Sovereign Debt, Bail-Outs and Contagion in a Monetary Union

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Motivation

Government bond spread (% points)

- Greece
- Italy
- Portugal
- Spain

Euro introduction
Greek crisis

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Research question(s)

One of the key properties of the Euro-zone sovereign-debt crisis episode is the sudden surge in sovereign-debt spreads in Southern Europe by the time of the Greek debt crisis.

Questions:

- What explains the surge in spreads after the Greek crises?
- Why did we observe a contagion of interest-rate rise to some countries with sound fundamentals - such as Portugal?
- What induced the interest rates to converge in the first place and what kept them low for so long?
What we do

- First, a simple theory of sovereign debt and default in a monetary union with ...
  
i. **Key assumption**: A defaulting country must exit the monetary union, unless bailed out.

  ii. Explicitly analyze the bail-out decision within a monetary union, which attaches values to the continued-membership of countries.

  iii. The value function exhibits an Increasing Returns to Scale property (first-exit has disproportionately big hit on the union value).

- Second, incorporate this theoretical structure into an otherwise standard small-open economy DSGE framework, calibrate it for Portugal and investigate an EMU scenario.
Preview of results and the key mechanism

1. Implicit bail-out guarantees (within the union) eliminate interest rate spreads.

2. A crisis in one country causes contagion (through lowering implicit bail-out guarantees extended to other countries).

3. Contagion causes a deep and prolonged recession (similar to the European experience).

4. Mechanism:
1. In normal times unlikely to see multiple defaults,

2. Costs associated with \textit{first-exit} too high to allow exit,

3. When one country in trouble, the next one will be considered jointly ⇒ \textit{first-exit premium} divided,

4. Implicit bail-out guarantee for a sound, but indebted country may disappear.
Stylized facts

1. Late 1990s (euro introduction) - gradual convergence of interest rates,

2. 1999-2008 (euro decade) - no spreads:
   - Insensitivity to fiscal variables
     e.g. Bernoth et al. (2012), Beirne and Fratzscher (2013),
   - Underpricing of risk
     e.g. Aizenman et al. (2013), Ghosh et al. (2013),

3. 2009-2010 (Greek crisis) - re-emergence of spreads in peripheral countries:
   - Contagion
     e.g. Mink and De Haan (2013), Ludwig (2014).
Sovereign debt

No arbitrage condition:

\[ 1 + r^* = (1 - p(B))(1 + r^G) + p(B)(1 - \theta)(1 + r^G), \]  

(1)

where

- \( r^* \) - risk-free interest rate (exogenous),
- \( r^G \) - interest rate on sovereign bonds,
- \( B \) - sovereign debt,
- \( p(B) \) - risk of default,
- \( \theta \) - expected losses for investors in case of a default.

\( r^G \) as a function of \( B \) and \( \theta \).
Two regimes:

1. **Stand-alone:**
   - no expectation of bail-out
   - high $\theta$
   - high interest rate, $r^G >> r^*$

2. **Cooperative:**
   - bail-out is expected
   - $\theta = 0$
   - low interest rate, $r^G = r^*$
Value of the union for the other countries:

\[ M(k) = \begin{cases} 
  m_0 + m_1 \cdot k & \text{if } k = N \\
  m_1 \cdot k & \text{if } k < N.
\end{cases} \tag{2} \]

- \( N \) - initial number of countries in the union,
- \( m_1 \) - intrinsic value of the country for the union,
- \( m_0 \) - first-exit effect.
Assumption:
A defaulting country exits the union, unless bailed out.

Explicit bail-out decision:

$$\tilde{\theta}(1 + r^G)B_t < M(N) - M(N - 1) = m_0 + m_1. \quad (3)$$

- $\tilde{\theta}(1 + r^G)B_t$: bail-out costs
- $M(N) - M(N - 1) = m_0 + m_1$: gains from bail-out
Prevailing regime

\[ \text{bail-out costs} \]

\[ m_0 + m_1 \]

CO regime

multiple equilibria

SA regime

BO^{SA}

BO^{CO}

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Contagion

- Country A (Greece) already in trouble,

- Potential bail-out decision for country B (e.g. Portugal) changes:
  1. if A got bailed out, then joint decision:
     \[
     \bar{\theta}(1 + r^G) (B^A + B^B) < M(N) - M(N - 2) = m_0 + 2m_1.
     \]
     - bail-out costs A & B
     - gains from bail-out
     
  2. if A exited:
     \[
     \bar{\theta}(1 + r^G)B^B < M(N - 1) - M(N - 2) = m_1.
     \]
     - bail-out costs B
     - gains from bail-out

(Eijffinger, Kobielarz & Uras 2015)
Contagion

\[ B_t = B = \bar{B} \]

\[ m_0 + m_1 \]

\[ m_1 \]

\[ \text{bail-out costs} \]
Contagion

\[ m_0 + m_1 \]

\[ B \]

\[ B_t \]

\[ B \]

\[ B \]

\[ B_0 \]

\[ B_1 \]

\[ B_2 \]

\[ B_3 \]

\[ BO^{SA} \]

\[ BO^{CO} \]

bail-out costs
Contagion - mechanism

- Bail-out request from A (Greece) $\rightarrow$ lower bail-out limit for country B,
- Key assumption: *first-exit* effect (credibility term),
- Regime switch: from CO to SA:
  - $\theta$: 0 to $\bar{\theta}$,
  - $r^G$: $r^*$ to $r^G(B) >> r^*$. 
Model

A standard SOE DSGE-model

- Households
- Firms
- Government

Innovations:

- Fiscal limit $\Rightarrow$ Sovereign default risk
- Explicit bail-out decision within the union
- Sovereign risk channel in private interest rates
Households

Maximize expected lifetime utility

\[ \max E_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{1-\sigma} (c_t - \chi l_t^\nu)^{1-\sigma}, \]  

subject to

- capital accumulation:

\[ k_{t+1} = (1 - \delta) k_t + i_t, \]  

- budget constraint:

\[ c_t + i_t + \Phi(k_{t+1} - k_t) + (1 + r_{t-1}^H) b_{t-1} + \Psi(b_t) = b_t + w_t l_t + u_t k_t - T_t + G_t. \]
Production function:

\[ F(k, l) = Ak^\alpha l^{1-\alpha}, \]  

(9)

Face working capital constraint - have to borrow to pay for labor.

FOC’s:

\[ F_l(k, l) = \frac{w}{1 + r}, \]  

(10)

\[ F_k(k, l) = u. \]  

(11)
Government

Intertemporal budget constraint

\[ G_t + (1 + r_{t-1}^G)B_{t-1} = B_t + T_t, \]  

(12)

Reaction function for tax revenues:

\[ T_t = \tau Y \left[ \rho Y_t + (1 - \rho \bar{Y}) \bar{Y} \right] + \tau^B (B_{t-1} - \bar{B}), \]  

(13)

and constant expenditure \( G_t = \bar{G} \).
Following Bi(2012), default as a stochastic event. Probability of default:

\[ p(B_t) = P(B_t > B^*_t+1) = \frac{\exp(\eta_1 + \eta_2 B_t)}{1 + \exp(\eta_1 + \eta_2 B_t)}, \quad (14) \]

Sovereign interest rate:

\[ 1 + r^G_t = (1 + r^*) \left( 1 - \frac{\exp(\eta_1 + \eta_2 B_t)}{1 + \exp(\eta_1 + \eta_2 B_t)} \theta \right)^{-1}, \quad (15) \]

Private interest rates follow sovereign i.r.: \( r^H_t = r^G_t \).
Calibrated to the Portuguese economy

Two regime switches:
1. Euro introduction: SA $\Rightarrow$ CO
2. Greek crisis & contagion: CO $\Rightarrow$ SA

Fiscal policy:
1. Expansion at the beginning of crisis,
2. Strong austerity later (to prevent explosive dynamics).
## Calibration

<table>
<thead>
<tr>
<th><strong>Households</strong></th>
<th><strong>Government</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount factor</td>
<td>Steady state tax rate</td>
</tr>
<tr>
<td>$\beta = 0.95$</td>
<td>$\tau_Y = 0.40$</td>
</tr>
<tr>
<td>Utility curvature</td>
<td>Sensitivity of taxes to output</td>
</tr>
<tr>
<td>$\sigma = 5.00$</td>
<td>$\rho^T = 0.25$</td>
</tr>
<tr>
<td>Labor curvature</td>
<td>Tax responsiveness to debt</td>
</tr>
<tr>
<td>$\nu = 1.60$</td>
<td>$\tau^B = 0.25$</td>
</tr>
<tr>
<td>Relative weight of labor</td>
<td>Long-run government spending</td>
</tr>
<tr>
<td>$\chi = 2.48$</td>
<td>$\bar{G} = 0.36$</td>
</tr>
<tr>
<td>Depreciation rate of capital</td>
<td>Expected losses on bonds</td>
</tr>
<tr>
<td>$\delta = 0.10$</td>
<td>$\theta = 0.10$</td>
</tr>
<tr>
<td>Capital adjustment costs</td>
<td>Fiscal limit distribution</td>
</tr>
<tr>
<td>$\phi = 8.00$</td>
<td>$\eta_1 = -11$</td>
</tr>
<tr>
<td>Portfolio adjustment costs</td>
<td>World risk-free interest rate</td>
</tr>
<tr>
<td>$\psi = 0.50$</td>
<td>$r^* = 0.05$</td>
</tr>
</tbody>
</table>

| **Firms**                     |                                 |
| Technology parameter          | Effective capital share         |
| $A = 1.67$                    | $\alpha = 0.33$                 |
Simulation results

- Government Debt (% GDP)
- Interest rate spread (% points)

- Euro introduction
- Greek crisis


Diagram showing simulation results vs. data for government debt and interest rate spread.
Simulation results

![Graph showing output gap and employment over time](image)

**Output Gap (%)**
- Greek crisis: -10, -9, -8, -7, -6, -5, -4, -3, -2, -1, 0

**Employment**
- Greek crisis: 0.88, 0.90, 0.92, 0.94, 0.96, 0.98, 1.00, 1.02, 1.04

**Simulation** vs **Data**

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Dynamic bail-outs

- So far: static, one-time bail-out decision,

- Dynamic bail-outs:
  - part of the debt taken over by the union,
  - repaid gradually over $T$ periods,
  - continuation of the bail-out decision reconsidered every period,
  - endogenous, continuous probabilities of regimes.
Application - Draghi Effect

- On July 26, 2012 Mario Draghi (ECB President) stated: 
  "The ECB is ready to do whatever it takes to preserve the euro."

- Large reduction of spreads, but not full elimination.

- In our extended model:

  Draghi Speech $\Rightarrow m_0 \uparrow$
Dynamic bail-outs - preliminary results

- actual spreads
- simulated
- simulated + Draghi
Conclusions

- The simple theoretical model could explain the behavior of interest rates within EMU quite well,

- Spreads in the EMU driven by regime switches,

- Scope for contagion within the monetary union,

- Interconnectedness - a rationale for coordination and stricter rules.
Future Work

- Counterfactual policy analysis,
- Optimal bail-out rules in a MU,
- Contagion directions - which countries get affected,
- ...

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THANK YOU