Capital Controls and Optimal Chinese Monetary Policy

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\textsuperscript{1}The views expressed herein are those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of San Francisco or the Federal Reserve System.
China’s monetary policy constrained by its trade policy

Existing trade policy regime:

1. Nominal exchange rate pegs
2. Closed capital account

- Undervalued currency $\Rightarrow$ persistent trade surpluses and foreign currency inflows.

- Capital controls $\Rightarrow$ rapid accumulation of foreign reserves on CB balance sheet.
PBOC engages in extensive foreign asset sterilization

- Under capital controls, restrictions on Chinese holding foreign assets and foreign investors holding Chinese assets
  - China’s international investment positions very small (Song, et al., 2013)
  - Significant deviations from CIP between 1999 and 2007 (Shu, et al., 2009)

- Exporters sell foreign-currency revenues to PBOC (China’s CB) at prevailing exchange rate

- PBOC sterilizes purchases by selling domestic bonds (to avoid increases in money supply)

- Relative yields of foreign and domestic assets determine sterilization gains or losses.
Global financial crisis changed sterilization calculus

- Prior to crisis, Chinese rates lower ⇒ fiscal benefits to sterilization [e.g. Prasad and Wei (2007)]
  - With crisis, large drops in global interest rates
- Positive spread in Chinese rates ⇒ marginal fiscal costs of sterilization
- PBOC now faces tradeoff between costs of sterilization and inflation
Global crisis and the “reversal of fortune” for PBOC

“*This looks like a glaring violation of UIP*” [Bob Hall, informal comments, 2014]

“*The dollar is our currency, but your problem.*” [John Connally, U.S. Treasury Secretary, 1971]
Higher sterilization cost accompanied by higher inflation
What we do in this paper

- Build a DSGE model with “Chinese characteristics”
  - Capital controls
  - Exchange rate pegs
  - Sterilized interventions
- Examine optimal monetary policy responses to a persistent decline in foreign interest rate
  - Tradeoff between sterilization costs and inflation
- Study alternative liberalization of policies in a unified DSGE framework
Related literature

- **Optimal monetary policy**
  - Simple NK models: maintaining price stability closes output gap (Woodford, 2003)
  - Nominal rigidities: tradeoff can arise (Erceg, et al., 2000; Mankiw-Reis, 2004; Benigno, 2004; Huang-Liu, 2005)

- **Capital controls**
  - Jeanne and Korinek (2010) and Bianchi (2013): Time-varying borrowing tax stabilizes credit cycles, improves welfare
  - Farhi and Werning (2012): Capital controls mitigate effects of excessive capital movements
  - Song, Storesletten, and Zilibotti (2013): Capital controls exacerbate misallocation for China

- **This paper**: Capital controls imply a monetary policy tradeoff between sterilization costs and inflation stability
Model features

1. Capital market frictions:
   - Imperfect asset substitutability $\Rightarrow$ UIP wedge
   - Restricted private-sector access to foreign asset markets (capital controls)
   - Foreign investors not allowed to hold Chinese assets

2. Nominal rigidities

3. Pegged exchange rate and sterilization policy
   - CB targets pace of nominal exchange rate appreciation and purchases foreign assets at ongoing exchange rate
   - Financed by sterilization (domestic bonds) or increase in money supply
Model feature I: Imperfect asset substitutability

- Utility function

\[ U = \mathbb{E} \sum_{t=0}^{\infty} \beta^t \left\{ \ln C_t + \Phi_m \ln \frac{M_t}{P_t} - \Phi_l \frac{L_t^{1+\eta}}{1 + \eta} \right\} \]

- Household faces budget constraints with quadratic portfolio adjustment costs

\[ C_t + \frac{M_t}{P_t} + \frac{B_t + e_t B_{pt}^*}{P_t} \left[ 1 + \frac{\Omega_b}{2} \left( \frac{B_t}{B_t + e_t B_{pt}^*} - \bar{\psi} \right)^2 \right] \leq \]

\[ w_t L_t + \frac{M_{t-1}}{P_t} + \frac{R_{t-1} B_{t-1} + e_t R_{t-1}^* B_{p,t-1}^*}{P_t} + \frac{D_t}{P_t}, \]

- \( \Omega_b \) reflects restricted access to foreign asset markets under capital controls, but allowing for “leakage”
Model feature I: Imperfect asset substitutability (cont’d)

- Portfolio adjustment costs $\Rightarrow$ UIP wedge:
  \[
  \hat{R}_t - \hat{R}_t^* = E_t \hat{\gamma}_{e,t+1} + \Omega_b \hat{\psi} \hat{\psi}_t,
  \]
  where $\psi_t$ denotes portfolio share of domestic bond

- Presence of UIP wedge $\Rightarrow$ imperfect international risk sharing: inefficiency even without monopolistic distortions
Model feature II: Nominal rigidities

- **Production function**

\[ Y_t(j) = \Gamma_t(j)^{\phi}(Z_tL_t(j))^{1-\phi}, \quad j \in [0, 1] \]

where \( \Gamma_t \) is a composite of domestic and imported intermediate goods

- **Quadratic price adjustment costs**

\[ \frac{\Omega_p}{2} \left( \frac{P_{t+k}(j)}{\pi P_{t+k-1}(j)} - 1 \right)^2 C_{t+k} \]

- **Phillips curve with sticky prices \( \Rightarrow \) monetary policy has real effects**
Model feature III: Sterilization

- Foreign investors are not allowed to hold Chinese assets (part of capital controls)
- Flow of funds constraint for government

\[ e_t(B^*_{gt} - R^*_{t-1}B^*_{g,t-1}) \leq B_t - R_{t-1}B_{t-1} + M^s_t - M^s_{t-1} \]

- CB purchases foreign assets at the ongoing exchange rate, financed by domestic bond or money supply
- Non-Ricardian feature: No lump-sum taxes/transfers ⇒ CB portfolio compositions have real effects
External accounts

- Current account net exports plus earnings on foreign assets

\[ ca_t = e_t \frac{B_t^* - B_{t-1}^*}{P_t} = X_t - q_t \Gamma_f t + \frac{e_t(R_{t-1}^* - 1)B_{t-1}^*}{P_t} \]

- Export demand taken as given

\[ X_t = \left( \frac{P_t}{e_t P_t^*} \right)^{-\theta} \tilde{X}_t^* Z_t = q_t^\theta \tilde{X}_t^* Z_t \]
External shocks are persistent

- **Interest rate shock**

\[ \ln R^*_t = (1 - \rho_r) \ln R^* + \rho_r \ln R^*_{t-1} + \sigma_r \varepsilon_{rt} \]

- **Export demand shock**

\[ \ln \tilde{X}^*_t = (1 - \rho_x) \ln \tilde{X}^* + \rho_x \ln \tilde{X}^*_{t-1} + \sigma_x \varepsilon_{xt} \]
Optimal monetary policy

- Study Ramsey optimal policy under capital controls and exchange-rate pegs
- Ramsey planner maximizes representative household’s welfare subject to private optimizing conditions
- Study macro responses to shocks to foreign interest rate and export demand under calibrated parameters
- Examine counterfactual policy reforms
Parameter calibration (highlights)

- Use Chinese data as much as possible, otherwise std US
- Average growth rate: 8 percent per year
- Price contract duration: 4 quarters
- Share of domestic intermediate input $\alpha = 0.756$ (matches int. input share of 0.5 and Import/GDP=0.2)
- Steady-state trade surplus 3% of GDP (average 90-09)
- Export demand elasticity $\theta = 1.5$ (Feenstra, et al., 2012)
- Estimate modified UIP condition from 22 EMEs (01-11)
  - Implies $\Omega_b = 0.22$.
  - Set $\Omega_b = 0.6$ for China to capture tighter K controls than other EMEs
Impact of negative foreign interest rate shock ($\rho_{r^*} = 0.98$)

1. $R^* \downarrow \Rightarrow$ sterilization cost $\uparrow \Rightarrow$ CB sterilizes less $\Rightarrow$ money supply $\uparrow$

2. Private portfolio rebalancing: relatively higher domestic rate $\Rightarrow$ higher share of private domestic bond holdings ($\psi \uparrow$)

3. Expansion in money supply raises AD $\Rightarrow$ $y$ and $\pi$ rise

4. Since $e$ is fixed, rise in $\pi$ $\Rightarrow$ real appreciation $\Rightarrow$ CA $\downarrow$

5. Lower $R^*_t$ further reduces CA surplus

6. Net effects in calibrated model: decline in $R^*$ $\Rightarrow$ short run increases in $y$ and $\pi$
Effects of negative shock to foreign interest rate:

Benchmark

- **Real GDP**
- **Inflation**
- **Domestic bond share**
- **Money growth**
- **Real exchange rate**
- **Current account**
Counterfactual liberalization of policy

1. Partially lifting capital controls while keeping ex. rate peg
   - Lower $\Omega_b$ from 0.6 to 0.3 (closer to other EMEs)

2. Floating exchange rate while maintaining capital controls
   - Nominal anchor provided by Taylor rule

3. Liberalizing controls on both K account and exchange rate
   - Under each regime, study optimal monetary policy responses and welfare following external shocks
Macro stability and welfare under optimal policy

<table>
<thead>
<tr>
<th></th>
<th>Benchmark</th>
<th>Open capital account</th>
<th>Flex FX</th>
<th>Full reform</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma_y$</td>
<td>0.0285</td>
<td>0.0296</td>
<td>0.0078</td>
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<td>$\sigma_\pi$</td>
<td>0.0106</td>
<td>0.0112</td>
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<td>$\sigma_L$</td>
<td>0.0241</td>
<td>0.0239</td>
<td>0.0150</td>
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<td>$\sigma_q$</td>
<td>0.1899</td>
<td>0.1870</td>
<td>0.0926</td>
<td>0.1007</td>
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<td>$\sigma_{ca}$</td>
<td>3.6873</td>
<td>3.5944</td>
<td>3.3412</td>
<td>3.2838</td>
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<tr>
<td>Welfare gains</td>
<td>—</td>
<td>0.0002</td>
<td>0.0103</td>
<td>0.0080</td>
</tr>
</tbody>
</table>
New CLSZ paper examines RR policy

- Under capital controls, RR helps mop up foreign exchange reserves (Ma, et al. (2013))
- Under certain circumstances, may be cheaper mechanism for alleviating inflation pressures
- But need to consider allocative effects
- ↑ RR reallocates investment away from SOEs

PBOC frequently adjusts reserve requirements

Since 2006, adjusted RR 40 times
Between 2006 and 2011, RR rose from 8.5% to 21.5%
What we do

- Build a DSGE model with financial frictions and Chinese characteristics to study:
  1. implications of RR policy for allocation efficiency, aggregate productivity, and social welfare
  2. role of RR policy in stabilizing business cycle fluctuations
  3. optimal RR policy and its interactions with interest-rate policy
Main finding: Interest rate and RR complementary policy instruments

- Interest-rate rule effective for stabilizing inflation and output
- RR rule helpful for reallocating resources between sectors
- Greater welfare gains when both instruments used together
Setup

- Generalize BGG (1999) to capture Chinese characteristics
  - Two sectors: SOEs and POEs, with identical technology, but POE TFP higher
  - Two types of financial intermediaries and segmented credit markets
    - Commercial banks (lend to SOEs)
    - Shadow banks (lend to POEs)
  - Government guarantees SOE debt
    - Commercial banks subject to reserve requirements
### Compare macro stability and welfare under 4 alternative policy rules

<table>
<thead>
<tr>
<th>Variables</th>
<th>Benchmark</th>
<th>Optimal $\tau$ rule</th>
<th>Optimal $R$ rule</th>
<th>Jointly optimal rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\psi_{rp}$</td>
<td>1.50</td>
<td>1.50</td>
<td>1.93</td>
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<td>$\psi_{ry}$</td>
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<td>0.50</td>
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<td>$\psi_{\tau p}$</td>
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<td>374</td>
<td>0.00</td>
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<tr>
<td>$\psi_{\tau y}$</td>
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<td>417</td>
<td>0.00</td>
<td>-913</td>
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</table>

**Volatility**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Benchmark</th>
<th>Optimal $\tau$ rule</th>
<th>Optimal $R$ rule</th>
<th>Jointly optimal rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>$GDP$</td>
<td>5.351%</td>
<td>5.375%</td>
<td>5.321%</td>
<td>5.325%</td>
</tr>
<tr>
<td>$\pi$</td>
<td>0.617%</td>
<td>0.598%</td>
<td>0.381%</td>
<td>0.398%</td>
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<tr>
<td>$C$</td>
<td>4.956%</td>
<td>4.954%</td>
<td>4.926%</td>
<td>4.925%</td>
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<tr>
<td>$H$</td>
<td>0.749%</td>
<td>0.723%</td>
<td>0.792%</td>
<td>0.855%</td>
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<tr>
<td>$R$</td>
<td>0.525%</td>
<td>0.511%</td>
<td>0.475%</td>
<td>0.724%</td>
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<tr>
<td>$Y_s$</td>
<td>5.374%</td>
<td>5.412%</td>
<td>5.363%</td>
<td>6.887%</td>
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<tr>
<td>$Y_p$</td>
<td>5.468%</td>
<td>5.534%</td>
<td>5.493%</td>
<td>5.438%</td>
</tr>
</tbody>
</table>

**Welfare**

| Welfare gains | — | 0.019% | 0.023% | 0.493% |
Changes in RR reveal tradeoff between allocation efficiency and bankruptcy costs

- RR and interest rates are complementary policy instruments
  - Interest rate effective for macro stabilization
  - RR more useful for improving allocation efficiency and welfare

- Jointly optimal policies appear to rely on much larger RR and interest rate adjustments than either individual rule

- May not see these policies in practice for reasons outside our model
Conclusion

- Examine capital controls and RR policies in DSGE model with Chinese characteristics
  - Large welfare gains under jointly optimal rule imply complementarity of policies
- Caveats:
  - Results are “second-best”
  - Policy changes may markedly change tradeoffs
- Capital controls and RR considered independently, but commonly used together
  - Synthesis would be welcome, but numerically challenging
  - On list for future work
## Parameter calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td><strong>Preferences</strong></td>
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<tr>
<td>$\beta$</td>
<td>Subjective discount factor</td>
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<td>$\Phi_m$</td>
<td>Utility weight on money balances</td>
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<td>$\eta$</td>
<td>Inverse Frisch elasticity</td>
<td>2</td>
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<tr>
<td><strong>Technologies</strong></td>
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<tr>
<td>$\phi$</td>
<td>Cost share of intermediate goods</td>
<td>0.50</td>
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<td>$\lambda_z$</td>
<td>Mean productivity growth rate</td>
<td>1.02</td>
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<tr>
<td><strong>Nominal rigidities</strong></td>
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<tr>
<td>$\theta_p$</td>
<td>Elasticity of substitution</td>
<td>10</td>
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<tr>
<td>$\Omega_p$</td>
<td>Price adjustment cost</td>
<td>60</td>
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<td><strong>Portfolio adjustment</strong></td>
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<tr>
<td>$\Omega_b$</td>
<td>Portfolio adjustment cost parameter</td>
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<tr>
<td>$\psi$</td>
<td>Average portfolio share of domestic bonds</td>
<td>0.9</td>
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<tr>
<td><strong>International trade</strong></td>
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<tr>
<td>$\alpha$</td>
<td>Share of domestic intermediate goods</td>
<td>0.7556</td>
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<td>$\theta$</td>
<td>Export demand elasticity</td>
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<td><strong>Shock processes</strong></td>
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<tr>
<td>$\rho_r$</td>
<td>Persistence of foreign interest rate shock</td>
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<td>Persistence of export demand shock</td>
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<td>$\sigma_x$</td>
<td>Standard deviation of export demand shock</td>
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