Serial Default and Debt Renegotiation

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Motivations: Stylized facts

- 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 at the debt renegotiations.
Motivations: Stylized facts (cont.)

[Graph showing the relationship between bond spreads, external debt/GDP, and credit rating for various countries, illustrating the concept of serial default.]
Motivations: Stylized facts (cont.)
Incorporating endogenous additional spread premia
→ These premia 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.
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 spread premia will lead to higher probability of next default.
Implications of the paper

- The negative relationship between recovery rates and increases in spreads.
  - The 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).
  - The trade-off of investors between receiving the debt payment (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 ratio is weakly increasing with credit history (number of past debt renegotiations).
  - Spread return for a given debt-to-GDP level is also weakly increasing with credit history.
The country has defaulted in the past
→ Debt renegotiations with investors.

The negative relationship between the recovery rates and increase in spreads at the debt renegotiations.
→ If the country could not pay back the full level of debt at the renegotiation, the investors have imposed higher spreads on the future bonds.

The borrowing cost of the country has increased due to these additional spread premia.
→ The country is more likely to default, given the debt-to-GDP ratio and income level.

The default probability is weakly increasing respect to the credit history.
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
Model: General features

- Sovereign default and renegotiation in a dynamic model of small open economy
- A risk-averse country and a continuum of risk-neutral investors
- Stochastic income $y_t \rightarrow$ probability distribution: $\mu(y_{t+1}|y_t)$
- Credit history $h_t$ (number of debt renegotiation) $\rightarrow$ reverts with probability $\chi$
- 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 $\rightarrow$ One-round Nash bargaining
Key differences between Yue (2006) and this paper

- 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.
  → Yue (2006): credit condition will always return to the same level without the experience of the default.

- My model incorporates effects of additional spread premia after the default (which leads to increase probability of next defaults.)
  → Yue (2006): it does not consider the effect of additional spread premia (no impacts on default probability.)
Model: Timing

1. Investors choose $b_{t+1}$
2. Prices of bonds are determined.
3. Credit history reverts with probability $x$.

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 history records the current debt renegotiation - $h_{t+1} = h_t + 1$
Model: Renegotiation problem

- Investors’ surplus

\[ \Delta^L (a_t, sp_t; b_t, h_t, y_t) = -a_t b_t - sp_t \left[ \sum_{i=h_{t+1}}^{h_{\text{max}}} R(b_t, i, y_t) \right] \] (14)

- Discounted value of expected debt for next period (evaluated with investors’ discount factor) \( \beta^l = 1/(1 + r) \)

\[ P(b_t, h_t, y_t) = \beta^l \int_Y I \left( \frac{b_{t+1}(b_t, h_t, y_t)}{h_t, y_{t+1}} \right) b_{t+1}(b_t, h_t, y_t) d\mu(y_{t+1}, y_t) \] (10)

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

- 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)

Note: it incorporates the expected default choices in the future.
Equilibrium

**Definition**

A recursive equilibrium is a set of functions: 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 $R^*(b_t, h_t, y_t)$, recovery rate $\alpha^*(b_t, h_t, y_t)$, additional spread premia $\phi^*(b_t, h_t, y_t)$, bond price function $q^*(b_{t+1}, h_t, y_t)$ and total spread $s^*(b_{t+1}, h_t, y_t)$ which

1. satisfy the country’s optimization problem (1)-(10);
2. solve the debt renegotiation problem (15);
3. 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 (2008)</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</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_{max} = 0.01 )</td>
<td>Computed</td>
</tr>
<tr>
<td>Maximum level of credit history</td>
<td>( h_{max} = 3 )</td>
<td>Computed</td>
</tr>
<tr>
<td>Probability of upgrading in credit history</td>
<td>( \chi = 0.025 )</td>
<td>Chatterjee et al (2007)</td>
</tr>
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Baseline case
Quantitative analysis (cont.)

- Default probability with $\phi_{\text{max}} = 0.03$
Simulation results
- I run 1000 rounds of simulation, with 2000 periods each round and extract last 100 periods

| Table 5: Model statistics for Argentina (annual-base) |
|---------------------------------|-----------------|
|                                 | Data            | Simulation results |
| Target statistics               | Argentina*¹  | Brady Bonds | EMBI Ave.*² | Model | Yue (2006) |
| Default probability             | 2.76%           | n.a         | n.a.        | 2.20% | 1.98%       |
| Average bond spreads            | 4.08%           | 5.78%       | 3.31%       | 4.00% | 1.49%       |
| Bond spreads std*³              | 1.68%           | 3.13%       | 0.78%       | 7.00% | 3.27%       |

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

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

Composition of spreads

- (a) spread components based on "pure" default probability
  \[\rightarrow \text{"spreads associated with future elements"}\]
- (b) spread components associated with additional components in spreads
  \[\sum_{i=0}^{h_t-1} \phi(b_t, i, y_t)\]
  \[\rightarrow \text{"spreads associated with the past default history"}\]
Case with $\phi_{\text{max}} = 0.03$
Conclusion

- Negative relationship between recovery rates and increase in spreads
  → The country faces a trade-off between paying full level of debt at renegotiation (short-run cost) and deterioration in long-term credit (long-run cost).
  → Investors face a trade-off between receiving the debt payment (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 ratio is weakly increasing with credit history (number of past debt renegotiations).
  → The spread return for a given debt-to-GDP level is also weakly increasing with credit history.