Monetary Policy and Sovereign Debt Vulnerability

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Motivation: European debt crisis

- Legacy of 2007-9 financial crisis: large fiscal deficits and soaring government debt
- Before summer 2012, sovereign yields rose sharply in EMU periphery (GR, IR, IT, PT, SP) ...
  - ... but not in other highly indebted countries (US, UK, etc.)
- Many argue a key difference is: US-UK can deflate debt away, EMU periphery countries cannot
Motivation: role of monetary policy

• What role, if any, should monetary policy play in guaranteeing sovereign debt sustainability?

• Arguments for and against monetary policy involvement:
  • provide ‘monetary backstop’ against default fears
  • creating inflation also entails costs
  • effect on inflation expectations (and yields) if low monetary credibility

• This paper: analyze trade-offs between price stability and sovereign debt sustainability...
  • ... when gov’t cannot make credible commitments
Framework of analysis

- Small open-economy, continuous-time model
- Benevolent government issues *nominal* defaultable debt to foreign investors
- Gov’t may default on debt at any time
  - costs of default: exclusion from capital markets + output loss
- Government chooses fiscal (primary deficit) and monetary policy (inflation) under discretion
- Benefits and costs of inflation:
  - debt can be deflated away
  - direct welfare losses
Preview of results

- Calibrate to average peripheral EMU economy

- Analyze two monetary regimes:
  1. *inflationary regime*: benevolent gov’t chooses inflation discretionarily
  2. *no inflation regime*: zero inflation at all times

- In (2), government *gives up* option to deflate debt away
  - issue foreign currency debt
  - join monetary union with strong anti-inflation mandate

- **Main result**: Welfare is higher in *no inflation* regime, for any debt ratio and on average
Literature review

- Links between sovereign debt vulnerability and monetary policy

- Optimal fundamental sovereign default in quantitative models
  - Aguiar and Gopinath (2006), Arellano (2008), etc.

- Extend literature on continuous-time models of default to the pricing of defaultable nominal sovereign debt
The model: output, prices and debt

• Single consumption good with int’l price = 1. Exogenous output endowment,

\[ dY_t = \mu Y_t dt + \sigma Y_t dW_t. \]
The model: output, prices and debt

- Single consumption good with int’l price $= 1$. Exogenous output endowment,

$$dY_t = \mu Y_t dt + \sigma Y_t dW_t.$$ 

- Local currency price,

$$dP_t = \pi_t P_t dt.$$ 

The model: output, prices and debt

- Single consumption good with int’l price = 1. Exogenous output endowment,
  \[ dY_t = \mu Y_t dt + \sigma Y_t dW_t. \]
- Local currency price,
  \[ dP_t = \pi_t P_t dt. \]
- Sovereign debt,
  \[ dB_t = B_t^{\text{new}} dt - \lambda dtB_t. \]

\( \lambda \): amortization rate; fully held by foreign investors
The model: output, prices and debt

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• Government’s flow of funds

\[ Q_t B_t^{new} = (\lambda + \delta) B_t + P_t (C_t - Y_t). \]

\( \delta \): coupon rate
The state variable: debt-to-GDP ratio

- Debt-to-GDP ratio

\[ b_t \equiv \frac{B_t}{P_t Y_t} \]
The state variable: debt-to-GDP ratio

- Debt-to-GDP ratio

\[ b_t \equiv B_t / (P_t Y_t) \]

- Applying Itô’s lemma

\[
\begin{align*}
\text{db}_t &= \left[ \left( \frac{\lambda + \delta}{Q_t} - \lambda + \sigma^2 - \mu - \pi_t \right) b_t + \frac{c_t}{Q_t} \right] dt - \sigma_b t dW_t,
\end{align*}
\]

where

\[ c_t \equiv \frac{(C_t - Y_t)}{Y_t} \]

is primary deficit ratio
Preferences

- Household preferences,

\[
U_0 = \mathbb{E}_0 \left[ \int_0^\infty e^{-\rho t} \left( \log(C_t) - \frac{\psi}{2} \pi_t^2 \right) dt \right].
\]

\(\psi > 0\) : distaste for inflation, reduced-form \(\pi\)-disutility following Aguiar et al. (2013)
Preferences

- Household preferences,

\[ U_0 = \mathbb{E}_0 \left[ \int_0^\infty e^{-\rho t} \left( \log(C_t) - \frac{\psi}{2} \pi_t^2 \right) dt \right]. \]

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- Using \( C_t = (1 + c_t) Y_t \),

\[ U_0 = \mathbb{E}_0 \left[ \int_0^\infty e^{-\rho t} \left( \log(1 + c_t) - \frac{\psi}{2} \pi_t^2 \right) dt \right] + V_0^{aut}, \]

where \( V_0^{aut} = \mathbb{E}_0 \left[ \int_0^\infty e^{-\rho t} \log(Y_t) dt \right] \) is the (exogenous) autarky value.
Fiscal and monetary policy

- At each point in time, choose
  - default or continue repaying debt $\Leftrightarrow$ optimal *default threshold* $b^*$
  - primary deficit ratio ($c_t$), inflation rate ($\pi_t$)

under *discretion* (take investor’s pricing scheme $Q(b)$ as given)

- First analyze default scenario

- Then lay out general optimization problem
The default scenario

- Default (at a debt ratio \( b \)) implies
  - exclusion from capital markets (reenter at rate \( \chi \))
  - and contraction in output endowment (in logs, \( \varepsilon \max\{0, b - \hat{b}\} \))
- At end of exclusion period, gov’t reenters markets with debt ratio \( \theta b \)
- Value of defaulting (net of autarky value),

\[
V_{\text{def}}(b) = -\frac{\varepsilon \max\{0, b - \hat{b}\}}{\rho + \chi} + \frac{\chi}{\rho + \chi} V(\theta b).
\]
The general problem

- Let \( T(b^*) \) be \textit{time-to-default}. Government value function,

\[
V(b) = \max_{b^*, \{c_t, \pi_t\}} \mathbb{E} \left\{ \int_0^{T(b^*)} e^{-\rho t} \left( \log(1 + c_t) - \frac{\psi}{2} \pi_t^2 \right) dt \right. \\
\left. + e^{-\rho T(b^*)} V_{\text{def}}(b^*) \mid b_0 = b \right\}
\]

subject to \( b \)'s law of motion, and

\[
V(b^*) = V_{\text{def}}(b^*), \\
V'(b^*) = V'_{\text{def}}(b^*), \\
i.e. \text{ value matching} \& \text{ smooth pasting conditions}
The 'no inflation' regime

- Consider an alternative scenario where

\[ \pi (b) = 0 \]

for all \( b \).
- Government *renounces* the ability to deflate debt away
- Possible interpretations:
  - Issue foreign currency debt
  - Join a monetary union with a strong anti-inflationary stance
  - (Appoint extremely conservative central banker)
International investors (bond pricing)

- Risk-neutral investors can invest elsewhere at riskless real rate $\bar{r}$
- Unit price of the nominal non-contingent bond

$$Q(b) = \mathbb{E} \left[ \int_0^{T^*} e^{-(\bar{r}+\lambda)t} - \int_0^t \pi_s \, ds \left( \lambda + \delta \right) \, dt ight. \\
\left. + e^{-\bar{r}(T^*+\tau) - \lambda T^* - \int_0^{T^*} \pi_s \, ds} \theta \frac{Y_{T^*+\tau}}{Y_{T^*}} Q(\theta b^*) \right| b_0 = b, \right.$$  

$T^* \equiv T(b^*)$, with boundary condition

$$Q(b^*) = \mathbb{E} \left[ e^{-\bar{r}\tau} \theta \frac{Y_{\tau}}{Y_0} Q(\theta b^*) \right] = \frac{\chi}{\bar{r} + \chi - \mu} \theta Q(\theta b^*).$$
Calibration

- Calibrate to the average peripheral EMU economy, time unit $= 1$ year

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
<th>Source/Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{r}$</td>
<td>0.04</td>
<td>world real interest rate</td>
<td>standard</td>
</tr>
<tr>
<td>$\rho$</td>
<td>0.20</td>
<td>subjective discount rate</td>
<td>standard</td>
</tr>
<tr>
<td>$\mu$</td>
<td>0.022</td>
<td>drift output growth</td>
<td>average growth EMU periphery</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>0.032</td>
<td>diffusion output growth</td>
<td>growth volatility EMU periphery</td>
</tr>
<tr>
<td>$\lambda$</td>
<td>0.16</td>
<td>bond amortization rate</td>
<td>Macaulay duration $= 5$ years</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.04</td>
<td>bond coupon rate</td>
<td>price of riskless real bond $= 1$</td>
</tr>
<tr>
<td>$\chi$</td>
<td>0.33</td>
<td>reentry rate</td>
<td>mean duration of exclusion $= 3$ years</td>
</tr>
<tr>
<td>$\theta$</td>
<td>0.56</td>
<td>recovery rate parameter</td>
<td>mean recovery rate $= 60%$</td>
</tr>
<tr>
<td>$\epsilon$</td>
<td>1.50</td>
<td>default cost parameter</td>
<td>output loss during exclusion $= 6%$</td>
</tr>
<tr>
<td>$\hat{b}$</td>
<td>0.332</td>
<td>default cost parameter</td>
<td>average external debt/GDP ratio (35.6%)</td>
</tr>
<tr>
<td>$\psi$</td>
<td>9.15</td>
<td>inflation disutility parameter</td>
<td>mean inflation rate (1987-1997) $= 3.2%$</td>
</tr>
</tbody>
</table>
Equilibrium: inflationary regime

- **Value function, V**
  - Inflationary

- **Primary deficit to gdp, c**

- **Expected time to default, T^d**

- **Bond price, Q**

- **Inflation, \( \pi \)**

- **Nominal interest rate, \( r \)**
Equilibrium: inflationary vs no-inflation regime

- **Value function, V**
  - No inflation
  - Inflationary

- **Bond price, Q**
  - Inflation, π

- **Primary deficit to gdp, c**

- **Expected time to default, T^c**

- **Nominal interest rate, r**
Risk premia & inflation premia

- Nominal bond yield \( r(b) \) can be decomposed as *risk premium* + *inflation premium*
Average performance

- Inflationary regime yields lower value function $V(b)$ at any debt ratio, but...

- ... If it delivers sufficiently lower debt ratio most of the time, average welfare could be higher

- Compute stationary debt distribution so as to calculate unconditional average values
Stationary debt distribution

- Inflationary regime shifts distribution to the left (debt deflation)...

![Diagram showing the distribution of debt-to-GDP ratio](image-url)
Average performance (cont’d)

- ... but not enough to make inflationary policy better on average

<table>
<thead>
<tr>
<th></th>
<th>Data 1995-2012</th>
<th>No inflation</th>
<th>Inflationary</th>
</tr>
</thead>
<tbody>
<tr>
<td>debt-to-GDP, $b$ (%)</td>
<td>35.6</td>
<td>35.6</td>
<td>35.6</td>
</tr>
<tr>
<td>primary deficit ratio, $c$ (%)</td>
<td>-4.1</td>
<td>-0.01</td>
<td>-0.12</td>
</tr>
<tr>
<td>inflation, $\pi$ (%)</td>
<td>0.4</td>
<td>0</td>
<td>3.20</td>
</tr>
<tr>
<td>bond yields (net of $\bar{r}$), $r - \bar{r}$ (bp)</td>
<td>187</td>
<td>154</td>
<td>448</td>
</tr>
<tr>
<td>risk premium, $r - \tilde{r}$ (bp)</td>
<td>154</td>
<td>154</td>
<td>139</td>
</tr>
<tr>
<td>inflation premium, $\bar{r} - \tilde{r}$ (bp)</td>
<td>33</td>
<td>0</td>
<td>309</td>
</tr>
<tr>
<td>Exp. time to default, $T^e$ (years)</td>
<td>-</td>
<td>29.4</td>
<td>37.1</td>
</tr>
<tr>
<td>Welfare loss, $V - V_{\pi=0}$ (% cons.)</td>
<td>-</td>
<td>0</td>
<td>-0.25</td>
</tr>
</tbody>
</table>

- Again, ↑ mean risk premia dominated by ↓ in mean inflation premia & direct utility costs
Robustness

- Investigate robustness to alternative calibrations of:
  - bond amortization rate \((\lambda)\)
  - bond recovery parameter \((\theta)\)
  - output loss from default \((\hat{b})\)

- For all parameter values, we continue to find higher average welfare in no-inflation regime
Monetary policy delegation

- 'No inflation’ regime equivalent to appointing an extremely conservative central banker
- Consider intermediate arrangement: appoint a central banker...
  - who dislikes inflation more than society...
  - ... but not so much as to set $\pi = 0$ at all times
- Given government’s $c(b)$ and $b^*$, central banker chooses $\pi$ ...
- to maximize its value function $\tilde{V}$, defined similarly to $V$, but with $\tilde{\psi} \geq \psi$
Monetary policy delegation: results

- Average welfare increases monotonically with $⟨\tilde{\psi}/\psi⟩$ but never reaches $E(V_{\pi=0})$
Conclusions

- Analyzed trade-offs between price stability and sovereign debt sustainability...
  - ... in an open-economy model with nominal debt and optimal default

- Welfare is higher if gov’t renounces the option to deflate debt away, e.g. by
  - issuing foreign currency debt
  - joining an anti-inflationary monetary union

- Intuition: benefits (lower inflation premia, no direct welfare costs) outweigh costs (higher risk premia)
### Appendix: Robustness

<table>
<thead>
<tr>
<th></th>
<th>Welfare</th>
<th>Time to default</th>
<th>Inflation</th>
<th>Risk premium</th>
<th>Inflation premium</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>% cons.</td>
<td>years</td>
<td>%</td>
<td>bp</td>
<td>bp</td>
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<tr>
<td><strong>Benchmark</strong></td>
<td></td>
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<tr>
<td>No inflation</td>
<td>0</td>
<td>29.4</td>
<td>0</td>
<td>317</td>
<td>0</td>
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<tr>
<td>Inflationary</td>
<td>-0.25</td>
<td>37.1</td>
<td>2.97</td>
<td>298</td>
<td>299</td>
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<tr>
<td><strong>Difference</strong></td>
<td>0.25</td>
<td>-7.7</td>
<td>-2.97</td>
<td>19</td>
<td>-299</td>
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<tr>
<td><strong>Duration = 3</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>No inflation</td>
<td>0.1</td>
<td>49.4</td>
<td>0</td>
<td>311</td>
<td>0</td>
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<tr>
<td>Inflationary</td>
<td>-0.36</td>
<td>47.4</td>
<td>3.28</td>
<td>304</td>
<td>331</td>
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<td><strong>Difference</strong></td>
<td>0.35</td>
<td>-7.0</td>
<td>3.28</td>
<td>7</td>
<td>-331</td>
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<td><strong>Duration = 7</strong></td>
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<td>No inflation</td>
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<td>26.0</td>
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<td>Inflationary</td>
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<td>34.7</td>
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<td>-8.7</td>
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<td>-278</td>
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<td><strong>Recovery rate = 50%</strong></td>
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<tr>
<td>No inflation</td>
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<td>401</td>
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<tr>
<td>Inflationary</td>
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<td>38.5</td>
<td>3.00</td>
<td>373</td>
<td>302</td>
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<td><strong>Difference</strong></td>
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<td>-3.00</td>
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<td>-302</td>
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<td><strong>Recovery rate = 70%</strong></td>
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<tr>
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<td><strong>Difference</strong></td>
<td>0.29</td>
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<tr>
<td><strong>Default costs = 3.5%</strong></td>
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<tr>
<td>No inflation</td>
<td>0.43</td>
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<td>318</td>
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<tr>
<td>Inflationary</td>
<td>0.33</td>
<td>34.6</td>
<td>1.87</td>
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<td>189</td>
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<tr>
<td><strong>Difference</strong></td>
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<td>-4.9</td>
<td>-1.87</td>
<td>14</td>
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<td><strong>Default costs = 7%</strong></td>
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<tr>
<td>No inflation</td>
<td>-0.22</td>
<td>29.6</td>
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<td>314</td>
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<tr>
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<td>3.50</td>
<td>293</td>
<td>353</td>
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<tr>
<td><strong>Difference</strong></td>
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<td>-9.1</td>
<td>-3.50</td>
<td>21</td>
<td>-353</td>
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