Sovereign default and renegotiation: recovery rates, interest rate spreads, and credit history

Tamon Asonuma

Boston University

Summer Econometric Society Meeting
June 4 2009
Motivations - - - Stylized facts

Figure 2: External debt/GDP, bond spreads, and credit ratings, average 2003-2005

Source: De Paoli, Hoggarth and Saporta (2006)
Motivations - - - Stylized facts (cont.)

![Graph showing recovery rates and increase in spreads at the time of negotiation for various countries.](image)

**Legend:**
- Angola
- Bolivia
- Dominican Rep. 1983
- Dominican Rep. 2005
- Ecuador 2000
- Jordan
- Russia 1991
- Sierra Leone
- Ukraine 1998
- Venezuela 1990
- Argentina 1989
- Dominican Rep. 2005
- Ecuador 1982
- Greece
- Kenya
- Nigeria
- Russia 1998
- South Africa
- Sri Lanka
- Uruguay 1990
- Uruguay 2003
- Zimbabwe
- Regressed line
Motivations (cont.)

- Given debt/GDP ratio, the countries which have defaulted in the past, might have higher default probability, and higher spreads.
- The negative relationship between recovery rates and increase in spreads.
  - a trade-off of the country between paying full level of debts at renegotiation (short-run cost) and deterioration in long-term credit (long-run cost).
  - a trade-off of investors between recovering the debt (short-run surplus) and demanding higher rates of returns in the future (long-run surplus).
Previous literature

- Serial defaults
  1. Reinhart, Rogoff, and Savastano (2003), Reinhart and Rogoff (2005) - role of past credit history
  2. Eichengreen, Hausmann, and Panizza (2003) - "Original sin"

- Sovereign default and renegotiation
  1. Yue (2006) - debt renegotiation with one-round Nash bargaining game
  2. Bi (2008), Benjamin and Wright (2008) - multi-round bargaining to consider delay in renegotiation
New features of the model

- Incorporating endogenous additional components in spreads: These components are determined at the debt renegotiation together with recovery rates.

- Credit condition, i.e., borrowing cost of the country after re-entry to the market depends on how much the country pays back at the renegotiation.
The goals of the paper

- To explain the interaction between recovery rates and increase in spreads which are determined at the renegotiation.
- To provide explanation of the mechanism of serial defaults - to analyze how the additional components in spreads will lead to higher probability of next default.
Implications of the paper

- The negative relationship between recovery rates and increases in spreads.
  - a trade-off of the country between paying full level of debt at renegotiation (short-run cost) and deterioration in long-run credit (long-run cost).
  - a trade-off of investors between recovering the debt (short-run surplus) and demanding higher rates of returns in the future (long-run surplus).

- The equilibrium probability of default for a given debt-to-GDP level is weakly increasing with credit history (number of past defaults).
  - Spread return for a given debt-to-GDP level is also weakly increasing with credit history.
Model: General features

- Sovereign default and renegotiation in a dynamic model of small open economy
- A risk-averse country and continuum of risk-neutral investors
- Stochastic income shock $y_t$ - - -probability distribution : $\mu(y_{t+1}|y_t)$
- Incomplete capital market - - exchange one-period zero-coupon bonds price of bonds $q(b_{t+1}, h_t, y_t)$ - - determined at equilibrium
- One-side commitment: foreign investors always commit to repay but the country does not.
- Renegotiation after default between the country and investors - - One-round Nash bargaining
Key differences between Yue (2006) and this model

- **Credit condition, i.e. borrowing cost of the country after re-entry to the market** depends on how much the country pays back at the negotiation.
  - Yue (2006): credit condition will always return to the same level without the experience of the default.

- **Our model** incorporates effects of additional increase in spreads after the default (which lead to increase probability of next defaults.)
  - Yue (2006): it does not consider the effect of additional increase in spreads (no impacts on default probability.)
Model: Timing of the model

1. Investors choose $b_{t+1}$
2. Prices of bonds are determined.
3. No change in $h_t$.

Choose to pay the debts.
1. Choose $c_t$ and $b_{t+1}$
2. Default risk is determined.

Choose to default.
1. Debt renegotiation - $\alpha(b_t, h_t, y_t)$ and $\phi(b_t, h_t, y_t)$ are determined.
2. Suffers output cost - $\lambda_d y_t$
3. Does not issue bond - $b_{t+1} = 0$
4. Consumption is determined.
5. Credit condition deteriorates - $h_{t+1} = h_t + 1$
Model: Renegotiation problem (cont.)

- Investors’ surplus
  \[ \Delta^L(a_t, sp_t; b_t, h_t, y_t) = -a_t b_t - sp_t R(b_t, h_t, y_t) \]  
  (14)

- Discounted value of expected debt for next period (evaluated with investors’ discount factor) \( \beta^I = 1/(1+r) \)
  \[ P(b_t, h_t, y_t) = \beta^I \int_Y \left( b_{t+1}(b_t, h_t, y_t), h_t, y_{t+1} \right) b_{t+1}(b_t, h_t, y_t) d\mu(y_{t+1}, y_t) \]  
  (10)

  \[ s.t. \quad b_{t+1} = b^*_t(b_t, h_t, y_t), \]

- Discounted value of expected future payments (evaluated with investors’ discount factor)
  \[ R(b_t, h_t, y_t) = P(b_t, h_t, y_t) + \frac{1}{1+r} \int_Y R(b_{t+1}, h_t, y_{t+1}) d\mu(y_{t+1}, y_t) \]  
  (11)

  \[ s.t. \quad b_{t+1} = b^*_t(b_t, h_t, y_t), \]
**Equilibrium**

**Definition**

Recursive equilibrium is a set of functions for, (A) the country's value function $V^*(b_t, h_t, y_t)$, asset position $b^*_{t+1}(b_t, h_t, y_t)$, consumption $c^*_t(b_t, h_t, y_t)$, default set $D^*(b_t, h_t)$, discounted expected payment $P^*(b_t, h_t, y_t)$, (B) recovery rate $\alpha^*(b_t, h_t, y_t)$, additional component in interest spreads $\phi^*(b_t, h_t, y_t)$, and (C) bond price function $q^*(b_{t+1}, h_t, y_t)$ and total spread $s^*(b_{t+1}, h_t, y_t)$ such that

1. these satisfy the country’s optimization problem (1)-(10).
2. these solve the debt renegotiation problem (15).
3. these satisfy the optimal conditions of foreign investors’ problem (17),(19) and (20).
Quantitative analysis

- CRRA utility: \( u(c_t) = \frac{c_t^{1-\sigma} - 1}{1-\sigma} \)
- Income process: \( \log(y_t) = (1 - \rho_g) \log(1 + \mu_g) + \rho_g \log(y_{t-1}) + \epsilon_t^g \)
- Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk aversion</td>
<td>( \sigma = 2 )</td>
<td>RBC Literature</td>
</tr>
<tr>
<td>Risk-free interest rate</td>
<td>( r = 0.017 )</td>
<td>Arellano (2007)</td>
</tr>
<tr>
<td>Baseline output loss in default</td>
<td>( \lambda_d = 0.02 )</td>
<td>Sturzeneger (2002)</td>
</tr>
<tr>
<td>Average endowment growth</td>
<td>( \mu_g = 0.0042 )</td>
<td>Yue (2006)</td>
</tr>
<tr>
<td>Standard deviation of endowment growth shock</td>
<td>( \sigma_g = 0.0253 )</td>
<td>Yue (2006)</td>
</tr>
<tr>
<td>Endowment growth AR(1) coefficient</td>
<td>( \rho_g = 0.41 )</td>
<td>Yue (2006)</td>
</tr>
<tr>
<td>Discount factor</td>
<td>( \beta = 0.74 )</td>
<td>Yue (2006)</td>
</tr>
<tr>
<td>Baseline bargaining power</td>
<td>( \theta = 0.83 )</td>
<td>Yue (2006)</td>
</tr>
<tr>
<td>Direct sanction</td>
<td>( \lambda_s = 0.012 )</td>
<td>Yue (2006)</td>
</tr>
<tr>
<td>Maximum level of additional component in spreads</td>
<td>( \phi_{\text{max}} = 0.01 )</td>
<td>Computed</td>
</tr>
</tbody>
</table>
Baseline case
Baseline case

![Default probability with h=0, h=1 and h=2](image.png)
Simulation results
- We run 1000 rounds of simulation, with 2000 periods each round and extract last 100 periods

<table>
<thead>
<tr>
<th>Table 5: Model statistics for Argentina (annual-base)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Statistics</td>
</tr>
<tr>
<td>Data</td>
</tr>
<tr>
<td>Argentina*1</td>
</tr>
<tr>
<td>Default probability</td>
</tr>
<tr>
<td>2.76%</td>
</tr>
<tr>
<td>Average bond spreads</td>
</tr>
<tr>
<td>4.08%</td>
</tr>
<tr>
<td>Bond spreads std*3</td>
</tr>
<tr>
<td>1.68%</td>
</tr>
<tr>
<td>Simulation results</td>
</tr>
<tr>
<td>Model</td>
</tr>
<tr>
<td>2.20%</td>
</tr>
<tr>
<td>4.00%</td>
</tr>
<tr>
<td>6.98%</td>
</tr>
</tbody>
</table>

Source: Datastream and Yue (2006)
Impacts of additional components in total spreads

\[
s(b_{t+1}, h_t, y_t) = \begin{cases} 
0 & \text{if } b_{t+1} \geq 0 \\
\frac{1+r+\sum_{i=0}^{h_t-1} \phi(b_t, i, y_t)}{[1-p(b_{t+1}, h_t, y_t) + p(b_{t+1}, h_t, y_t)\gamma(b_{t+1}, h_t, y_t)]} - (1 + r) & \text{otherwise}
\end{cases}
\]

(20a)
Quantitative analysis (conti.)

(1) baseline case

Spreads with $h=2$

- "pure" y-min
- Total y-min
- "Pure" y-max
- Total y-max

Spreads vs Asset/GDP
Conclusion

- Negative relationship between recovery rates and increase in spreads
  - a trade-off of the country between paying full level of debt at negotiation (short-run cost) and deterioration in long-term credit (long-run cost).
  - a trade-off of investors between recovering the debt (short-run surplus) and demanding higher rates of returns in the future (long-run surplus).

- The equilibrium probability of default for a given debt-to-GDP level is weakly increasing with credit history (number of past default).
  - Spread return for a given debt-to-GDP level is also weakly increasing with credit history (number of past defaults).