Welfare Analysis of Currency Regimes with Defaultable Debts

Aloisio Araujo (EPGE/FGV and IMPA)
Marcia Leon (Banco Central do Brasil)
Rafael Santos (Banco Central do Brasil)

May 2012
Presentation

1. Motivation
2. The Cole-Kehoe Model
3. The Model with Local-Currency Debt
4. The Model with Common-Currency Debt
5. Computed Model Results
6. Conclusions
1. MOTIVATION

Use the self-fulfilling debt crisis model of Cole-Kehoe to evaluate financial aspects of currency regimes:

- Dollarization
- Common Currency
- Local Currency

The optimal currency regime depends on:

- Correlation of External Shocks (Refinancing Risks) among countries of a monetary union
- Risk of Political Inflation
2 - The Cole-Kehoe Model

It has two parts:

a) a dynamic, stochastic general equilibrium model, with probability $\pi$ of a self-fulfilling debt crisis occurring;

b) a simulation exercise to obtain the debt-crisis zone and the welfare levels for an economy under a possible speculative attack on its public debt.
2 - The Cole-Kehoe Model

• One good: $f(k_t)$;

• Three participants:
  (i) national consumers;
  (ii) international bankers; and
  (iii) the government.

• One sunspot $\zeta_t$: bankers’ confidence that government will not default; i.i.d., uniform $[0,1]$ and $P [\zeta_t \leq \pi ] = \pi$

• $\zeta_t$ also indicates the refinancing risk faced by indebted economies.

• Foreign-currency debt, $B_t$: in the hands of int’l bankers; probability $\pi$ of no rollover in the crisis zone; if there is default, it is full. ($Z_t = 0$). No default ($Z_t = 1$).
2 - The Cole-Kehoe Model

(i) Consumer’s problem

\[
\max_{c_t, k_{t+1}} E \sum_{t=0}^{\infty} \beta^t \left[ \rho c_t + v(g_t) \right]
\]

s.t.

\[
c_t + k_{t+1} - k_t \leq (1 - \theta) \left[ a_t f(k_t) - \delta k_t \right]
\]

\[
k_0 > 0
\]

\(a_t\) - productivity factor

If the government has defaulted, then \(a_t = \alpha\), \(0 < \alpha < 1\).

Otherwise, \(a_t = 1\).
(ii) International bankers’ problem

$$\max_{x_t, b_{t+1}} \mathbb{E} \sum_{t=0}^{\infty} \beta^t x_t$$

s.t.

$$x_t + q^*_t b_{t+1} \leq \bar{x} + z_t b_t$$

$$b_0 > 0$$

$q^*_t$ - price, at $t$, of one-period government bond that pays one good, if there is no default.
(iii) Government

Benevolent and with no commitment.

Decision variables: $B_{t+1}, z_t, g_t$

Budget constraint

$$g_t + z_t B_t \leq \theta [a_t f(k_t) - \delta k_t] + q^*_t B_{t+1}$$

Strategic behavior since foresees $q^*_t, c_t, k_{t+1}, g_t, z_t, a_t$
2 - The Cole-Kehoe Model

- Timing of actions within a period

  a) $\zeta$ is realized and state $s = (K, B, a_{-1}, \zeta)$

  b) government, given $q^* = q^*(s, B')$, chooses $B'$

  c) bankers decide whether to purchase $B'$

  d) government chooses $z$ and $g$

  e) consumers, given $a(s, z)$, choose $c$ and $k'$
2 - The Cole-Kehoe Model

• An Equilibrium

a) Characterization of consumers and bankers behavior

Consumers: \( k' \) takes three values: \( k^n > k^\pi > k^d \) depending on \( E [a'] \)

\[
k^n, \ E [a'] = 1; \ k^\pi, \ E [a'] = 1 - \pi + \pi\alpha; \ k^d, \ E [a'] = \alpha
\]

Bankers: \( q^* \) takes three values: \( \beta, \ \beta (1-\pi), \ 0 \) depending on \( E [z'] \) since \( q^* = \beta E [z'] \)

\[
\beta, \ E [z'] = 1; \ \beta (1-\pi), \ E [z'] = 1 - \pi ; \ 0, \ E [z'] = 0
\]
b) **Definition:** Crisis Zone with probability $\pi$

Debt interval that a crisis can occur with probability $\pi$.

For one-period gov’t bonds and $s = (k^n, B, 1, \zeta)$:

\[
\left( \overline{b}(k^n), \overline{B}(k^n, \pi) \right)
\]

\[
\begin{align*}
B' & \leq \overline{b}(k^n) & \text{no crisis zone} \\
\overline{b}(k^n) & < B' \leq \overline{B}(k^n, \pi) & \text{crisis zone} \\
B' & > \overline{B}(k^n, \pi) & \text{full default only zone}
\end{align*}
\]
3 – Local-currency debt model
Araujo and Leon (RBE, 2002)

- Public debt denominated in two currencies: foreign, $B_t$, and local, $D_t$

- A **full default** on $B_t$ may be avoided through a **partial default** on debt denominated in local currency, $D_t$

- $D_t$ only in the hands of national investors; credit rollover always.

- Government decision variable to partial default, $\nu$.
  
  No partial default, local bond pays one good ($\nu = 1$).
  Otherwise, it pays less than one good, ($\nu = \phi$), $\phi < 1$. 
3 – Local-currency debt model

• Cost of partial default: productivity falls to $\alpha \phi > \alpha$
  
  If $z = 0$ (full default on $B_t$), then $a = \alpha$ forever

  If $\nu = \phi$ (partial default on $D_t$), then $a = \alpha \phi$ forever

• Intense speculative attack:
  
  If $\zeta_t < \pi^d$, then $z = 0$ and full default on $B_t$

• Moderate speculative attack:
  
  If $\pi^d < \zeta_t < \pi^{up}$, then $z = 1$ and a fraction $\phi$ of $B_t$
  
  is renewed and there is partial default on $D_t$ to avoid a full
  
  default on $B_t$. 
3 – Local-currency debt model

- **Political Inflation**
  
  If $\pi^{up} < \zeta_t < \pi^{up\psi}$, then $z = 1$ and total $B_t$ is renewed, but there is partial default on $D_t$.

- **Risk of political inflation, $\pi^p$**
  
  $$\pi^p = \pi^{up\psi} - \pi^{up}$$

- **Partial default revenues:**
  
  → to avoid full default on $B_t$; or
  
  → for political purposes (risk of political inflation)
3 – Local-currency debt model

An equilibrium is analogous to the original C-K

- Consumers’ new budget constraint:
  \[ c_t + k_{t+1} - k_t + q_t d_{t+1} \leq (1-\theta) [a_t f(k_t) - \delta k_t] + \nu_t d_t \]

  besides \( c_t \) and \( k_{t+1} \) also chooses \( d_{t+1} \)

- Government new budget constraint:
  \[ g_t + z_t B_t + \nu_t D_t \leq \theta [a_t f(k_t) - \delta k_t] + q_t^* B_{t+1} + q_t D_{t+1} \]

  besides \( B_{t+1}, z_t \) and \( g_t \) also chooses \( D_{t+1} \) and \( \nu_t \)
4. Common-currency debt model

• \( I \) countries in a monetary union and a central government
• Each country \( i \) issues debt in common currency, \( D^i_t \)
• Possibility of a partial default on common-currency debt, which depends on decision process.
• Partial-default decision: Member-countries vote: \( \nu^i \); and Union decision: \( \nu^u \)
4. Common-currency debt model

- Two decision processes are considered:
  1) The right of veto: \( u^u = \phi \iff u^i = \phi \), for all \( i \)
  2) Political influence over the union’s central bank:
     Each member implements its decision with probability \( pw^i \) and \( \Sigma pw^i = 1 \).

- Correlation of external shocks, \( \rho \)
  The external shock (refinancing risk), \( \zeta^i \), of each country \( i \)
  correlates with the one from the other countries.
5. Computed Model Results

- Numerical Findings follow from the welfare analysis of alternative currency regimes, depending on the risk of political inflation, $\pi^p$, and the correlation of external shocks (re refinancing risks), $\rho$.

- A country (country A) has to decide either to maintain its local-currency regime, or to join a common-currency regime with a partner country (country B), or to dollarize by adopting the currency of a third country.

- Country B is assumed to have all parameters equal to those of country A, except for a possible change in the risk of political inflation.
5. Computed Model Results

• **Numerical Finding 1**

  The bigger the risk of political inflation, the larger the region where dollarization maximizes welfare. *(See Figure 2)*

• **Numerical Finding 2**

  The larger the correlation of external shocks ρ, the larger the region where common-currency maximizes welfare. *(See Figure 2)*
5. Computed Model Results

• **Numerical Finding 3**

As $\pi^{pB}$ decreases the range for $\rho$ in which the common-currency regime is optimal increases over the *Dollar* region and decreases over the *Local-Currency* region. *(Compare Figures 2 and 3)*

Note: In Figure 2, the risk of political inflation of country B, $\pi^{pB}$, is 0.7 and, in Figure 3, is zero.
5. Computed Model Results

- **Numerical Finding 4**

  For high levels of the risk of political inflation in country A, $\pi^p_A$, the region where dollarization is preferred increases as $p^w_A$ increases.

  *(See Figure 4)*
Optimal Monetary Arrangement (n=2)
Decision process: Right of Veto
Risk of political inflation in the other country (B): 0.7 and 0
Optimal Monetary Arrangement (n=2)
Political Weight in the decision process: 0, 0.4 and 0.8
Risk of political inflation in the other country (B): 0.7

Figure 4

![Graph showing the relationship between risk of political inflation and external shocks correlation for different political weights. The graph illustrates how changes in political weights affect the risk of inflation in the dollar and local currency under varying levels of external shocks correlation.](image)
6. Conclusions

• Choices of currency regimes considering financial aspects:

Low risk of political inflation and low external correlation $\Rightarrow$ Local-currency regime

High risk of political inflation and high external correlation $\Rightarrow$ Common-currency regime

High risk of political inflation and low correlation $\Rightarrow$ Dollarization
THANK YOU FOR YOUR ATTENTION
5. Computed Model Results

Benchmark: the Brazilian economy (1998/2001)

<table>
<thead>
<tr>
<th>Length (Years)</th>
<th>Model</th>
<th>Brazil (98-01)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Maturity</td>
<td>1</td>
<td>∈ [.4;2.2]</td>
</tr>
<tr>
<td>Average Duration</td>
<td>1</td>
<td>∈ [.2; .9]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables Relative to GDP</th>
<th>Model</th>
<th>Brazil (98-01)</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Debt</td>
<td>45</td>
<td>∈ [31;45]</td>
</tr>
<tr>
<td>External Public Debt</td>
<td>45</td>
<td>∈ [9;24]</td>
</tr>
<tr>
<td>Local Currency Public Debt</td>
<td>30</td>
<td>∈ [27;31]</td>
</tr>
<tr>
<td>Capital Outflow</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Investment</td>
<td>16</td>
<td>∈ [20;22]</td>
</tr>
<tr>
<td>Private consumption</td>
<td>60</td>
<td>∈ [61;62]</td>
</tr>
<tr>
<td>Public Expenditure</td>
<td>20</td>
<td>19</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>β</td>
<td>0.95</td>
</tr>
<tr>
<td>θ</td>
<td>0.30</td>
</tr>
<tr>
<td>ν(g)</td>
<td>ln(g)</td>
</tr>
<tr>
<td>f(k)</td>
<td>k^{0.4}</td>
</tr>
<tr>
<td>δ</td>
<td>0.05</td>
</tr>
<tr>
<td>α</td>
<td>0.95</td>
</tr>
<tr>
<td>α^φ</td>
<td>0.998</td>
</tr>
<tr>
<td>ϕ</td>
<td>0.62</td>
</tr>
<tr>
<td>φ</td>
<td>0.85</td>
</tr>
<tr>
<td>π^d</td>
<td>0.04</td>
</tr>
<tr>
<td>π^i</td>
<td>0.04</td>
</tr>
<tr>
<td>π^p</td>
<td>∈[0;0.9]</td>
</tr>
<tr>
<td>ρ</td>
<td>∈[-0.3;1]</td>
</tr>
</tbody>
</table>

ρ is the correlation between moderate attacks, conditional to the no occurrence of an intense one.