Sudden Stops and Sovereign Defaults.

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June 2011
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Result: sudden stop (SS) shows up in bond prices but not in borrowing flows until outright default materializes.

Mechanism: with market access, an increase in financing needs signals persistent negative shock to tax revenues and hence to debt repayment capacity, which raises spreads and in turn lowers the cost of a subsequent default.

Equilibrium 1: separating equilibrium where the SS precedes both the default and the eventual drop in net inflows

Equilibrium 2: pooling equilibrium in which spreads stay put and the SS will not precede a sovereign default.
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Motivating Facts from European Crisis

1. Uncertainty about the state of public finances

New York Times (February 11) "tax revenues in Greece fell 5.4 billion short of its budgeted revenues last year. (...) In fact, tax collection was so poor that the Greek government decided last September to offer an amnesty program, allowing tax payers to settle their outstanding debt by paying just 55% of the bill.”

Revisions in national budget figures (typically in downward direction), often announced by the respective authorities with substantial lags, all of which have been accompanied by large swings in sovereign spreads.

Continuing and (Intensifying) Market Access.

Countries have been able to tap markets for the most part throughout the turmoil, albeit at a much higher spread.

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This paper attempts to close the gap between literature on sudden stop and literature on sovereign default.

**Sudden Stop literature:** Calvo (1998), Cabalero-Krishnamurti (2011), Kehoe et al. (2005), Mendoza (2006, 2009)

- Relative Price Movement and Unhedged Debt: Currency Mismatch.
- Focus on Quantities rather than Prices.

**Sovereign Default Literature**

- Aguiar and Gopinath (2006): Countries with higher underlying persistence of output shocks are more prone to default.
- Symmetric Information Models cannot explain large country risk fluctuations under continuous market access.
Roadmap

1. Stylized Facts
2. The Model
3. Numerical Results
Definition of a debt crisis: outright default and near default.

- Outright defaults as per the Standard & Poor classification of sovereign defaults
- "near-defaults" episodes of large IMF support where "large" is taken of at least twice as large as the respective country’s quota in the IMF, when all net disbursements are computed from program’s inception to end.

Pre-2007 vs Post-2007 sample: Mostly Europe + Emerging Europe.

Event study analysis around the default event.
Figure 1: Net External Debt Around External Debt Crises (cross-country mean as percent of GDP)

Figure 2: Gross Total Public Debt Around External Debt Crises (ratio to GDP)
Figure 3. Sovereign Spreads in the run-Up to External Debt Crises (percent)
Fiscal Deficit and Tax Revenues

Figure 4. Fiscal Deficits in the run-Up to External Debt Crises
(ratio to GDP)

Figure 5: Real Tax Revenues Around External Debt Crises
(in deviations from a HP-filtered trend)
Model Set-Up

- 3 period model: $t = 0, 1, 2$

A government issues bonds in international capital markets to finance investment in a long-term project which can be related to physical infrastructure and/or human capital development (e.g. education and health).

The project’s investment requirement in period 0 generates fiscal revenues $\tau_0$, $\tau_1$ and $\tau_2$ in periods 0, 1 and 2 respectively.

The sovereign issues long-term debt to be paid in period 2. It issues $D_0 = \tau_0$ at time $t = 0$, it pays interest $r_0 \tau_0$ in $t = 1$ promises to pay $(1 + r_0) \tau_0$ in $t = 2$.

In period $t = 1$ government’s fiscal revenue is subject to a shock $\tilde{\epsilon}_1$ which assumes two values: $\epsilon_H 1 = \alpha \tau_1$ and $\epsilon_L 1 = \alpha \tau_1$, with probability $p$ and $1 - p$ respectively, where $\alpha < 1$.

A key assumption is that the shock in period 1 is persistent, so that $\rho \epsilon_1$ still affects the fiscal revenues in the final period.
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- A **key assumption** is that the shock in period 1 is persistent, so that \( \rho \epsilon_1 \) still affects the fiscal revenues in the final period.
“Renegotiate" (R). Borrower can buy back its debt paying $(1 + r_0)\tau_0$ at $t = 1$ and re-issue the same debt $D_1 = \tau_0$ at $t = 1$ promising $(1 + r_1^R)\tau_0$ at $t = 2$. 

At the final period, the government is subjected to another fiscal shock $\tilde{\epsilon}_2 (\epsilon_{H2} \text{ or } \epsilon_{L2})$ with probability $q$ and $1 - q$ respectively. After the realization of the shock, the government decides whether to pay or default in all outstanding debt.
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   - After the realization of the shock, the government decides whether to pay or default in all outstanding debt.
Default Costs and Lenders/Sovereign Pay-offs.

- Hair Cut / Partial Default: \((1 - c) \times \text{total\_debt}\)
- Punishment/Sanctions: confiscation of a fraction \(\eta\) of fiscal revenues by creditors.
- Risk-neutral Lenders: break-even in expected terms.
- Sovereign Maximizes discounted sum of fiscal expenditures (*reduced form welfare function*)

\[
G_o = \tau_0
\]

\(\tau = 1\) shock: \(\varepsilon_1 = -/ + \alpha \tau_1\)

- decision \(\tau = 1\): re-finance

\[
G^R_1 = \tau_1 + \varepsilon_1 - r_0 \tau_0 = (1 + \alpha) \tau_1 - r_0 \tau_0
\]

- decision \(\tau = 1\) : re-issue:

\[
G^I_1 = \tau_1 + \varepsilon_1 - r_0 \tau_0 + \alpha \tau_1 = \tau_1 - r_0 \tau_0
\]

- \(\tau = 2\) : shock: \(\varepsilon_2 + \rho \varepsilon_1 = \varepsilon_2 + / - \rho \alpha \tau_1\)
- decision \(\tau = 2\) : repay of default.
Asymmetric Information and Sudden Stop.

- **Asymmetric Information:** While the borrower can perfectly observe the realization of the middle period shock $\tilde{\epsilon}_1$, lenders cannot.

  Information Revelation: The only way lenders can infer some information about the realization of the shock is through the borrower's action in the middle period: to issue new debt ($I$) or to re-negotiate ($R$). Lenders at $t=1$, after observing the borrower action (issue or re-negotiate) update their beliefs of future default and re-price debt accordingly.

  We define a **sudden stop** (SS) as an inward shift in the supply curve of funds. For tractability we are not modeling the quantity choice, so quantity issuance is taken exogenous. Focus on endogenous and sudden changes in prices as opposed to quantities. Sudden Stop is characterized by the difference in rates charged by lenders in period 1:

  $$r_I - r_R$$
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We model the borrower and lender interaction as a game. The borrower’s strategy is to issue (I) or re-negotiate (R) in period 1 and to pay or not in period 2. The lender’s strategy is to set a break-even price. Lenders will have beliefs about borrower’s type (shock realization in period 1).

Theorem: There exists a separating perfect bayesian equilibrium in this economy in which Sudden Stop associated with hiking spreads but positive net borrowing precedes a Sovereign Default.
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A Perfect Bayesian equilibrium (PBE) is an equilibrium in which everybody’s response is optimal given everybody’s else response and beliefs, and beliefs are consistent with strategies and updates using Bayes’ (whenever possible).

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- Separating Equilibria: different shocks → different actions. Information revelation.
- Pooling Equilibrium: different shocks → same actions. No information revelation.

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Equilibria

   - Eq1: Nobody defaults.
3. Separating Equilibria: H re-finance; L re-issue
   - Eq 2: H never defaults, L only for a bad shock.
   - Eq 3: Both default for a bad shock.
   - Eq 4: H never defaults, L always defaults.
   - Eq 5: L always defaults, H only for a bad shock.
   - Eq 6: Both always default.
4. Potential Multiplicity (not robust)
## Numerical Calibration

<table>
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<th>parameter</th>
<th>parameter name</th>
<th>Baseline</th>
<th>Alt. 1</th>
<th>Alt. 2</th>
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<tr>
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<td>Discount Factor</td>
<td>0.96</td>
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<td>$\tau_0$</td>
<td>Initial Borrowing</td>
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<td>$c$</td>
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<td>$\eta$</td>
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<td>$\rho$</td>
<td>Probability of a good shock</td>
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<td>___</td>
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<tr>
<td>$\rho$</td>
<td>Persistence of Shock</td>
<td>[0.5, 0.95]</td>
<td>___</td>
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<tr>
<td>$\alpha_1$</td>
<td>Fiscal Shock: $\varepsilon_1 = \alpha_1 \tau_0$</td>
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<tr>
<td>$\alpha_2$</td>
<td>Fiscal Shock: $\varepsilon_2 = \alpha_2 \tau_0$</td>
<td>$\alpha_1 = \alpha_2$</td>
<td>$\alpha_1 = \alpha_2$</td>
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BASELINE MODEL

(a) Index Number of Equilibrium

(b) Size of Sudden Stop / Interest Rate Spread Re-Issuers - Re-financers

(c) Net Inflows / Re-issuers

(d) Net Outflows / Re-Financers
Alternative: Smaller Haircut $c=0.75$

(a) Index Number of Equilibrium

(b) Size of Sudden Stop / Interest Rate Spread Re-Issuers - Re-financers

(c) Net Outflows / Re-issuers

(d) Net Outflows / Re-Financers
Concluding Remarks

• A framework to jointly analyze SS and SD with asymmetries about fiscal fundamentals and persistence of fiscal shocks.

• **Separating Equilibrium:** borrowing (even if successful) signals to investors that debt repayment capacity has been compromised.
  - future expected ratio of debt to revenue ratio goes up, raising repayment risk.
  - Risk neutral investors hike up spreads which, in turn, increases the cost of future repayment and thus lowers the cost of a subsequent default.

• In this separating equilibrium, the SS (defined as an inward shift in lenders’ supply schedule) precedes the sovereign default.
  - drop in net capital flows may take place only long after a large drop in output and tax revenues; capital inflows only dry up later once default materializes.

• Another equilibrium (**pooling equilibrium**) in which the country “fakes”: despite being hit by a bad fiscal shock.