Sovereign Debt and Structural Reforms

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The Debt Dilemma

• The Great Recession hit some Euro countries hard (Portugal, Ireland, Italy, Greece, Spain).

• Natural policy response to a negative income shock:
  1. Borrow against future (higher) income to achieve consumption smoothing.
  2. Introduce structural reforms to spur growth and speed up recovery

• Problem: sovereign debt contracts are hard to enforce
  • Additional debt issuance increases default risk premia
  • Incentives to reform might be affected by debt burden
Building Blocks of the Theory

- A sovereign country has fallen in a recession.
- Recovery can be accelerated by costly structural reforms.
- Debt repayment is subject to limited enforcement.
- Debt renegotiation can avert (mitigate) the cost of default.
- **Stochastic** default costs determine the terms of renegotiation
  - e.g., internal politics, international sympathy, value of trade
  - see evidence in Sturzenegger & Zettelmeyer (JIMF2011), Reinhart & Trebesch (JEEA2016).
Questions

- Study interaction of three frictions in a dynamic model:
  1. Limited commitment (debt can be reneged on)
  2. Moral hazard (reform effort is not verifiable)
  3. Incomplete markets (no state-contingent debt)

- Under what conditions does the market equilibrium attain/fail to attain efficiency?

- Quantitative questions:
  1. How large are the potential welfare gains from
     - GDP-linked bonds?
     - Verifiable effort?
     - Commitment to repay debt?
  2. Would ruling out renegotiation improve welfare?
Environment: Technology

- Stochastic aggregate endowments, 
  \( w \in [\underline{w}, \bar{w}] \) ("recession" and "recovery").
- A two-state Markov switching regime
  - \( p_t \in [\underline{p}, \bar{p}] \subseteq [0, 1] \) is the (endogenous) probability of leaving the low state (\( w \));
  - "recovery" is an absorbing state with commitment to repay (relaxed later).
Environment: Preferences

- Representative infinitely-lived agent with preferences:
  
  \[ E_0 \sum \beta^t \left[ u(c_t) - \phi_t I_{\{\text{default in } t\}} - X(p_t) \right]. \]

- \( X \) is the utility cost of reform, assumed to be an increasing convex function of the probability of recovery:
  \( X'(p) > 0, \ X''(p) > 0. \)

- In normal times, \( X = 0. \)
Consider a planner who has access to a savings technology with return \( R = \frac{1}{\beta} \).

Maximize agent’s utility subject to lifetime budget constraint:

- expected PV of income equals expected PV of consumption.

Assume that the planner can dictate both consumption and effort choice,

The optimal allocation:

1. Constant consumption sequence
2. Constant reform effort during recession.

Note that if \( R < \frac{1}{\beta} \), the planner frontloads consumption and backloads effort.
Markets

- A benevolent government issues one-period discount bonds $b'$, i.e., claims to one unit of next-period consumption.
- The bond price is denoted by $Q$.
- Small open economy:
  - Bonds are purchased by risk neutral foreign investors;
  - Risk-free world interest rate: $R$. 
Default and Renegotiation in Recession I

- Every period, the government decides whether to *honor* the outstanding debt, repudiate it ("inexcusable default"), or renegotiate it.
- Default is subject to a stochastic (i.i.d.) cost, $\phi$, drawn from a p.d.f. $f(\phi)$ (c.d.f. $F(\phi)$).
- The realization of the default cost is common knowledge.
- The government decides whether to honor after observing the realization of $\phi$. 
Whenever the default threat is credible, creditors make a **take-it-or-leave-it renegotiation** offer.

- The offer keeps the government indifferent between defaulting and honoring the renegotiated debt level.
- No cost is due under renegotiation (for simplicity).
- When the risk of renegotiation is positive, \( Q < 1/R \).
Equilibrium Concept: Markov Equilibrium

- Focus on Markov equilibria
  - Equilibrium functions only depend on payoff-relevant state variables, i.e., $b$ and $\phi$.
  - Rules out reputational equilibria (e.g. equilibria conditional on effort previous period)
    - Direct default cost vs. reputation (B&R 2015).
  - Captures assumption that the market cannot commit to punish sovereign for past behavior.
Value Functions

- In recession

\[ V(b, \phi) = \max \{ W(b), W(0) - \phi \}, \]

where

\[ W(b) = \max_{b' \in [\bar{b}, \tilde{b}]} \{ u(Q(b') \times b' + \bar{w} - b) + Z(b') \} \]

\[ Z(b') = \max_{p \in [\tilde{p}, \bar{p}]} \left\{ -X(p) + \beta \left[ \begin{array}{c} p \tilde{V}(b') \\ + (1 - p) E_{\phi'}[V(b', \phi')] \end{array} \right] \right\} \]

- In recovery the economy achieves the first-best allocation with constant consumption if \( \beta R = 1 \),

\[ \tilde{V}(b') = \frac{u(\bar{w} - b'(1 - R^{-1}))}{1 - \beta}. \]
Renegotiation Threshold

- Define $\hat{b}(\phi)$ as the renegotiated debt that keeps the sovereign indifferent between repaying $\hat{b}(\phi)$ and outright default:

$$W(\hat{b}(\phi)) = W(0) - \phi.$$

- Given the realization of $\phi$ the sovereign will threaten to default if $b > \hat{b}(\phi)$.

- Or, identically, $\exists \Phi(b)$ such that the sovereign will threaten to default if $\phi < \Phi(b)$.

- Debt overhang:
  When $b' > \hat{b}(\phi_{\text{max}})$ then debt is renegotiated for sure in a future recession!
Competitive equilibrium

- Characterize equilibrium in three steps
  - Optimal reform effort
  - Equilibrium bond price
  - Conditional Euler equation for consumption
Reform Effort

- Recall timing: the government chooses $b'$ first, and then $p$.
- Investors have rational expectations over $p$.
- The reform effort solves:

$$
\Psi (b') = \arg \max_{p \in [\underline{p}, \bar{p}]} \left\{ -X(p) + \beta \left[ p\bar{V}(b') + (1 - p) E_{\phi'}[V(b', \phi')] \right] \right\}.
$$

- The first order condition yields:

$$
\left. X'(\Psi (b')) \right|_{\text{Marg. cost reform.}} = \beta \left[ \bar{V}(b') - \left[ 1 - F(\Phi(b')) \right] W(b') + \int_{0}^{\Phi(b')} W(\hat{b}(\phi')) dF(\phi') \right].
$$

Exp. benefit of leaving the rec.
Figure: Reform effort function
Equilibrium Debt Price

- Since investors are risk neutral, the expected rate of return on the sovereign debt must equal $R$

$$Q(b') b' = \frac{1}{R} \Psi(b') b' + \frac{1}{R} (1 - \Psi(b')) \Pi(b')$$

Exp. repayment in rec.

$$\Pi(b') = \left( 1 - F(\Phi(b')) \right) \times b'$$

Probability full repayment

$$+ \int_0^{\Phi(b')} \hat{b}(\phi') dF(\phi')$$

Exp. debt recovery under reneg. ($\phi' < \Phi(b')$)
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**Figure:** Bond price function $Q(b)$ in recession.
Conditional Euler Equation

- Conditional on no renegotiation (H="honor debt") in the future, a version of the Euler equation (CEE) holds:

\[ \beta R \times E \left[ \frac{u'(c')}{u'(c)} | H \right] = 1 + \frac{\Psi'(b')}{Pr(H|b')} \left[ b' - \Pi(b') \right] . \]

- In case of future renegotiation, consumption increases (relative to case when debt is honored)
- The standard incomplete markets Euler equation applies:
  - without limited commitment (\(\Pi(b') = b'\)) and,
  - no moral hazard (\(\Psi'(b') = 0\)).
Figure: Simulation of consumption, effort, and debt for $\beta R = 1$. 
GDP-linked Debt

- We have exogenously assumed that the interest rate on debt is the same irrespectively of the income shock realization (in the literature, "non-state-contingent debt")
- The analysis can be extended to allow for GDP-linked debt.
- Market for GDP-linked debt cannot restore efficiency.
  - Culprit: moral hazard problem and limited commitment.
- Key insight: state-contingent debt is of limited use in recession
  - State-contingent debt would allow the country to insure against the continuation of the recession
  - However, insurance mitigates incentives to reform
Comparison to Allocations with Less Frictions

- First-best allocation (without frictions).
- Limited commitment
  - w/o moral hazard (verifiable effort)
  - with moral hazard (non-verifiable effort)
- Implementation of the allocation with verifiable effort:
  - Assistance program of an institution (i.e., the IMF) that can verify effort provision.
Recurrent Recessions

- Extend limited commitment to the recovery state
- Exogenous (low) probability of falling back into recession
- $\beta R < 1$ (to have a stationary debt distribution)
- Market equilibrium:
  - during normal times debt (wealth) tends to a target level
  - during recessions debt increases
Parameters calibrated externally

- A period corresponds to one year
- Recession causes a 40% income fall (Greece 2007-13, output loss relative to trend)
- Probability of falling back into a recession: 1%
- Annual real gross interest rate: $ R = 1.02$
- CRRA-utility with risk aversion of 2
- Effort cost is iso-elastic: $X(p) = \zeta \times p^{1+\varphi}$
- Assume that $\bar{\phi} - \phi$ is distributed exponential, with truncation point $\bar{\phi}$ and rate parameter $\eta$. 
## Targeted Moments

<table>
<thead>
<tr>
<th>Target</th>
<th>Data</th>
<th>Model</th>
<th>Par.</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average debt: (% GDP, GIIIPS, 1950-2015)</td>
<td>54.9%</td>
<td>53.7%</td>
<td>$\beta$</td>
<td>0.972</td>
</tr>
<tr>
<td>Bond spread: (GIIIPS, at 100% debt-output ratio, 2008-2012)</td>
<td>4.04%</td>
<td>3.99%</td>
<td>$\eta$</td>
<td>1.804</td>
</tr>
<tr>
<td>Maximum debt level: (% of normal output, Collard et al. 2015)</td>
<td>178%</td>
<td>176%</td>
<td>$\bar{\phi}$</td>
<td>2.134</td>
</tr>
<tr>
<td>Expected recession duration: (at max. reform effort, years)</td>
<td>5</td>
<td>4.95</td>
<td>$\varphi$</td>
<td>14.24</td>
</tr>
<tr>
<td>Expected recession duration: (at the debt limit $\bar{b}$, years)</td>
<td>10</td>
<td>9.99</td>
<td>$\zeta$</td>
<td>14.55</td>
</tr>
</tbody>
</table>
Non-Targeted Moments

- Calibration yields an average bond spread of 3%, in line with data for GIIPS-vs-Germany 1992-2015 (2.5%).
- Renegotiation probability is 6.5%, in line with Tomz and Wright (2013).
- Average haircut conditional on renegotiation is 41%, in line with Tomz and Wright (2013).
- Variation in haircuts is in line with Cruces and Trebesch (2013).
- Average debt relief (market value) 21%, in line with Reinhart and Trebesch (2016).
- Debt-GDP ratio’s are higher in renegotiation periods (89.7%) compared to the average debt-GDP ratio (53.7%), in line with Asonuma and Trebesch (2016).
Quantitative Welfare Effects

- Compute welfare gain of going from benchmark economy (competitive equilibrium) to an alternative economy, measured as equivalent variation (in % of consumption).
- Evaluated at 100% debt-GDP ratio during recession

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Total Debt Equivalent</th>
<th>Debt Equivalent (% of Rec. GDP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP-linked Debt</td>
<td>0.9</td>
<td>34</td>
</tr>
<tr>
<td>No moral hazard</td>
<td>3.0</td>
<td>113</td>
</tr>
<tr>
<td>First Best</td>
<td>13.2</td>
<td>580</td>
</tr>
</tbody>
</table>
Ruling Out Renegotiation

• Experiments:
  1. Disallow renegotiation (New York versus Argentina)
     • Either honor debt or outright default (Arellano, 2008)
  2. Assistance program, but commit to punish any deviation (debt renegotiation or reforms) with termination of contract
     • Grexit: Debt guarantee, but no further borrowing.

• Effects:
  • default occurs in equilibrium
  • larger default premium
  • less borrowing (and less risk sharing) in equilibrium
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(a) No Renegotiation

(b) Grexit

Consumption equivalent welfare loss (%)

Initial debt (% of GDP)

Initial debt (% of GDP)
Summary I

- A simple model of sovereign debt and structural reforms to evaluate the welfare effect of different policies.
- The model is tractable: analytical characterization of the stochastic equilibrium, including CEE, the equilibrium price of debt and the probability of renegotiation.
- equilibrium outcome: an “unlucky” borrower (recession drags on) will eventually enter the debt overhang region.
Summary II

- An efficient assistance program requires:
  - budget support (i.e., loans) during recession followed by settling the sovereign country with a (large) debt on market terms upon recovery;
  - monitoring of reform effort;
  - fiscal austerity.

- When faced by a credible default threat, the “agency” gives in and sweetens the deal: higher consumption, lower reform effort.
  - no Grexit.
Summary III

- Time consistent? Yes, our model incorporates that a large debt increases the probability that Greece does not repay after recovering.
- The model is quantitatively consistent with realistic (high) debt, plausible default premium, and with the empirical haircuts after renegotiation.
Related Literature

- Model is related to Bulow & Rogoff (1989)
  - Renegotiation entails no cost;
  - (Potential) default cost defines threat point for renegotiation;
  - Repeated renegotiation is equilibrium outcome.

- Add to B&R: risk aversion, a borrowing motive (consumption smoothing in recess.), reform effort, and quantitative analysis

- Quantitative models with costly default and renegotiation
  - Aguiar and Gopinath (2006), Arellano (2008), etc.

- Models of sovereign debt restructuring
A Planning Problem

- A dynamic principle-agent problem with one-sided commitment.
- Planner faces the same limited enforcement constraint as the market, but
  - ... can commit to future policies
  - ... can make state-contingent promises.
- There is a limit to the punishment that the planner can inflict to the agent
  - → send her to the market equilibrium.
- Promised utility approach, following Thomas and Worrall (1988).
Two cases

1. Planner cannot verify reform effort (as can markets).
2. Planner can verify reform effort.
Constrained Optimum with Limited Commitment and Moral Hazard

\[ P(v) = \max_{\{\bar{\omega}_\phi, \omega_\phi, c_\phi, p_\phi\}} \int_{\chi} \left[ w - c_\phi + \frac{1}{R} \left( p_\phi \bar{P}(\bar{\omega}_\phi) + (1 - p_\phi) P(\omega_\phi) \right) \right] dF(\phi) \]

subject to

\[ \int_{\chi} \left( u(c_\phi) - X(p_\phi) + \beta \left( (1 - p_\phi) \omega_\phi + p_\phi \bar{\omega}_\phi \right) \right) dF(\phi) = v \]

(PKC)

\[ u(c_\phi) - X(p_\phi) + \beta \left( (1 - p_\phi) \omega_\phi + p_\phi \bar{\omega}_\phi \right) \geq W(0, w) - \phi \] (PC)

\[ p_\phi = \arg \max_{p \in [p, \bar{p}]} -X(p) + \beta \left( (1 - p) \omega_\phi + p \bar{\omega}_\phi \right) \]

(IC)

1. \( P, \bar{P} \) can be interpreted as PV of creditors' exp. profits
2. \( \omega_\phi \) is the promised utility conditional on the state (i.e., the realization of \( \phi \))
Assistance Plan

- An agency (e.g., the IMF)...  
  1. Buys the outstanding initial debt $b_0$
  2. sets a constant transfer (loan) per period
  3. requests a repayment ($b_n$) as soon as the recession ends
  4. sweetens the deal each time the borrower gets a low $\phi$
  5. out-of-equilibrium threat: drop borrower if effort deviation

- Initial promise $\nu_0$ depends on the expected profit of the intervention:
  - Here zero profit implies: $P(\nu_0) = \Pi(b_0)$. 
Figure: Implementation of constrained efficiency by means of an assistance program: simulation of consumption, effort and "implicit debt" over time.
If the Planner Cannot Verify Effort...

- **Proposition**: if the planner cannot verify effort, then the planning (constrained optimal) allocation is equivalent to the market equilibrium with gdp-linked debt.

- Note: the result requires that the punishment for deviation is to go to the mkt with state-contingent debt.