A Simple Quantitative Model of Financial Crises in Open Economies

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March, 2016
Motivation

Stylized facts from financial crises

- external borrowing interest rate rises

- firms under financial distress fire-sale asset: e.g., Schnabel and Shin (2004), Coval and Stafford (2007)

  - misallocation accounts for more than half of measured aggregate TFP drop in Argentina 2001
What we do in the model

- financial crises driven only by external interest rate spike
- firms/banks who have high leverage bind financial constraints and fire-sale asset
- capital misallocation and endogenous output drop
Model - Households

- **Endowment**: $W$ (natural resources e.g., oil)

- **Dividend** $d$ from firms

- **Produce** by employing capital good: $y_h = Bk_h^\alpha$ with $0 < \alpha < 1$
  - interpretation: combination of households, and firms who do not expose to external debt

- **Consumption** given by
  
  $$C = W + d + Bk_h^\alpha + q(k_h - k'_h)$$

  with $q$ capital good price and use '$' to denote next period variable

- **Lifetime utility**
  
  $$\sum_{t=0}^{\infty} \beta^t U(C_t) = \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\sigma} - 1}{1-\sigma}$$
“Firms” capture firms/banks who exposed to foreign debt in reality

Firms’ capital structure: external **debt** and domestic **equity**:

\[
V(b, k_b, \tilde{s}) = \max_{b', d, k'_b} d + E[\beta \frac{\Lambda'}{\Lambda} V(b', k'_b, \tilde{s}')]
\]

where \(\tilde{s}\) denotes aggregate state.

- **Dividend** payment \(d = Ak_b^\alpha - b + \frac{b'}{R} - \frac{\xi}{2} b'^2 + q(k_b - k'_b)\)
Model - Firms

- Dividend **constraint** (equity issuance constraint when \( d = 0 \))
  \[ d \geq dA_k^\alpha \]

  - Brav et al. (2005) managers’ desire to **avoid dividend cuts**

- Upon interest rate spike, firms would like to cut dividend or raise equity but can not, so fire-sale to unconstrained sector
  - occasionally binding financial constraint: non-linear dynamics
  - misallocation of capital induces output drop

- Fixed capital supply \( K = K_h + K_b \)
Private Sector Equilibrium

- Only interest rate shock
- Variables \( \{K'_h, K'_b, C, \Lambda, b', \mu, q, R\} \), where \( \mu \) is LM of the dividend constraint

\[
q = \beta E \left[ \frac{\Lambda'}{\Lambda} (B \alpha K'_h \alpha^{-1} + q') \right]
\]

\[
q(1 + \mu) = \beta E \left[ \frac{\Lambda'}{\Lambda} [(A \alpha K'_b \alpha^{-1} + q')(1 + \mu') - d\mu' A \alpha K'_b \alpha^{-1}] \right]
\]

\[
K = K_h + K_b
\]

\[
C = W + AK_b^\alpha + BK_h^\alpha - b + \frac{b'}{R} - \frac{\xi}{2} b'^2
\]

\[
(1 + \mu) \left( \frac{1}{R} - \xi b' \right) = \beta E \left( \frac{\Lambda'}{\Lambda} (1 + \mu') \right)
\]

\[
\mu( AK_b^\alpha - b + \frac{b'}{R} - \frac{\xi}{2} b'^2 + q[K_b - K'_b] - dAK_b^\alpha) = 0, \mu \geq 0, d \geq dAK_b^\alpha
\]

\[
\Lambda = C^{-\sigma}
\]

- Interest rate shocks: **Regime 1**, AR(1) process with low mean; **Regime 2**, very high interest rate to capture the ”asymmetry” of interest rate process
Regime 1: \( \log R' - \mu_R = \rho (\log R - \mu_R) + \sigma_R \epsilon \), Regime 2: \( \log R = \mu_R^H \). Regime switching: prob. \( p_{12} \) and \( p_{21} \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>( \sigma )</td>
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<tr>
<td>( \beta )</td>
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<tr>
<td>( \xi )</td>
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<td>( W )</td>
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<td>( A )</td>
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<tr>
<td>( B )</td>
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<tr>
<td>( \alpha )</td>
<td>0.65</td>
</tr>
<tr>
<td>( K )</td>
<td>1</td>
</tr>
</tbody>
</table>

Grids for \( b \): \([-2.5, 1.35]\]
Grids for \( k_b \): \([0.3, 0.7]\]
Simulation - Compare $d = 0.83$ (Left) and $d = -\infty$ (Right)

- **precautionary** debt position under financial friction: mean debt 0.9561 v.s. 0.9711
Simulation - Compare $d = 0.83$ (Left) and $d = -\infty$ (Right)

- **misallocation** and endogenous output drop
Simulation - Crisis Dynamics with $d = 0.83$

- **Crisis Definition**: period $t$ output is above or equal to mean of output, while $t + 5$, output is 2% below mean. Average windows $t - 4$ to $t + 10$. 

![Graphs of Crisis Dynamics](image_url)

- Output
- Bank Capital
- Exogenous Interest Rate
- External Debt
here closed economy will not generate output loss as immune from external interest rate shock

pecuniary externality through capital price $q$: scope for capital control or external leverage regulation

$$AK_b^\alpha - b + \frac{b'}{R} - \frac{\xi}{2} b'^2 + q(K_b - K'_b) \geq dAK_b^\alpha$$
Conclusion

- Build up a simple model of financial crises in open economies
- Asset fire-sale of firms under high debt, upon interest rate spike
- Capital misallocation and endogenous output drop
- Future work: add collateral constraint to amplify misallocation; study government asset purchase policy, leverage regulation policy and dividend tax policy etc.