Sovereign Risk and Bank Balance Sheets: The Role of Macroprudential Policies

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The views expressed here should not be interpreted as reflecting the views of the Federal Reserve Board of Governors, any other person associated with the Federal Reserve System or the International Monetary Fund.
Motivation

- Banks are one of the major holders of government debt.
- They play a key role in financing investment projects.
- They face capital requirements.
- How do the changes in the riskiness of government debt affect banks’ decision to finance investment projects?
- How important are the capital requirements in transmitting the sovereign risk to a tightening in credit or vice versa?
Financial stress in Greece, Ireland, Italy, Portugal, and Spain (GIIPS) underscores the linkages between bank balance sheets and sovereign risk.

As the crisis deepened, government bond spreads have risen.

Banks have charged higher rates for loans to nonfinancial corporations.

They also cut back on lending.
Figure: Spreads on 10-year bonds
Figure: Loan Rates to Nonfinancial Corporations
Figure: Net Loans to Nonfinancial Corporations
Main Goal

- To build a unified framework of bank balance sheets and endogenous sovereign risk, which feature
  - A joint determination of sovereign debt and bank balance sheets,
  - A role for capital requirements in affecting macroeconomic fluctuations.
- Policy experiments on the effects of changes in macroprudential regulation.
Related Literature

- **Sovereign default:**
  - Theoretical models with financial sector: Bolton and Jeanne (2010), Gennaioli, Martin and Rossi (2010), among others.

- **Banking:**

- **The role of financial frictions:**
  - Financial shocks: Jerman and Quadrini (2010), among others.
Model Ingredients

- A representative household, a continuum of entrepreneurs/firms, a bank, a government and foreign investors.
- Bank intermediates resources between the household, entrepreneurs and the government.
  - It faces a capital requirement limiting the amount of lending.
- Firms’ technology is risky and they borrow from bank to fund working capital.
- Government issues bonds and cannot commit to repay.
- Household makes a constant amount of deposits to the bank, supplies labor, and consumes.
Representative Household

- Endowed with a unit of labor, $h_t$,
- Supplies labor at a wage rate, $w_t$,
  - A fraction of firms fail, so some members of the “family” do not get paid in full.
- Deposits a constant amount, $d$, every period,
- Receives bank and firm profits and transfers from the government, $T_t$. 
Household maximizes lifetime utility

$$E_0 \left[ \sum_{t=0}^{\infty} \beta^t \frac{\left( c_t - \frac{\chi_t h_t}{\eta} \right)^{1-\sigma}}{1 - \sigma} \right]$$

s.t.

$$c_t = \hat{w}_t h_t + D_t^b + D_t^f + T_t.$$
Objective function

\[ E_t \left[ \max \left\{ z_{t+1} h_t^\alpha - w_t h_t - r_t \ell_t^d, 0 \right\} \right] \]

Production technology

\[ f(z_{t+1}, h_t) = \begin{cases} 
  z_{t+1} h_t^\alpha & \text{with prob } p(z_{t+1}) \\
  0 & \text{with prob } 1 - p(z_{t+1}) 
\end{cases} \]

A fraction \( \theta \) of the total wage bill needs to be paid in advance:

\[ \theta w_t h_t \leq \ell_t^d \]
Banking Sector

- At the beginning of the period
  - Sources of funds:
    - Deposits, $d_t$
    - Government bonds due, $b_t$, if the sovereign does not default
    - New external funds, $-\tilde{s}_t$, at a cost $\phi(\tilde{s}_t)$: $\phi(s_t) = I_{s_t<0}[\phi_0(-s_t) + \phi_1 s_t^2]$
  - Uses of funds (st capital requirement is met):
    - Loans to firms, $\ell_t$
    - Government bond purchases, $b_{t+1}$, if the bond market is open
  - Feasibility constraint in case of no default:
    \[
    \tilde{s}_t = d_t + b_t - \ell_t - q_t b_{t+1}.
    \]

    If the government defaults:
    \[
    \tilde{s}_t = d_t - \ell_t.
    \]
Banking Sector

- At the end of the period $z_{t+1}$ and firm idiosyncratic shocks are realized
  - Receives returns on loans to firms,
  - Pays interest on deposits,
  - If the proceeds from its operations is positive, pay out dividends. Otherwise issue new shares, $-s$, at a cost $\phi(s)$

- Total net equity issuance:

  $$s_{t+1} = \tilde{s}_t + p(z_{t+1})(1 + r^\ell_t)\ell_t - (1 + r^d_t)d_t - \phi(\tilde{s}_t)$$

- Net payment to shareholders is

  $$D_{t+1} = s_{t+1} - \phi(s_{t+1}).$$
Bank is the dominant player in the domestic loan market.

- It is small and acts competitively in the sovereign debt market.
- Government provides deposit insurance; it is optimal for bank to drive the interest rate paid on deposits down to $r^d_t = r_t$. 
Banking Sector

\[
W^{d=0}(b, B, z) = \max_{\ell, b', \tilde{s}, s'} E \left[ D_b(s') + \tilde{R}^{-1} W(b', B', z') \right]
\]

s.t.

\[
\begin{align*}
\tilde{s} & = d + b - \ell - q(b', B', z)b', \\
e & = \ell - q(b', B', z)b' - d, \\
e & \ge \varphi (\ell + \omega b'), \\
s' & = \tilde{s} + p(z')(1 + r^\ell)\ell - (1 + r^d)d - \phi(\tilde{s}), \\
D_b(s') & = s' - \phi(s'), \\
\ell & = \ell^d(r^\ell)
\end{align*}
\]
$$W^{d=1}(z) = \max_{\ell, \tilde{s}, s'} E \left[ \mathcal{D}(s') + \tilde{R}^{-1} \left( \mu W^{d=0}(0, 0, z') + (1 - \mu) W^{d=1}(z') \right) \right]$$

s.t.

$$\tilde{s} = d - \ell,$$
$$e = \ell - d,$$
$$e \geq \varphi(\ell),$$
$$s' = \tilde{s} + p(z')(1 + r^\ell)\ell - (1 + r^d)d - \phi(\tilde{s}),$$
$$\mathcal{D}^b(s') = s' - \phi(s'),$$
$$\ell = \ell^d(r^\ell)$$

$$W(b', B', z') = D W^{d=1}(z') + (1 - D) W^{d=0}(b', B', z')$$
Government

- Is benevolent,
- Issues debt, $B_{t+1}$, at a discount price $q_t$,
- Transfers the proceeds as a lump-sum to the household sector.
- Debt contracts are not enforceable, so government might default.
- In case of default, the government remains in autarky for a stochastic period of time.
Default decision is given by:

\[ V(b, B, z) = \max_{d \in \{0, 1\}} \left\{ V^{d=0}(b, B, z), V^{d=1}(z) \right\}. \]
Government maximization

\[ V^{d=0}(b, B, z) = \max_{B'} E \beta \left\{ U(c', h^*) + V(b', B', z') \right\} \]

s.t.

\[
\begin{align*}
  c' &= p(z')z'(h^*)^\alpha + B - q(b', B', z)B' - \phi(\tilde{s}) - \phi(s') \\
  h^* &= h^*(r^{\ell,d=0}(b, B, z)) \\
  b' &= b'^{d=0}(b, B, z) \\
  \tilde{s} &= \tilde{s}^{d=0}(b, B, z) \\
  s' &= s'^{d=0}(z', b, B, z)
\end{align*}
\]
The value function under default:

\[ V^{d=1}(z) = E_\beta \left\{ U(c', h^*) + \left[ \mu V^{d=0}(0, 0, z') + (1 - \mu) V^{d=1}(z') \right] \right\}. \]

s.t.

\[
\begin{align*}
c' &= p(z') z'(h^*)^\alpha - \phi(\tilde{s}) - \phi(s') \\
h^* &= h^*(r^{\ell,d=1}(z)) \\
\tilde{s} &= \tilde{s}^{d=1}(z) \\
s' &= s'^{d=0}(z', z)
\end{align*}
\]
Domestic bank is small relative to the rest of the world, 

\[ q(b, B, z) = \frac{p(b, B, z)}{(1 + r)} \]

where \( p(\cdot) \) is the government's default probability.

Domestic bank is the only buyer, i.e., closed economy, 

\[ b + B = 0. \]
**Table: Holders of Sovereign Debt**

<table>
<thead>
<tr>
<th>Country</th>
<th>Domestic Banks</th>
<th>Residents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Banks</td>
<td>All</td>
</tr>
<tr>
<td>Italy</td>
<td>0.44</td>
<td>0.48</td>
</tr>
<tr>
<td>Spain</td>
<td>0.77</td>
<td>0.55</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.18</td>
<td>0.14</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.35</td>
<td>-</td>
</tr>
<tr>
<td>Greece</td>
<td>0.52</td>
<td>-</td>
</tr>
</tbody>
</table>
Expected profits on a loan of size $B_{t+1}$ at price $q_t$ are equal to

$$\Omega_t = -q_t(-B_{t+1}) + \frac{(1 - p_t)}{(1 + r)}(-B_{t+1}).$$

$p_t$: the expected probability of government default in period $t$. 
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Notation</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk aversion</td>
<td>$\sigma$</td>
<td>2</td>
</tr>
<tr>
<td>Discount factor</td>
<td>$\beta$</td>
<td>0.98</td>
</tr>
<tr>
<td>Reentry probability</td>
<td>$\mu$</td>
<td>0.10</td>
</tr>
<tr>
<td>Risk free interest rate</td>
<td>$r_f$</td>
<td>0.010</td>
</tr>
<tr>
<td>Autocorrelation of TFP</td>
<td>$\rho$</td>
<td>0.692</td>
</tr>
<tr>
<td>Standard deviation of TFP</td>
<td>$\sigma_\epsilon$</td>
<td>0.016</td>
</tr>
<tr>
<td>Curvature parameter of labor supply</td>
<td>$\eta$</td>
<td>1.1</td>
</tr>
<tr>
<td>Labor share in output</td>
<td>$\alpha$</td>
<td>0.90</td>
</tr>
<tr>
<td>Capital requirement</td>
<td>$\varphi$</td>
<td>0.04</td>
</tr>
<tr>
<td>Working capital constraint</td>
<td>$\theta$</td>
<td>0.3</td>
</tr>
<tr>
<td>Deposits</td>
<td>$d$</td>
<td>0.4</td>
</tr>
</tbody>
</table>
Table: Experiments on the Capital Requirement

<table>
<thead>
<tr>
<th></th>
<th>$\varphi = -\infty$</th>
<th>$\varphi = 0.04$</th>
<th>$\varphi = 0.10$</th>
<th>$\varphi = 0.40$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E[b]$</td>
<td>0.006</td>
<td>0.009</td>
<td>0.013</td>
<td>0.144</td>
</tr>
<tr>
<td>$E\left[\frac{\ell}{\ell + qb'}\right]$</td>
<td>0.986</td>
<td>0.982</td>
<td>0.972</td>
<td>0.757</td>
</tr>
<tr>
<td>$E[\ell]$</td>
<td>1.171</td>
<td>1.166</td>
<td>1.156</td>
<td>1.159</td>
</tr>
<tr>
<td>$E[c]$</td>
<td>2.122</td>
<td>2.131</td>
<td>2.149</td>
<td>2.145</td>
</tr>
<tr>
<td>$\sigma(c)$</td>
<td>0.160</td>
<td>0.149</td>
<td>0.139</td>
<td>0.161</td>
</tr>
</tbody>
</table>
Bank balance sheet and sovereign default risk interaction is at the core of the problems in GIIPS.

We build a quantitative model featuring this interaction and capturing the role of capital requirements on aggregate fluctuations.

Preliminary results show that the model captures some of the salient features of the behavior of bank loans and banks holdings of government debt.

The results also shed light on the role of capital requirements.

Work in progress...

- Study counterfactuals, i.e. risk weighted assets vs total leverage.