Government Debt and Optimal Monetary and Fiscal Policy

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Motivation

- Build-up in government debt following financial crisis
- What normative implications from debt build-up for optimal conduct of monetary and fiscal policies?
- Not a paper about 'the crisis', but about the 'heritage' from crisis...
Motivation

- Monetary and Fiscal Policy:
  - nominal interest rates; tax vs debt financing; government spending
  
  How do optimal *levels* depend on outstanding gov. debt?
  
  How do *stabilization responses* (techn. shocks) depend on debt?

- What do optimal policies imply for optimal debt evolution over time?
  
  Policy discussion vs. economic theory (Barro (1979))

  Standard models provide motives for debt reduction!
Model Sketch


- Private sector:
  - households: consumption & saving, labor supply
  - firm sector: monopoly power & nominal rigidities (à la Rotemberg)
    linear technology in labor, fixed capital, technology shocks

- Public sector:
  - nominal interest rate
  - gov. spending: public goods provision (non-standard)
  - labor income taxation (distortionary, Ricardian equivalence fails)
  - issues nominal non-contingent debt
Three sources of economic distortions:

1. Monopoly power by firms
   \[ \Rightarrow \text{mark-up over costs & output inefficiently low (cannot be eliminated)} \]

2. Distortionary labor income taxes
   \[ \Rightarrow \text{government spending & debt service cost give rise to adverse labor supply and output effects} \]

3. Nominal rigidities:
   \[ \Rightarrow \text{MP affects output} \]
   \[ \Rightarrow \text{MP cannot easily change P to raise state-contingent taxes (nominal debt)} \]
Normative Implications: Levels

In the absence of shocks:

- Price stability optimal independently of debt level
- Tax rates increase with debt level
- Government spending lower the higher is government debt
- Government debt $\Rightarrow$ large welfare implications

Baseline parameterization:
Every 100% increase in debt/GDP ratio $\Rightarrow$ 5% cons. reduction per period
Optimal response to negative technology shock:
Normative Implications: Stabilization Policy

- **Optimal response to negative technology shock:**
  - **No outstanding government debt:**
    - reduced government spending to balance budget,
    - no response of taxes, debt and inflation
    - interest rates increase

Positive government debt (100% of GDP):
- larger revenue shortfalls: taxes rates are higher
- stronger spending cut,
- persistent increase in debt and taxes
- temporary (but small) increase in inflation
- interest rates decrease
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Higher government debt $\Rightarrow$ higher budget & tax risk

1st order approx: debt is a random walk as in Barro (1979)

2nd order motives for debt reduction: can be quantitatively significant
Ramsey Problem: Formal Description

\[
\left\{ c_t, h_t, \Pi_t, R_t \geq 1, \tau_t, g_t, b_t \right\}_{t=0}^{\infty} \quad \left\{ \gamma^1_t, \gamma^2_t, \gamma^3_t, \gamma^4_t \right\}_{t=0}^{\infty}
\]

\[
\max \left( \sum_{t=0}^{\infty} \beta^t u(c_t, h_t, g_t) \right)
\]

\[
+ \beta^t \gamma^1_t \left( u_{c,t} (\Pi_t - 1) \Pi_t - \frac{u_{c,t} z_t}{\theta} h_t \left( 1 + \eta + \frac{u_{h,t}}{u_{c,t} (1-\tau_t)} \frac{\eta}{z_t} \right) \right)
\]

\[
+ \beta^t \gamma^2_t \left( \frac{u_{c,t}}{R_t} - \beta \frac{u_{c,t+1}}{\Pi_{t+1}} \right)
\]

\[
+ \beta^t \gamma^3_t \left( z_t h_t - c_t - \frac{\theta}{2} (\Pi_t - 1)^2 - g_t \right)
\]

\[
+ \beta^t \gamma^4_t \left( b_t - \frac{\tau_t}{1-\tau_t} \frac{u_{h,t}}{u_{c,t}} h_t - g_t - \frac{R_{t-1}}{\Pi_t} b_{t-1} \right)
\]
Recursive Representation of Solution

- Vector of decision variables

\[ y_t = (c_t, h_t, \Pi_t, R_t, \tau_t, g_t, \gamma^1_t, \gamma^2_t, \gamma^3_t, \gamma^4_t) \]

& state variables

\[ x_t = (z_t, \mu^1_t, \mu^2_t, b_{t-1}, R_{t-1}) \]

with \( b_{t-1} = B_{t-1} / P_{t-1} \) given.
Recursive Representation of Solution

- Vector of decision variables
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  with \( b_{t-1} = B_{t-1}/P_{t-1} \) given.

- Solution: \( y_t = g(x_t) \) that satisfies the FOCS.
Continuum of deterministic steady states:

FOC for bonds:

\[ 0 = \gamma_t^4 - \beta E_t \gamma_{t+1}^4 \frac{R_t}{\Pi_{t+1}} \]

From Euler equation

\[ 0 = u_{c,t} - \beta E_t u_{c,t+1} \frac{R_t}{\Pi_{t+1}} \]

FOC for bonds imposes no restrictions on SS outcome

(one dimensional indeterminacy)
Deterministic Steady State: Analytic Results

- First best steady state (preferences & technology)
  \[ u_g = u_c = -u_h \]

- Ramsey steady states (with distortions)
  \[ -u_h = \left( \frac{1 + \eta}{\eta} - \frac{g + (\beta^{-1} - 1)b}{h} \right) u_c \]
  \[ -u_h \leq u_g \]
  \[ \Pi = 1 \]

Reducing gov spending below first best $\Rightarrow$ reduces tax wedge
Utility function

\[ u(c_t, h_t, g_t) = \log(c_t) - \omega_h \frac{h_t^{1+\varphi}}{1+\varphi} + \omega_g \log(g_t) \]  

Parameterization

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>quarterly discount factor ( \beta )</td>
<td>(0.9913)</td>
</tr>
<tr>
<td>price elasticity of demand ( \eta )</td>
<td>(-6)</td>
</tr>
<tr>
<td>degree of price stickiness ( \theta )</td>
<td>(17.5)</td>
</tr>
<tr>
<td>1/elasticity of labor supply ( \varphi )</td>
<td>(1)</td>
</tr>
<tr>
<td>utility weight on labor effort ( \omega_h )</td>
<td>(19.792)</td>
</tr>
<tr>
<td>utility weight on public goods ( \omega_g )</td>
<td>(0.2656)</td>
</tr>
<tr>
<td>technology shock process persistence ( \rho_z )</td>
<td>(0.95)</td>
</tr>
<tr>
<td>quarterly s.d. technology shock innovation ( \sigma )</td>
<td>(0.6%)</td>
</tr>
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## Quantification: Deterministic Steady State

<table>
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<tr>
<th>Debt/GDP</th>
<th>priv. cons ($c$)</th>
<th>hours ($h$)</th>
<th>gov. cons. ($g$)</th>
<th>taxes ($\tau$)</th>
<th>cons. equiv. variation</th>
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<tr>
<td>Zero debt</td>
<td>0.16</td>
<td>0.2</td>
<td>0.04</td>
<td>24%</td>
<td>0.00%</td>
</tr>
<tr>
<td>100% debt/GDP</td>
<td>-2.61%</td>
<td>-2.78%</td>
<td>-3.47%</td>
<td>+16.8%</td>
<td>-5.58%</td>
</tr>
<tr>
<td>200% debt/GDP</td>
<td>-5.25%</td>
<td>-5.62%</td>
<td>-7.02%</td>
<td>+33.3%</td>
<td>-11.0%</td>
</tr>
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<td><strong>First best SS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>debt/GDP</td>
<td>+25%</td>
<td>+26.5%</td>
<td>+32.5%</td>
<td>n.a.</td>
<td>+70.6%</td>
</tr>
<tr>
<td>-1076%</td>
<td></td>
<td></td>
<td></td>
<td></td>
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Quantification: Optimal Response to Technology Shocks

- How Does Optimal Stabilization Policy Depend on Initial Debt?
- 1st order approximation around 0% and 100% debt steady state
- Large sized negative technology shock: - 3 std deviations
- Technology initially decreases by 5.7%
Figure: Debt and Opt Policy
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- To 1st order: debt under optimal policy is random walk.

- **Innovation variance to random walk depends on debt level:**
  - zero debt: zero innovation variance
  - positive debt: positive variance

- Debt $\Rightarrow$ debt risk $\Rightarrow$ tax risk

- To capture risk aspects: 2nd order approx at deterministic SS
  - Use code by Gomme and Klein (2010)
  - Constant/drift term emerges decision & state transition laws
Incentives for Debt Reduction in a Stochastic Economy

The graph illustrates the optimal annual drift in the debt/GDP ratio for different values of \( \rho \):
- \( \rho = 0.95 \) (blue line)
- \( \rho = 0.5 \) (green line)
- \( \rho = 0 \) (red line)

The x-axis represents the debt/GDP ratio, ranging from -300 to 400. The y-axis shows the optimal annual drift in the debt/GDP ratio, ranging from -0.8 to 0.6.

The graph demonstrates how the optimal annual drift changes with the debt/GDP ratio and the correlation coefficient.
Figure:

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Debt and Opt Policy

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Comparing 1st & 2nd order accurate impulse responses:

Optimal debt dynamics differ significantly from random walk!
Figure: Optimal Speed of Debt Reduction: Exogenous vs. Endogenous Gov. Spending

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Conclusions

- Level of debt has important implications for optimal public spending levels and optimal stabilization policy.
- Debt $\Rightarrow$ budget & tax risks
  $\Rightarrow$ optimal to reduce debt levels over time
- Zero debt is absorbing steady state (to second order)
  Aiyagari, Marcet, Sargent Seppälä (2002): negative debt level
- Local analysis here: borrowing constraints not taken into account
  $\Rightarrow$ additional incentives for debt reduction
- Additional risk from other shocks w/o tax revenue implications
  discount factor shocks $\Rightarrow$ real interest rate
  debt reduction even more desirable