Breaking the Sovereign-Bank Nexus

Jorge Abad
<jorge.abad@cemfi.edu.es>

ECB conference on "Fiscal policy and EMU governance"
Frankfurt, December 2019

Motivation

"Our challenge in the euro area is to ensure that, when banks fail and the public sector has to intervene, it does not result in a recurrence of the sovereign-bank nexus."

– Draghi, 2014

Motivation

"Our challenge in the euro area is to ensure that, when banks fail and the public sector has to intervene, it does not result in a recurrence of the sovereign-bank nexus."

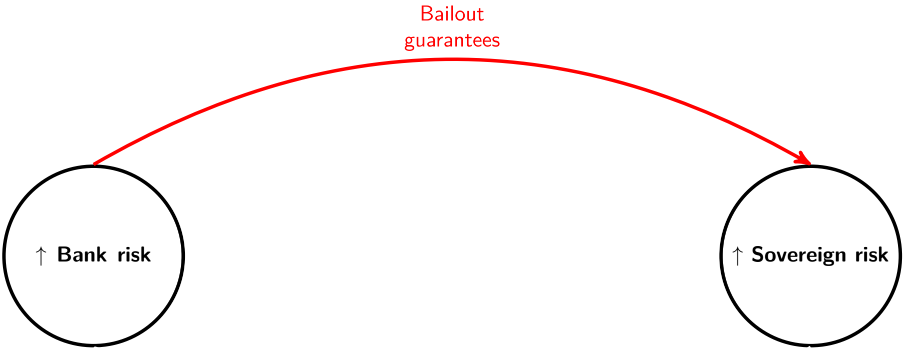
– Draghi, 2014

[Also referred to as *diabolic loop*, *doom loop* (Brunnermeier et al, 2016; Farhi, Tirole, 2018)]

The sovereign-bank nexus

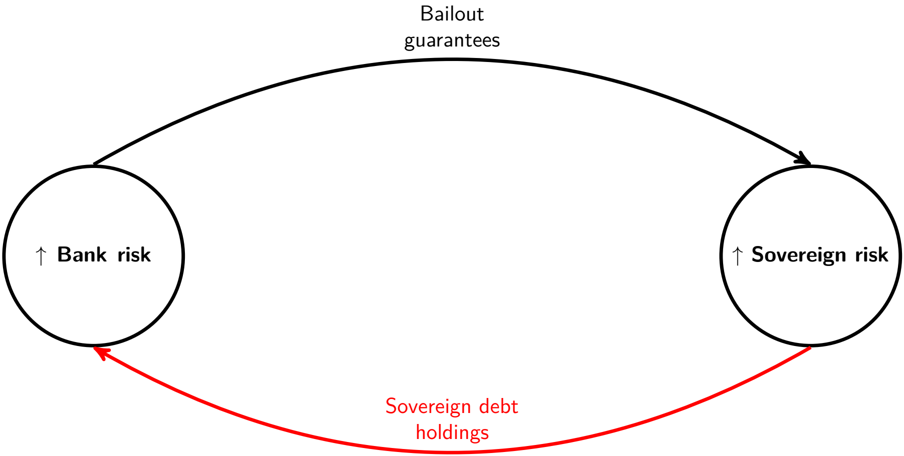
▸ Motivating evidence

The sovereign-bank nexus



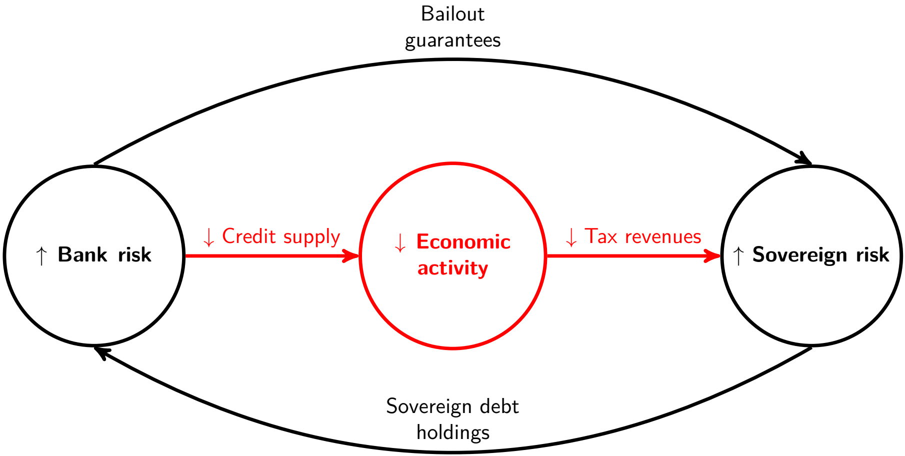
Motivating evidence

The sovereign-bank nexus



Motivating evidence

The sovereign-bank nexus



▸ Motivating evidence

This paper

- Dynamic macro model: focus on the interplay between bank failure risk and sovereign default risk
    - Bank risk: exposure to risky private sector assets and to risky sovereign debt
    - Sovereign risk: affected by bank risk through deposit insurance liabilities

This paper

- Dynamic macro model: focus on the interplay between bank failure risk and sovereign default risk
  - Bank risk: exposure to risky private sector assets and to risky sovereign debt
  - Sovereign risk: affected by bank risk through deposit insurance liabilities

- Quantitative account of the main mechanisms

  $\rightarrow$ Contribution of sovereign risk explains $\sim$60% of the drop in output during crises

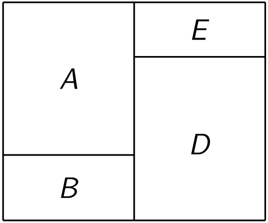
This paper

- Dynamic macro model: focus on the interplay between bank failure risk and sovereign default risk
  - Bank risk: exposure to risky private sector assets and to risky sovereign debt
  - Sovereign risk: affected by bank risk through deposit insurance liabilities
- Quantitative account of the main mechanisms

  $\rightarrow$ Contribution of sovereign risk explains $\sim$60% of the drop in output during crises
- Distortions associated with banks' risk-taking incentives provide a rationale for **capital regulation**

  $\rightarrow$ Optimal capital requirements can mitigate the negative effects of the nexus

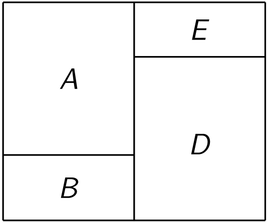
Regulatory framework



E: equity
D: deposits
B: sovereign bonds
A: other risky assets

Figure 1: A simplified bank balance sheet

Regulatory framework



E: equity
D: deposits
B: sovereign bonds
A: other risky assets

Figure 1: A simplified bank balance sheet

Bank capital regulation: $E \geq \gamma(A + \iota B)$

- A fraction γ of banks' risk-weighted assets has to be financed with equity
- Domestic sovereign bonds are treated as riskless (risk weight $\iota = 0$)

$\rightarrow$ Counterfactual analysis: what is the effect of changing ι and γ?

▸ Policy debate

Related literature

- Theoretical literature: Acharya, Drechsler, Schnabl (2014, JF); Gennaioli, Martin, Rossi (2014, JF); Brunnermeier et al (2016, AER); Cooper, Nikolov (2017, IER); Leonello (2018, JFE); Farhi, Tirole (2018, REStud)

  Contribution: Quantitative dynamic GE model of the sovereign-bank nexus

- Quantitative macro models with sov. default: Bocola (2016, JPE); Sosa-Padilla (2018, JME); Perez (2018); Arellano, Bai, Bocola (2019)

  Contribution: Explicit modelling of bank failure and associated distortions

- Financial crises and non-linearities: He, Krishnamurthy (2012, REStud); Brunnermeier, Sannikov (2014, AER); Gertler, Kiyotaki (2015, AER)
- Capital requirements in macro: Martinez-Miera, Suarez (2014); Mendicino et al. (2018, JMCB; forthcoming, JME); Elenev et al. (2018); Begenau (2019, JFE)

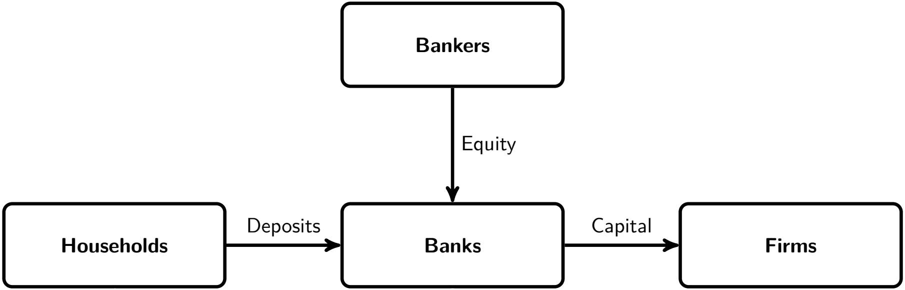
  Contribution: Feedback effects from sovereign risk

Additional references

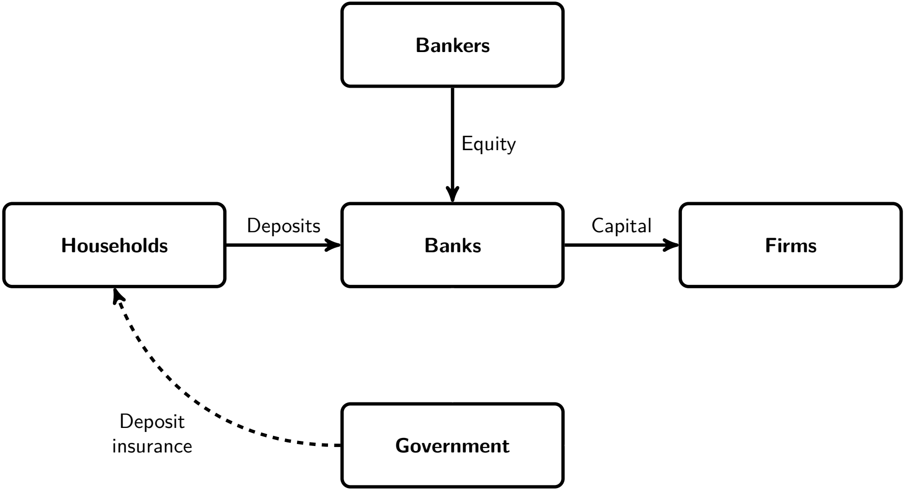
Overview of the model

Overview of the model

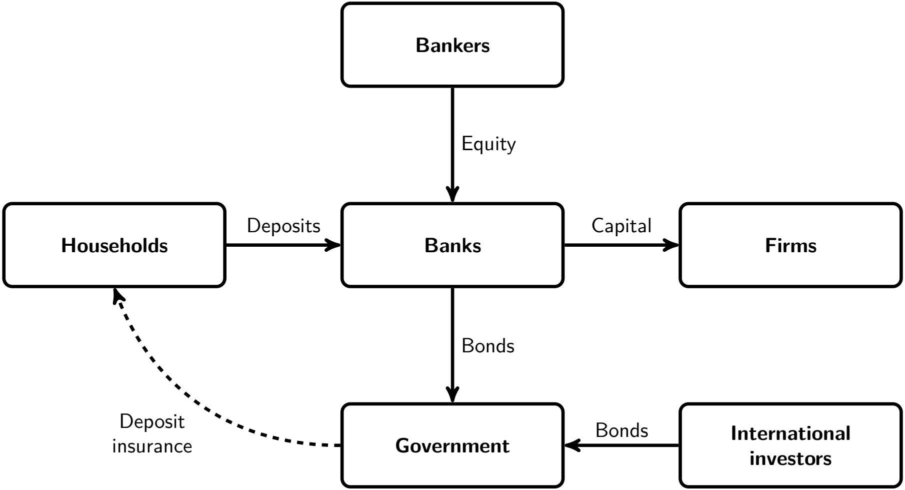
Overview of the model



Overview of the model



Overview of the model



Key ingredients

- Distortions associated with debt financing drive banks' risk taking:
    - Limited liability: banks' losses limited to their equity contribution
    - Opaque balance sheets + govt. guarantees: mispricing of risk at the margin

  $\rightarrow$ *Risk-shifting channel*

Key ingredients

- Distortions associated with debt financing drive banks' risk taking:
  - Limited liability: banks' losses limited to their equity contribution
  - Opaque balance sheets + govt. guarantees: mispricing of risk at the margin

  $\rightarrow$ *Risk-shifting channel*

- Capital regulation + limited participation in equity markets: bank intermediation is constrained by endogenous accumulation of capital

  $\rightarrow$ *Net worth channel*

Key ingredients

- Distortions associated with debt financing drive banks' risk taking:
  - Limited liability: banks' losses limited to their equity contribution
  - Opaque balance sheets + govt. guarantees: mispricing of risk at the margin

  $\rightarrow$ *Risk-shifting channel*

- Capital regulation + limited participation in equity markets: bank intermediation is constrained by endogenous accumulation of capital

  $\rightarrow$ *Net worth channel*

- Aggregate fluctuations driven by:
  - Exogenous shocks to sovereign and bank risk
  - Endogenous feedback between them through govt. bailout guarantees + banks' holdings of sovereign debt

Main mechanisms

1. An initial shock to the banking sector increases bank failure

Main mechanisms

1. An initial shock to the banking sector increases bank failure

2. Government debt goes up as a result of the bailout policy, raising default probability and sovereign bond yields

Main mechanisms

1. An initial shock to the banking sector increases bank failure
2. Government debt goes up as a result of the bailout policy, raising default probability and sovereign bond yields
3. Banks have incentives to increase their sovereign exposures (limited liability + high yields + zero risk weights)

Main mechanisms

1. An initial shock to the banking sector increases bank failure
2. Government debt goes up as a result of the bailout policy, raising default probability and sovereign bond yields
3. Banks have incentives to increase their sovereign exposures (limited liability + high yields + zero risk weights)
4. Higher riskiness increase bank funding costs, lowers banks' profitability, and decreases bank equity over time

Main mechanisms

1. An initial shock to the banking sector increases bank failure
2. Government debt goes up as a result of the bailout policy, raising default probability and sovereign bond yields
3. Banks have incentives to increase their sovereign exposures (limited liability + high yields + zero risk weights)
4. Higher riskiness increase bank funding costs, lowers banks' profitability, and decreases bank equity over time
5. Banks' constraints tighten and higher borrowing cost are translated to non-financial borrowers, depressing lending, investment and economic activity

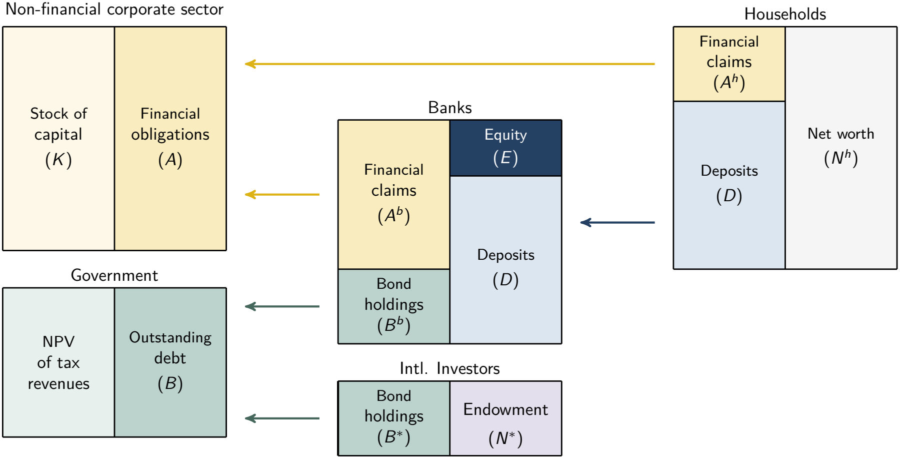
Quantitative analysis

- Global solution method (time iteration / policy function iteration) ▸ Details
- Calibration strategy
- Quantitative properties under the baseline parameterization
- Counterfactuals and policy analysis
    - Counterfactual 1: shutting down the amplification due to sovereign risk
    - Counterfactual 2: implications of bank capital requirements

Calibration strategy

- Pre-set parameters
  - Standard RBC macro parameters
  - Bank capital regulation (Basel II)
- Internally-calibrated parameters
  - Aggregate macroeconomic and financial data for Spain (1999-2018)
    - Consolidated sector financial accounts and cross-holdings of assets
    - Borrowing costs and asset returns

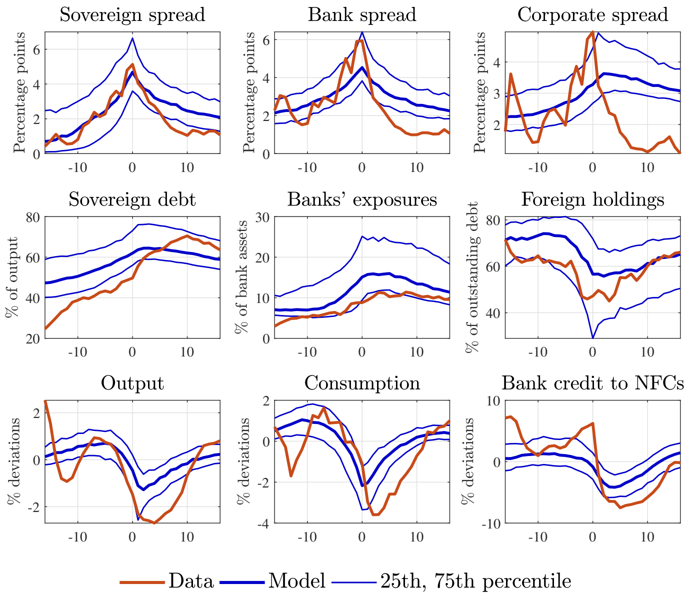
Balance sheets and flow of funds



Crisis event windows

- Simulate the model for 200,000 periods (discard first 1,000)
- Define a **crisis event** as a period with sovereign and bank spreads 2 standard deviations above unconditional mean
- Take 8-year windows centered around the period in which sov. spreads peak
- Compare median crisis (and 25th, 75th pctile) with Spanish data

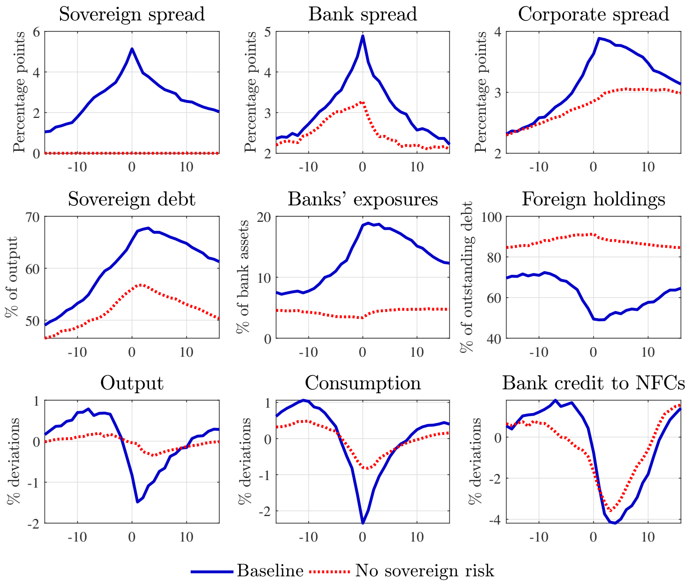
Crisis event windows



Counterfactual 1: shutting down sovereign risk

- What is the contribution of sovereign risk as an amplification mechanism?
- Counterfactual calibration: Sovereign debt is always risk free
- Plot crisis event windows under the same realization of shocks and compare with baseline model

Contribution of sovereign risk around crisis events



Counterfactual 2: Capital regulation

- What is the role of capital regulation?

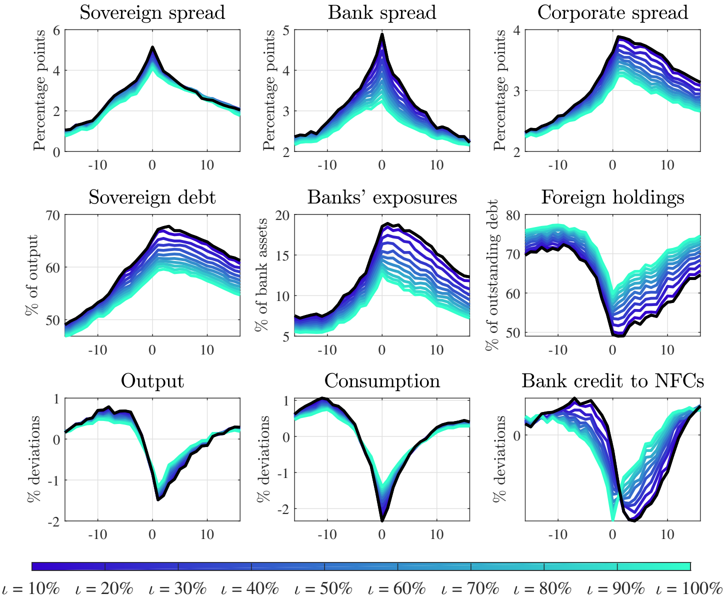
- Counterfactual calibration: $E_t \geq \gamma(A_t^b + \iota B_t^b)$

- Plot event windows under the same realization of shocks and compare with baseline model

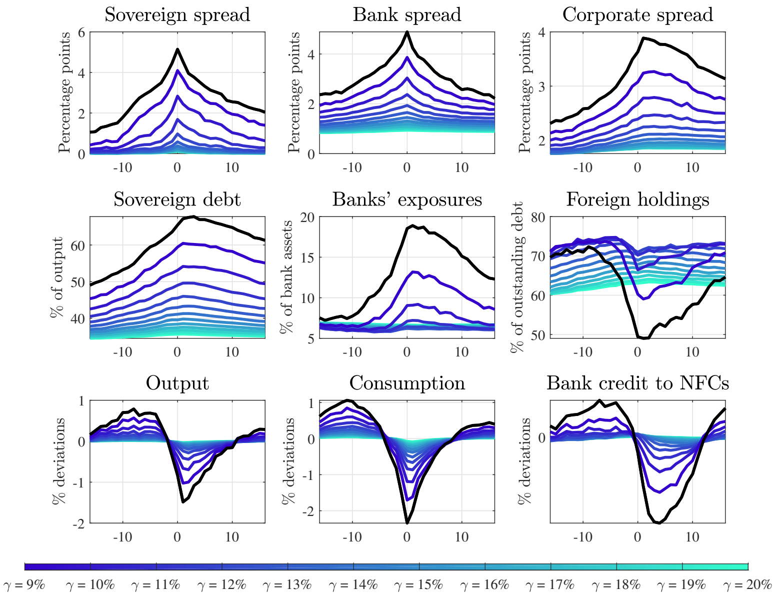
- Measure welfare gains $\rightarrow$ Optimal capital regulation

$$\mathcal{W}_0(\gamma, \iota) = \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t U(C_t; \gamma, \iota) \right]$$

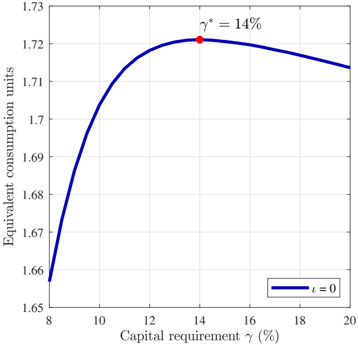
Effects of higher risk weight for sovereign exposures

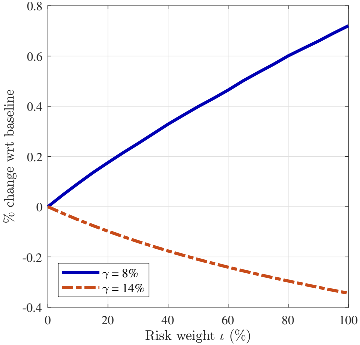


Effects of higher capital requirement

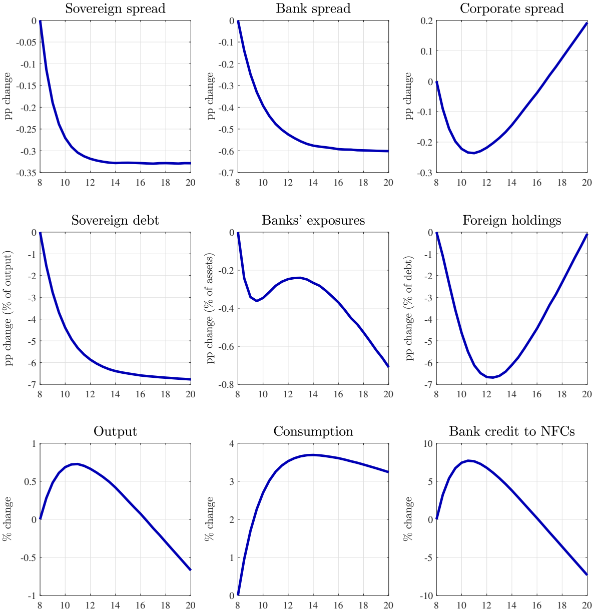


Welfare-maximizing capital regulation





Capital requirement - effect on unconditional means



Additional results

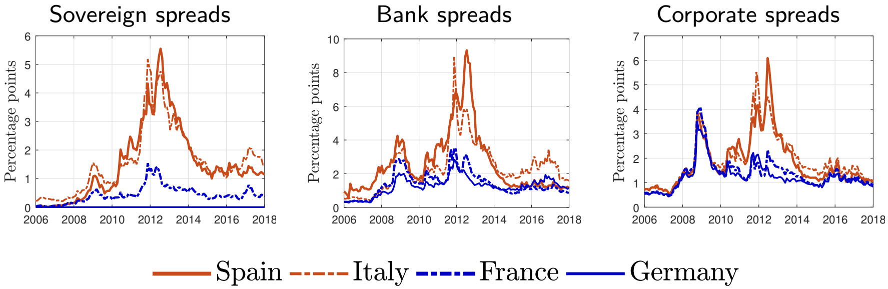
Concluding remarks

- Dynamic general equilibrium model of the sovereign-bank nexus
- Endogenous feedback effects between sovereign and bank risk
- Quantitative account of the mechanisms behind the nexus
- Bank failure and associated distortions provide a rationale for capital regulation
  - When leverage is high ($\gamma = 8\%$), positive risk weights are welfare improving
  - Optimal combination: higher requirements ($\gamma = 14\%$) with zero risk weights

Background materials

Motivating evidence: European sovereign debt crisis

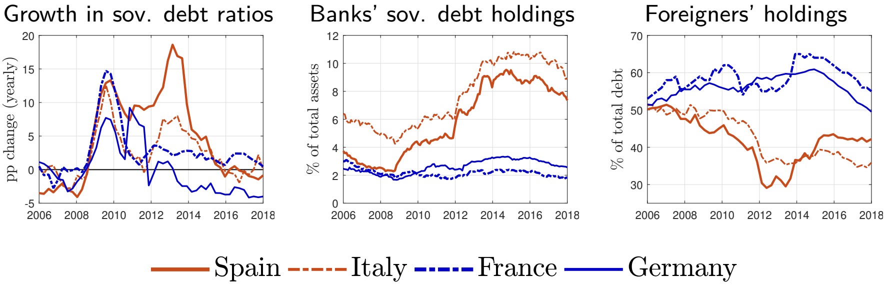
1. Widening of interest rate spreads in Euro periphery



Back to intro

Motivating evidence: European sovereign debt crisis

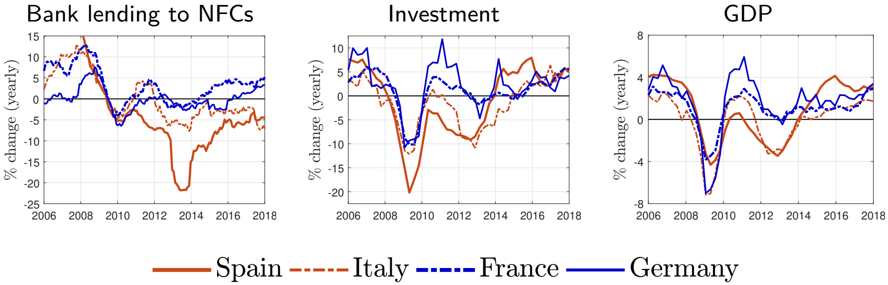
2. Accumulation of sovereign debt in hands of domestic banks



Back to intro

Motivating evidence: European sovereign debt crisis

3. Real consequences on the real economy



Back to intro

Motivating evidence and related literature

Fact 1

- Sovereign and bank spreads: Almeida et al (2017, JF)
- Sovereign spreads and economic activity: Bahaj (2019, JME)
- Bank and corporate spreads and economic activity: Gilchrist, Mojon (2018, EJ)

Fact 2

- Creditor discrimination: Broner, Erce, Martin, Ventura (2014, JME)
- Financial repression: Becker, Ivashina (2018, RF); Ongena, Popov, Van Horen (2019, AEJ:M); Acharya, Rajan (2013, RFS); Chari, Dovis, Kehoe (2019, JPE)
- Banks' risk-shifting: Acharya, Steffen (2015, JFE); Altavilla, Pagano, Simonelli (2017, RF); Crosignani (2017); Ari (2018)

Fact 3

- Sovereign shocks, bank credit supply, and real effects: Popov and Van Horen (2014, RF); Adelino and Ferreira (2016, RFS); Acharya et al (2018, RFS); Bofondi et al (2018, JEEA); Bottero et al (2018); De Marco (2019, JFQA)

Back to intro Back to literature review

Ongoing debate

"The current regulation's assumption that government bonds are risk-free has been dismissed by recent experience. The time is ripe to address the regulatory treatment of sovereign exposures. Without it, I see no reliable way of breaking the sovereign-banking nexus" (Weidmann, 2013)

"I doubt that further changes in prudential regulation are the right instrument for addressing the sovereign-bank nexus. The potential benefits of a reform are uncertain, while the potential costs could be sizeable." (Visco, 2016)

Back

Banks' liquidity management

As shown in Repullo and Suarez (2004):

- One-period, limited liability banks that can invest in two different risky assets would optimally specialize in one of them (two types of banks in equilibrium)
- ...unless there exist intermediation costs that imply some complementarity between the two assets
- Here: complementarity comes from different degrees of liquidity of each asset (maturity transformation of banks as in Diamond and Dybvig, 1983)

Role of government bonds in reducing banks' liquidity management costs:

- Assume banks receive a random stream of intra-period liquidity shocks
- Having access to a liquid asset (gov. bonds) allows banks to meet withdrawals without having to liquidate assets
- Liquidity role of public debt analyzed in the theoretical literature (Woodford, 1990; Holmstrom and Tirole, 1998)

Back

Pricing of deposits

- Banks are price-takers in the deposit market

  → Debt is mispriced at the margin: Negative externality of risk taking on other banks' funding costs

- Why?

  - Fungible nature of banks' assets
  - Access to funding from many sources and different markets, and in a sequential manner
  - Similar argument to Brunnermeier, Oehmke (2013) "*maturity rat race*"

Back

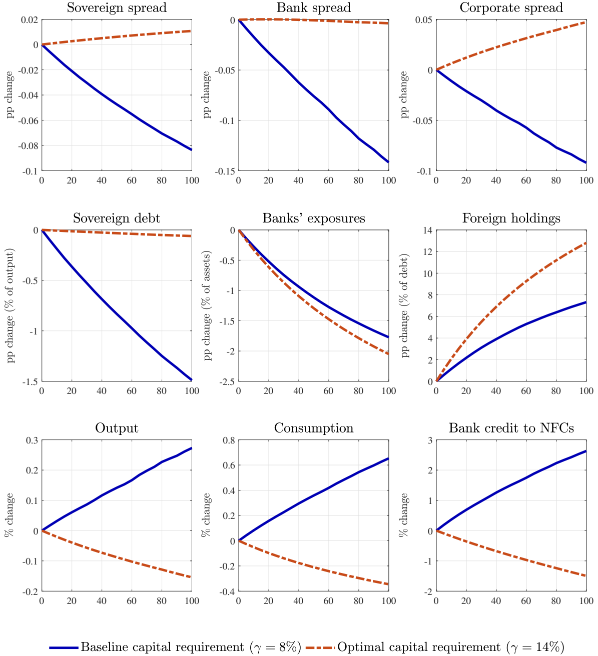
Opaque balance sheets

*"(In 2011), the **EBA** decided to give full and very granular **disclosure** of information on **individual banks' exposures to each sovereign**. Using the very granular information provided by the EBA, analysts calculated the capital position of each bank participating in the stress test when all sovereign exposures were valued at market prices. The first casualty was **Dexia**, which had **significant exposures** to sovereigns and municipalities in stressed countries. The bank started experiencing **difficulties in accessing market funding** and the liquidity problems led very fast to a crisis that quickly **drove the bank into resolution**."*

(Enria, Farkas and Overby, 2016)

Back

Risk weight - effect on unconditional means



Back

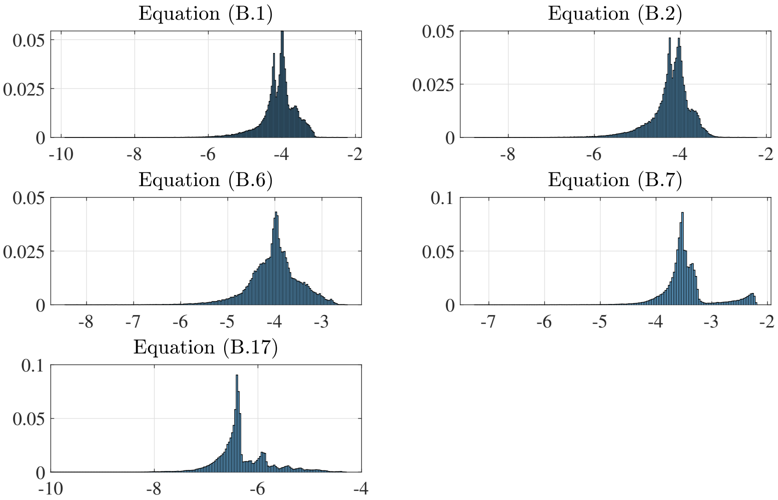
Solution method

Policy function iteration / time iteration (Coleman, 1990; Judd, 1996)

1. Initial step (*Set grid, initial policy and error tolerance*)
   - **1.1** Set equidistant grids for state variables S
   - **1.2** Discretize shocks using Rouwenhorst (1995) method
   - **1.3** Set guess policy functions $x(S)$
   - **1.4** Set error tolerance for time iteration $\bar{\epsilon} > 0$
2. Main step (*Update policy functions*)
   - **2.1** Solve for $t+1$ state S' given the current guess for the policy functions
   - **2.2** Compute time $t+1$ values of policy functions $x(S')$
   - **2.3** Find the values $\tilde{x}(S)$ that solve the system of equilibrium conditions
3. Final step (*Check error criterion*)
   - **3.1** Compute maximum error: $\epsilon = \max|x(S) - \tilde{x}(S)|$, for each policy $x(S)$
   - **3.2** Set $x(S) = \tilde{x}(S)$
   - **3.3** If $\max(\epsilon) < \bar{\epsilon}$, stop and report results; otherwise go back to step **2**.

Back

Solution accuracy



Back

Banks

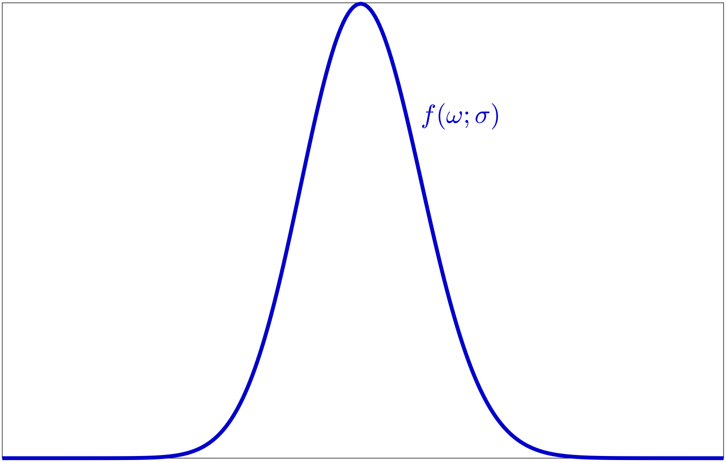
- Continuum of banks raise (partially insured) deposits D_t and equity E_t, and invest in claims to physical capital A_t^b and sovereign bonds B_t^b, to maximize:

$$\mathbb{E}_t[\Lambda_{t+1}^b \max\{\underbrace{\omega_{t+1} R_{t+1}^K A_t^b + \widetilde{R}_{t+1}^B B_t^b}_{\text{Asset returns}} - R_t^D D_t - \underbrace{m(D_t, B_t^b)}_{\substack{\text{Liquidity}\\ \text{mgmt cost}}}, 0\}] - v_t E_t$$

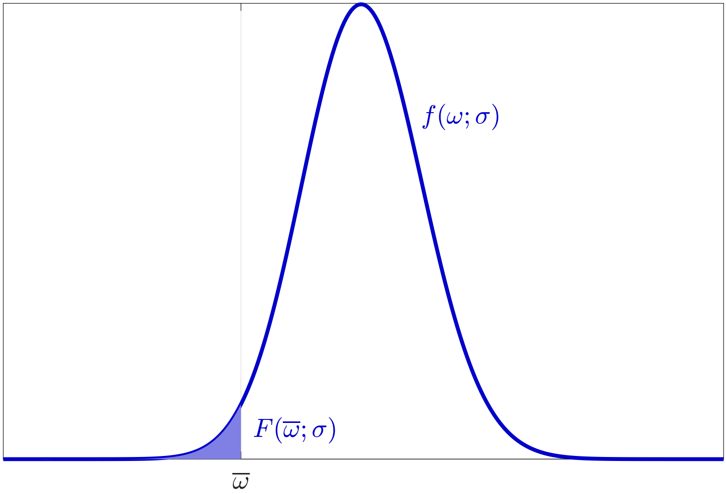
- Balance sheet constraint: $A_t^b + B_t^b = D_t + E_t$
- Regulatory capital requirement: $E_t \geq \gamma(A_t^b + \iota B_t^b)$
- Limited liability: banks with $\omega_{t+1} < \overline{\omega}_{t+1}$ default on their deposits

$$\overline{\omega}_{t+1} = \frac{R_t^D D_t + m(D_t, B_t^b) - \widetilde{R}_{t+1}^B B_t^b}{R_{t+1}^K A_t^b}$$

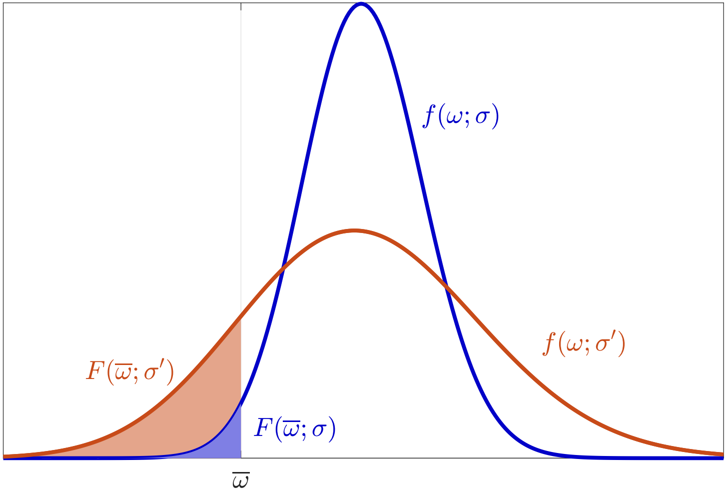
Bank risk shocks



Bank risk shocks



Bank risk shocks



$$\sigma' > \sigma \rightarrow F(\overline{\omega};\sigma') > F(\overline{\omega};\sigma)$$

Deposit insurance scheme

- The deposit insurance scheme takes over the assets of failed banks
- Asset repossession costs: fraction μ of the failed banks' assets
- Repays principal + promised return of insured deposits (and pays off to uninsured deposits the remaining fraction of reposed assets)

$$\Theta_t = \chi \left[\left(R^D_{t-1} D_{t-1} - \widetilde{R}^B_t B^b_{t-1} + m(D_t, B^b_t) \right) F_t - (1-\mu) R^K_t A^b_{t-1} \Gamma_t \right]$$

Deposit insurance scheme

- The deposit insurance scheme takes over the assets of failed banks
- Asset repossession costs: fraction μ of the failed banks' assets
- Repays principal + promised return of insured deposits (and pays off to uninsured deposits the remaining fraction of repossed assets)

$$\Theta_t = \chi \left[\left(R^D_{t-1} D_{t-1} - \widetilde{R}^B_t B^b_{t-1} + m(D_t, B^b_t) \right) F_t - (1-\mu) R^K_t A^b_{t-1} \Gamma_t \right]$$

$\rightarrow$ This burden on government finances feeds one side of the sovereign-bank nexus

Government

- Finances primary deficits by issuing one-period bonds (promised return R_t^B):

$$B_t = \underbrace{(1-\theta\xi_t)R_{t-1}^B}_{=\widetilde{R}_t^B} B_{t-1} + \underbrace{G_t - T_t + \Theta_t}_{\text{Primary deficit}}$$

- Default ($\xi_t = 1$) implies writing off a fraction θ of outstanding obligations

Government

- Finances primary deficits by issuing one-period bonds (promised return R_t^B):

$$B_t = \underbrace{(1-\theta\xi_t)R_{t-1}^B}_{=\widetilde{R}_t^B} B_{t-1} + \underbrace{G_t - T_t + \Theta_t}_{\text{Primary deficit}}$$

- Default ($\xi_t = 1$) implies writing off a fraction θ of outstanding obligations

- Fiscal limit as in Bi and Traum (2012) and Bocola (2016):

$$p_t \equiv \text{Prob}(\xi_{t+1} = 1 | B_t, s_t) = \frac{\exp(\eta_1 + \eta_2 B_t + s_t)}{1 + \exp(\eta_1 + \eta_2 B_t + s_t)},$$

where s_t is exogenous and follows an AR(1).

$\rightarrow$ $p_t > 0$ makes bank holdings of government debt risky, feeding the other side of the nexus

Government

- Finances primary deficits by issuing one-period bonds (promised return R_t^B):

$$B_t = \underbrace{(1-\theta\xi_t)R_{t-1}^B}_{=\widetilde{R}_t^B} B_{t-1} + \underbrace{G_t - T_t + \Theta_t}_{\text{Primary deficit}}$$

- Default ($\xi_t = 1$) implies writing off a fraction θ of outstanding obligations

- Fiscal limit as in Bi and Traum (2012) and Bocola (2016):

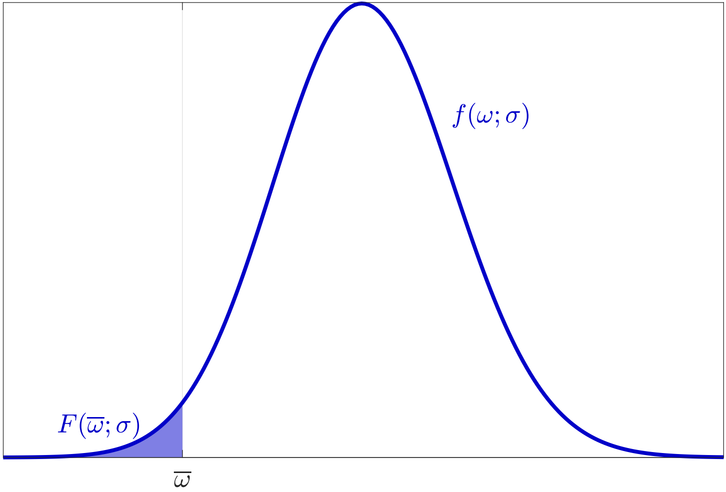
$$p_t \equiv \text{Prob}(\xi_{t+1} = 1 | B_t, s_t) = \frac{\exp(\eta_1 + \eta_2 B_t + s_t)}{1 + \exp(\eta_1 + \eta_2 B_t + s_t)},$$

  where s_t is exogenous and follows an AR(1).

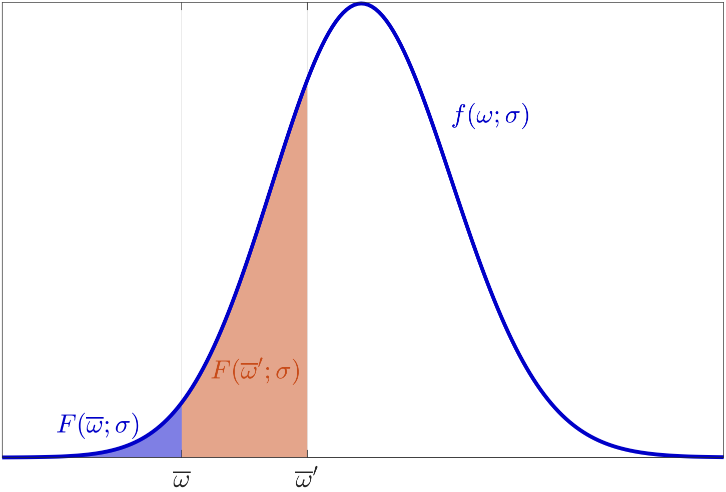
→ $p_t > 0$ makes bank holdings of government debt risky, feeding the other side of the nexus

- Spending rule: $G_t = g\overline{Y}$
- Tax rule: $T_t = \tau_y Y_t + \tau_b B_{t-1}$

Sovereign default and bank failure



Sovereign default and bank failure



$$\overline{\omega}_{t+1} = \frac{R_t^D D_t + m(D_t, B_t^b) - (1-\theta\xi_{t+1}) R_t^B B_t^b}{R_{t+1}^K A_t^b}$$