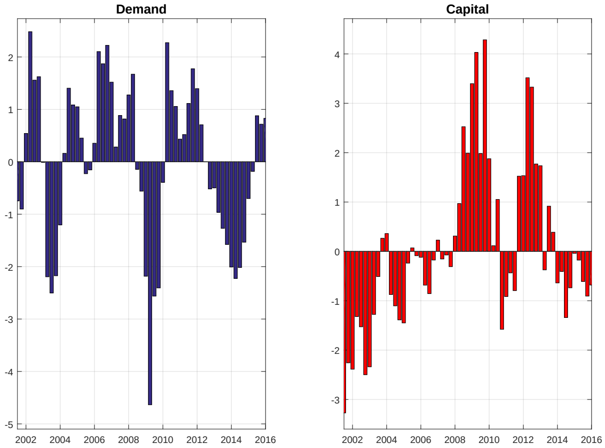

Figure 4: Estimated Structural Demand Shocks and Shocks to Bank Capital

Historical Decomposition

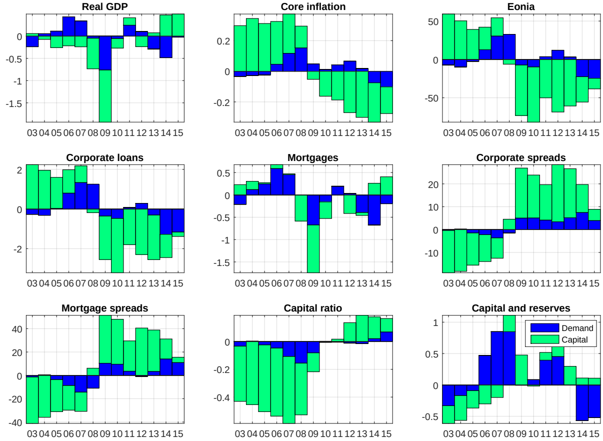

Figure 5: Contribution of Demand Shocks and Shocks to Bank Capital

Historical Decomposition

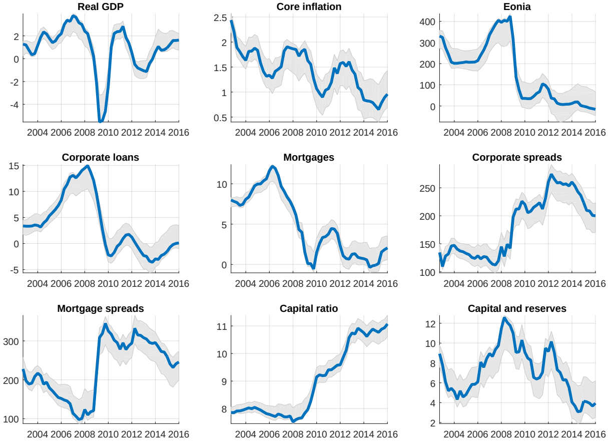

Figure 6: Counterfactual Evolution of the Variables with no Demand Shock

Historical Decomposition

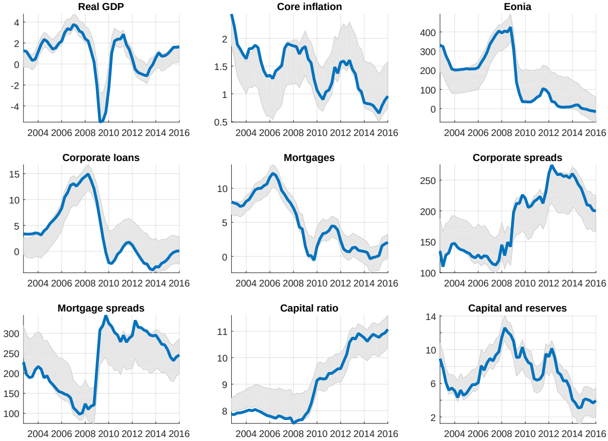

Figure 7: Counterfactual Evolution of the Variables with no Capital Shock

Scenario analysis

Scenario of Frontloading the Increase in the Capital Ratio prior to the Crisis

An explicit path for the capital ratio is assumed and the path for the remaining variables in the VAR is estimated, conditional on the evolution of the capital ratio:

- Starting in the first quarter of 2005 (capital ratio stood at about 8%), the ratio is assumed to increase proportionally during every quarter until the value observed in the first quarter of 2011 (about 9.4%).
- Higher capital ratios than those actually observed during this period.
- Increase in the capital ratio is assumed to take place at a time when the observed capital ratio was about to start falling.
- The path for the increase in the ratio contains the peak of the rate of growth of bank lending to households (mid-2006) and to corporations peaked (mid- 2008).
- This exercise could provide a quantitative illustration of the possible impact of the use of macro-prudential tools during the financial cycle.

Scenario of Frontloading the Increase in the Capital Ratio prior to the Crisis

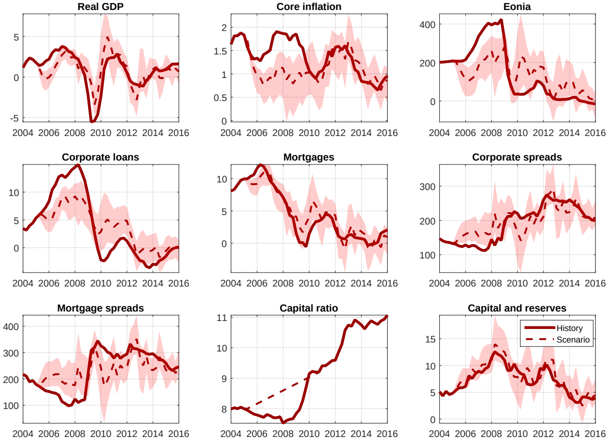

Figure 8: Counterfactual Evolution of the Variables Conditional on a New Path for the Capital Ratio

Conclusion

1. Impulse-response analysis shows that in response to a shock in bank capital, banks boost capital ratios by reducing their relative exposure to riskier assets and by adjusting lending to a larger extent that they increase the level of capital and reserves per se.

2. Historical shock decomposition analysis shows that bank capital shocks have contributed to increase capital ratios since the crisis, hence impairing bank lending growth and contributing to widened bank lending spreads.

3. Counterfactual analysis shows that higher capital ratios pre-crisis would have helped dampening the euro area credit and business cycle.

Thank you.

Details on Obtaining the DSGE Prior (Del Negro and Schorfheide (2004))

- We use the data on Output, Inflation, Interest Rates, Corp Spreads, Corp Loand and Capital and Reserves to estimate a version of Gertler and Karadi (2011) with six structural shocks: (i) technology, (ii) governm. spend, (iii) net worth shock, (iv) capital qualilty shock, (v) credit policy shock, (vi) monetary policy shock.
- We add three measurement errors and three variables in reduced form: Mortgage Loans, Mortgage Spreads and Capital & Reserves.
- We only estimate parameters associated with the shock, the three reduced-form equations and the optimal DSGE-prior weight τ, for the remaining parameters of the model we use standard calibrated values.
- As a byproduct of the Bayesian estimation of the parameter vector of the DSGE model θ, we obtain the theoretical autocovariances $\Gamma(\theta)$ which can be used to construct moments for the Normal and the Inverse-Wishart distribution.

return

Shock Identification

Implementation of Sign Restrictions

- Step 1: draw random matrix $K_{N \times N}$ from a multivariate standard normal distribution
- QR-decompose K such that

$$K = Q \cdot R, \qquad Q \cdot Q' = I$$

- Step 2: get $\tilde{A}_0$

$$\tilde{A}_0 = Q \cdot \hat{A}_0, \qquad \hat{A}_0 = chol(\Sigma)$$

- Step 3: update to get $\tilde{A}_0^{new}$
  - for every reduced form shock, assume unit shock, generate IRF and check if it is in line with contemporaneous and next periods sign restriction
  - if so, rearrange the rows of $\tilde{A}_0$ such that the rows corresponding to the reduced form shocks that met the restriction are moved to the top: $\rightarrow \tilde{A}_0^{new}$
- Step 4: obtain IRFs based on $\tilde{A}_0^{new}$

return