Financial Crises, Dollarization, and Lending of Last Resort in Open Economies

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Motivation

- Recurrent financial crises in emerging economies
- Role of dollar liabilities: amplification
- Constraints on policy
- Some facts:
  - Excess return on local currency vs dollar (UIP violation)
  - Sizeable fraction of domestic savings in dollars
This paper

- Financial instability modelled as panics
- A theory of dollarization with important roles for:
  - UIP premium
  - Currency choice of domestic savers
- Identify challenges for domestic lending of last resort
- Introduce notion of “fiscally credible LOLR”
- See if reserves help
Ingredients

- Small open economy
- Agents: consumers, banks, international investors
- Collateral constraints for banks
- Currency choice in borrowing/lending
- Segmented markets
- Government with limited fiscal capacity
Consumers

• Preferences

\[ \mathbb{E} \left[ \sum_{t=0}^{2} \beta^t U(c_t) \right] \]

\[ c_t = (c_t^T)^\omega (c_t^N)^{1-\omega} \]

• Supply 1 unit of labor to tradable sector

• Endowment \( e_{c,t}^N \) of non-tradables

• Tradable = numeraire (= “dollar”)

• \( p_t \) price of non-tradables ("real exchange rate")

• Budget constraint

\[ q_t^T a_{t+1}^T + p_t q_t^N a_{t+1}^N + c_t^T + p_t c_t^N = w_t + p_t e_{c,t}^N + a_t^T + p_t a_t^N \]
Production

- Production of tradables

\[ Y_t = K_t^\alpha L_t^{1-\alpha} \]

- Banks can convert 1 unit of tradable in capital

- Consumers can convert \( \phi > 1 \) units of tradable in capital

- Capital fully depreciates

- Fixed total endowment of non tradables

\[ e_{c,t}^N + e_{b,t}^N = e^N \]
Foreign investors

- Foreign investors:
  - risk neutral with discount rate $\beta$
  - only consume $T$
  - only hold $T$ bonds (segmentation)
Banks

- Bankers: risk neutral agents who consume only tradables at $t = 2$
- Budget constraint at $t = 0, 1$

$$k_{t+1} = r_t k_t - b_t^T + p_t (e_{b,t}^N - b_t^N) + q_t b_{t+1}^T + p_t q_t^N b_{t+1}^N$$

- Collateral constraint

$$b_{t+1}^T + p_{t+1} b_{t+1}^N \leq \theta k_{t+1}$$
1 No government intervention
   • $t = 1, 2$: continuation equilibria
   • $t = 0$: endogenous dollarization

2 Lending of last resort
   • $t = 1, 2$: ex-post interventions
   • $t = 0$: reserve accumulation
Continuation equilibrium: NT market

- In equilibrium price is constant in periods 1 and 2
- Equilibrium condition in NT good market

\[
\frac{1}{p_1} \frac{1 - \omega}{1 + \beta} \left( a_1^T + p_1 a_1^N + w_1 + \beta w_2 + p_1 (e_{c,1}^N + \beta e_{c,2}^N) \right) = e^N,
\]

- Future wages are \( w_2 = (1 - \alpha)K_2^\alpha \)
- Increasing relation

\[
p_1 = \mathcal{P}(K_2)
\]

- Balassa-Samuelson effect
Continuation equilibrium: Banks

- Net worth is increasing in $p_1$, assuming $e_{b,1}^N > b_1^N$

- Three cases:
  - High net worth: reach first best $K^*$
  - Low net worth: reach $K$ at which consumers use inferior investment technology
  - Intermediate net worth: $K_2$ is increasing in $p_1$

- So we have another increasing mapping

\[ K_2 = \mathcal{K}(p_1) \]
Continuation equilibria

(a) Unique continuation equilibrium

(b) Multiple continuation equilibria
Continuation equilibria

- Multiple equilibria possible
- “3rd generation” currency crisis (Krugman, 1999)
- Low equilibrium features:
  - Lower investment
  - Lower consumption
  - Lower CA deficit
  - Lower utility for bankers (under some condition)
- Shifting debt composition towards $T$ debt eliminates bad equilibrium
Debt denomination and multiplicity
1 No government intervention
   • $t = 1, 2$: continuation equilibria
   • $t = 0$: endogenous dollarization

2 Lending of last resort
   • $t = 1, 2$: ex-post interventions
   • $t = 0$: reserve accumulation
Endogenous dollarization

- Will banks choose debt composition that exposes them to a crisis?
- Or: can we sustain multiple continuation equilibria, with a sunspot selecting both with positive probability?
- A: Yes
  - Banks have a hedging motive, which tends to eliminate multiplicity
  - But households have a hedging motive too, which can dominate
Hedging

- Hedging motive for banks

\[ \lambda_{b,1} = \frac{r_2 - \theta}{1 - \beta \theta}. \]

- Hedging motive for consumers

\[ \lambda_{c,t} = (c_t^T)\omega(1-\gamma)\omega^{-1} \]

- Two states/two assets: equivalence with complete markets

- In equilibrium

\[ \lambda_{c,1} = \Phi \lambda_{b,1} \]
Fragile equilibrium

• Portfolio choice between T and NT saving/borrowing

• In fragile equilibrium, N bonds pay higher return in state of the world in which marginal utility of wealth is lower

\[1 + i_0^T - (1 + i_0^N)E \left[ \frac{p_1}{p_0} \right] = Cov \left( \left(1 + i_0^N \right) \frac{p_1}{p_0}, \frac{\lambda_1}{E[\lambda_1]} \right) < 0\]

• This holds both for banks’ and consumers’ marginal utility of wealth \( \lambda_1 \)

• Theory of dollarization: banks borrow in dollars because it’s cheap; it’s cheap because dollars appreciate when things go bad
Safe equilibrium

- When fragile equilibrium exists, there is also a safe equilibrium in which the continuation equilibrium is unique.

- In safe equilibrium:

\[ 1 + i_0^T - (1 + i_0^N)E\left[\frac{\rho_1}{\rho_0}\right] = 0 \]

- Now no risk, consumers no longer ask for protection.
• To construct examples, start from continuation with two equilibria and $b_1^N = a_1^N = 0$

• Choose risk aversion so risk-sharing condition satisfied

\[
\left( \frac{w_1 + \beta w_2^B + a_1^T}{w_1 + \beta w_2^G + a_1^T} \right)^{(1-\gamma)\omega^{-1}} = \frac{r_2^B - \theta}{r_2^G - \theta}
\]

• If consumers not risk averse enough, equilibrium is unique
### Example

<table>
<thead>
<tr>
<th></th>
<th>Safe</th>
<th>Fragile</th>
</tr>
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<tbody>
<tr>
<td>$a_1^N, b_1^N$</td>
<td>0.40</td>
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<tr>
<td>$a_1^T$</td>
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<tr>
<td>$b_1^T$</td>
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<td>St. dev. of log $w_2$</td>
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<tr>
<td>St. dev. of log $p_1$</td>
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<td>0.025</td>
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<td>Covar. of log $w_2$ and log $p_1$</td>
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<td>0.002</td>
</tr>
<tr>
<td>$\mathbb{E}[(1 + i_0^N)(p_1/p_0)]$</td>
<td>1.01</td>
<td>1.06</td>
</tr>
<tr>
<td>$(1 + i_0^T)$</td>
<td>1.01</td>
<td>1.01</td>
</tr>
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</table>
Roadmap

1. No government intervention
   - $t = 1, 2$: continuation equilibria
   - $t = 0$: endogenous dollarization

2. Lending of last resort
   - $t = 1, 2$: ex-post interventions
   - $t = 0$: reserve accumulation
Lending of Last Resort

- At $t = 1$ benevolent government transfers $T_b$ to banks in exchange for repayment $R$

- No superior ability to enforce

\[ R + b_2^T + p_2 b_2^N \leq \theta k_2 \]

- Limited fiscal capacity: only labor tax, with $\tau_t \leq \xi$

- Microfoundation: informal sector, with technology

\[ \tilde{K}_t^\alpha ((1 - \xi) \tilde{L}_t)^{1-\alpha} \]

- Government chooses $\{\tau_t, T_t, B_2^T, R, A_2^T\}$ to maximize social welfare

\[ \sum_{t=1}^{2} \beta^{t-1} U(c_t^T, e^N) + \Phi \beta c_b^T \]

- $\Phi$ chosen so that no redistributive motive at first best
Timing

Split $t = 1$ in two subperiods:

i. Agents form expectations $w_2^e$ and:
   - Trade on NT market and determine $p_1$
   - Set maximum they are willing to lend to the government based on expected fiscal resources

\[-A = \xi w_2^e + R^e\]

ii. Government sets optimal policy and remaining markets clear

Equilibrium:

- Government maximize, taking as given $p_1$ and $A$
- Private sector expectations consistent with government optimality
The government problem is equivalent to

$$\max_{c^T, c_b^T, k_2, K_2} (1 + \beta) U(c^T, e^N) + \Phi \beta c_b^T$$

subject to

$$(1 + \beta) c^T + \beta c_b^T \leq A_1^T + K_1^\alpha + \beta K_2^\alpha - k_2 - \phi (K_2 - k_2) \quad \text{(IRC)}$$

$$c_b^T \geq \alpha K_2^{\alpha-1} k_2 - \theta k_2 \quad \text{(PC)}$$

$$\frac{n_1}{1 - \beta \theta} \leq k_2 \leq \frac{M}{1 - \beta \theta} \quad \text{(FC)}$$

and equilibrium in inferior tech.

Define

$$M = n_1 + \xi (1 - \alpha) K_1^\alpha - \beta A$$

Key observation: $M$ is determined by private sector expectations
Optimal policy

- If $M < \hat{M}$ just implement bad continuation equilibrium.
- Locally no effects on wages (as $k_2 < K_2$)
- If $\hat{M} < M < M^*$ choose maximal intervention
- If $M \geq M^*$ implement good continuation equilibrium
- **Intuition**: Allocations are locally efficient because of complete markets and no pecuniary externalities at $B$
(c) Unique continuation equilibrium

(d) Multiple continuation equilibria
Fixed point

- Define $M$ under bad equilibrium beliefs

$$M^B = n_1^B + \xi (1 - \alpha)K_1^\alpha + \xi (1 - \alpha)K_2^\alpha$$

- If $M^B > \hat{M}$ government can uniquely select good equilibrium
- If $M^B < \hat{M}$ multiplicity survives government intervention
Roadmap

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Reserves

- Suppose now government enters $t = 1$ with position $A_1^T, A_1^N$
- The value of this position is
  \[ A_1^T + p_1 A_1^N \]
- Now when expectations are low, $p_1$ is low
- **Result:** If government takes positions $A_1^N < 0 < A_1^T$ that satisfy
  \[ A_1^T + p_1^B A_1^N > \hat{M} - M^B \]
  it can uniquely implement good equilibrium at $t = 1$
- Interpretation: borrowing in domestic currency to accumulate foreign currency reserves makes LOLR commitment credible
Remarks on reserves

- Required reserves increase with the leverage of the financial sector. Obstfeld et al. (2010); Ainzemann and Lee (2007)
- Reserve might never be used in equilibrium. Aizeman and Sun (2012); Jeanne and Sandri (2016)
- Reserves reduce exchange rate volatility
Moral hazard?

- For *given interest rates*, interventions that lowers $r_2$ in bad equilibrium give bankers incentive to issue more dollar debt.

- However, as households save more in NT, lower interest rates on NT borrowing give less incentive to borrow in dollars.

- **Result**: Reserve accumulation at $t = 0$ that eliminates bad equilibrium does not lead to more risk taking.
Concluding

• What does it mean to have a stable currency?

• Item: having abundant sources of funding in that currency

• Stable inflation is important, but also needs financial stability, so agents willing to save in local currency

• For future work: interactions with other policy tools (monetary policy, regulation, currency interventions)