Reserve Accumulation, Growth and Financial Crises

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Research questions

- What explains the spectacular accumulation of foreign exchange reserves in developing countries?

- Why do we observe a positive relationship between growth and current account surpluses?
Reserve accumulation in developing countries
GDP growth and current account (1980-2010)
GDP growth and reserve accumulation (1980-2010)
Empirical evidence

- Empirical regularities first emphasized by Gourinchas and Jeanne (2011) and by Alfaro, Kalemli-Ozcan and Volosovych (2011)

- These facts are hard to reconcile with the neoclassical growth model

- In the neoclassical growth model:
  - Faster growth is associated with higher capital inflows
  - The competitive equilibrium is efficient, hence no role for public intervention in capital flows
Our contribution

- We develop a theory of public intervention in capital flows

- Key elements:
  - Knowledge externalities in the tradable sector
  - International borrowing constraint

- The combination of these two elements provides an incentive for the government to accumulate reserves in order to stimulate growth
Our contribution (cont’d)

- Accumulation of reserves is associated with exchange rate undervaluation and faster growth

- Financial frictions create imperfect substitutability between private and public capital flows

- The possibility of using reserves during crises amplifies the positive relationship between reserve accumulation and growth

- The welfare gains from an appropriate reserve policy are substantial (in the order of a 1 percent permanent increase in consumption in our baseline calibration)
Related literature

- **Theories of reserve accumulation:** Durdu et al. (2010), Jeanne and Ranciere (2011), Dooley et al. (2003), Aizenman and Lee (2007), Rodrik (2009), Korinek and Serven (2010)

Plan of the talk

- Model
- Explanation of the mechanisms
- Reserve management in an economy opening to capital flows
- Welfare
Model

- Small open economy
- Two sectors: tradable and non-tradable
- Households, firms, foreign investors, government
Households

- Expected lifetime utility

\[ E_0 \left[ \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\gamma}}{1-\gamma} \right] \]

- Consumption aggregator

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

- Supply inelastically one unit of labor during each period

- Budget constraint

\[ C_t^T + P_t^N C_t^N = W_t + \Pi_t^T + \Pi_t^N \]
Real exchange rate and non-tradable sector

- Real exchange rate

\[ P_t^N = \frac{1 - \omega}{\omega} \frac{C_t^T}{C_t^N} \]

- Firms in the non-tradable sector maximize

\[ \Pi_t^N = P_t^N \left( L_t^N \right)^{\alpha_N} - W_t L_t^N \]
Firms: tradable sector

- Produce using labor $L_t^T$, imported inputs $M_t$ and knowledge $X_t$

$$Y_t^T = (X_t L_t^T)^{\alpha_T} M_t^{1-\alpha_T}$$

- Dividends

$$\Pi_t^T = Y_t^T - W_t L_t^T - P^M M_t - B_{t+1} + RB_t - T_t$$

- Firms maximize

$$E_0 \left[ \sum_{t=0}^{\infty} \beta^t \lambda_t \Pi_t^T \right]$$
Working capital

- Working capital requirement: a fraction $\phi$ of the imported inputs has to be paid before production takes place

$$\phi P^M M_t = D^G_t + D^P_t$$

- We assume a zero interest rate on intraperiod loans
Borrowing constraint

To prevent defaults foreign investors impose the borrowing limit

\[-RB_t + D^P_t \leq \kappa_t X_t\]

- Bonds maturing in period $t$
- Intratemporal loan at time $t$
- Credit shock

Binding borrowing constraint interferes with:

- Consumption smoothing
- Import of intermediate goods
Knowledge accumulation

- Knowledge evolves according to

\[ X_{t+1} = \psi X_t + M_t^\xi X_t^{1-\xi} \]

- This is meant to capture spillovers of foreign knowledge through the imports of intermediate goods

- **Externality**: since knowledge is non-excludable firms do not internalize the impact of their actions on the future stock of knowledge
Discussion of growth process

- **Cross-country knowledge spillovers:** Klenow and Rodriguez-Clare (2005)


- ** Tradable sector as engine of productivity convergence:** Rodrik (2012)

- **Knowledge externalities:** Romer (1990), Grossman and Helpman (1991), Aghion and Howitt (1992)
Government

- Collects taxes to finance reserve accumulation
- Uses reserves to provide working capital loans to firms (efficiency loss as in Gertler and Karadi (2009))

\[ FX_{t+1} = R^{FX}FX_t + T_t - D_t^G \frac{\theta}{1 - \theta} \]

- Reserves cannot be negative and pay a return lower than the world interest rate
Market clearing

- Tradable good

\[ C_t^T = Y_t^T - P^M M_t - B_{t+1} + RB_t - FX_{t+1} + R^{FX} FX_t - D_t^G \frac{\theta}{1 - \theta} \]

- Non-tradable good

\[ C_t^N = Y_t^N \]

- Labor

\[ L_t^T + L_t^N = 1 \]
Intervention - tranquil times

- When firms are not financially constrained an increase in reserves leads to a higher use of imported inputs and faster growth
  - Increase in the stock of reserves
  - Decrease in consumption of tradables
  - Real exchange rate depreciation
  - Wages decrease and firms in tradable sector employ more labor
  - Use of imported inputs increases
  - Faster accumulation of knowledge

- Focus on reserve accumulation rules of the form

\[ FX_{t+1} - R^{FX} FX_t = \chi Y_t^T \]
Intervention - tranquil times \( (FX_{t+1} - R^{FX}FX_t = \chi Y_t^T) \)
 Intervention - crises

- When firms are financially constrained

\[ M_t = \frac{X_t \kappa_t + RB_t + D_t^G}{\phi P^M} \]

- Government can increase the use of imported inputs by using foreign exchange reserves to finance working capital

- We assume that the government uses at most a fraction \( \chi^{WK} \) of its stock of reserves to finance working capital
Intervention - crises (cont’d)

**Credit shock**

**GDP**

**Imported inputs**

**Real exchange rate**

**Private foreign debt**

**Foreign exchange reserves**

- Red line: with intervention
- Blue line: w/o intervention
Policy intervention and financial liberalization

- To illustrate the properties of the model we look at the impact of policy on an economy that it is opening to capital flows (i.e. \( B_0 = FX_0 = 0 \))

- 1. We look at the effect on growth and capital flows by comparing an economy without intervention to one with the optimal policy rule (\( \chi = 0.09, \chi^{WK} = 1 \))

- 2. We compute the welfare gains from policy intervention

- We assume two possible realizations for the credit shock \( k_H > k_L \)
Table 1: Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
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<tbody>
<tr>
<td>Risk aversion</td>
<td>$\gamma$</td>
<td>2</td>
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<tr>
<td>Interest rate on private borrowing</td>
<td>$R$</td>
<td>1.04</td>
</tr>
<tr>
<td>Discount factor</td>
<td>$\beta$</td>
<td>$1/R$</td>
</tr>
<tr>
<td>Labor share in output in tradable sector</td>
<td>$\alpha_T$</td>
<td>0.65</td>
</tr>
<tr>
<td>Labor share in output in non-tradable sector</td>
<td>$\alpha_N$</td>
<td>0.65</td>
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<tr>
<td>Share of tradable goods in consumption</td>
<td>$\omega$</td>
<td>0.341</td>
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<tr>
<td>Price of imported inputs</td>
<td>$P^M$</td>
<td>1</td>
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<tr>
<td>Borrowing limit</td>
<td>$\kappa_L$</td>
<td>0.1</td>
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<tr>
<td>Probability of bad credit shock</td>
<td>$1 - \rho_H$</td>
<td>0.1</td>
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<tr>
<td>Probability of exiting bad credit shock</td>
<td>$1 - \rho_L$</td>
<td>0.5</td>
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<td>Working capital coefficient</td>
<td>$\phi$</td>
<td>0.33</td>
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<tr>
<td>Elasticity of TFP w.r.t. imported inputs</td>
<td>$\xi$</td>
<td>0.15</td>
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<td>Constant in knowledge accumulation process</td>
<td>$\psi$</td>
<td>0.34</td>
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<tr>
<td>Interest rate on reserves</td>
<td>$R^{FX}$</td>
<td>1</td>
</tr>
<tr>
<td>Efficiency of government intervention during crises</td>
<td>$\theta$</td>
<td>0.5</td>
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</tbody>
</table>
Reserve management, growth and capital flows

Private NFA/GDP

Reserves/GDP

Current account/GDP

Knowledge growth

Probability binding constraint

GDP

Consumption of tradables

Consumption of nontradables

Real exchange rate

No intervention

Optimal policy
Welfare

![Graph showing consumption equivalent in percent for different values of $\chi^{WK}$]
The social planner does not accumulate reserves.

The first best can be replicated by subsidizing the purchase of intermediate inputs.

Subsidies to exporters can conflict with trade agreements.

Reserve accumulation can be used to circumvent the restrictions imposed by trade agreements.
Conclusions

- We provide a novel framework able to reproduce the positive correlation between reserve accumulation, current account surplus and growth observed in the data.

- Future research:
  - Interaction between reserve management and capital controls
  - Global imbalances and reserve accumulation