Modeling Sterilized Interventions and Balance Sheet Effects of Monetary Policy

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Outline

1. Motivation
2. Model
3. Discussion
4. Simulations
Main Themes

- Exchange rate interventions an important and actively used instrument in developing world
- Standard modeling of CB ex rate behavior using a modified Taylor rule inadequate
- Our model has FX interventions as an additional instrument working through balance sheet effects
  - Simple banking sector
  - Two risk premiums closing the model financial stocks
- Useful for modeling of hybrid IT regimes, crawling pegs or ex rate corridors
Ex Rate Interventions an Important Activity

- BIS Survey (2004)
- CB FX market activities
  - Reserve accumulation
  - Short-term oscillations smoothing
  - Market making
  - Reaching objectives, e.g. inflation, output
- Especially in developing and emerging economies
Ex Rate Interventions an Important Activity

Source: Haver, CEIC, Bloomberg, UBS estimates
Complex Policy Frameworks in Developing World

- Typically multiple objectives and instruments
- E.g. Pakistan
  - Objectives: inflation, FX reserve accumulation, domestic demand
  - Instruments: interest rate, FX interventions
  - Tightly managed ex rate by interventions
  - Independent interest rate setting targeting inflation
...and not only there

- Switzerland
  - Established IT
  - FX interventions as a part of monetary policy easing strategy
- Israel
  - Established IT
  - FX reserve accumulation program since 2008
  - Used as part of quantitative easing to support competitiveness and growth
- Emerging Europe
  - FX interventions back in fashion
  - Slovakia, Hungary, Romania, Poland, CR, Serbia...
Motivation

Conceptually Different Exchange Rate Activities

- Exchange Rate Management
  - CB FX market actions directly affecting the ex rate as the **operational objective**
  - via FX market interventions

- Exchange Rate Targeting
  - CB actions directed at achieving **intermediate objective** in terms of ex rate
  - e.g. by changing the interest rate
Motivation

Different Channels Involved

- FX targeting relies on otherwise standard instrument transmission channels
  - E.g. by affecting the interest rate setting
- FX management/interventions work as an independent instrument
  - Often hoping to enact different channels
  - E.g. interest rate for inflation, FX interventions to support growth
Motivation

Standard Modeling focused on Ex Rate Targeting

- Most literature focused on 'dirty' IT practices
  - Scott et al (2009) a review
- Does it make sense for a CB to include an ex rate term into the Taylor rule?

\[ i = \tilde{i} + \alpha (\pi - \pi^T) + \delta \hat{y} + \chi \Upsilon \]  
\[ \Upsilon = \hat{q} - \eta \hat{q}_{-1}, \]  
\[ \Upsilon = \eta \Delta s + (1 - \eta) (s - s^T). \]
Standard Literature Finds Little Support for Ex Rate Targeting

- Few reasons to include ex rate in developed economies
- EMs different structure
  - Financial and payment dollarization
  - Financially shallow and vulnerable
  - Credibility and expectations formation
  - Real ex rate appreciation
- Even in EMs: ex rate should play only limited role in the Taylor and carries significant risks

Benes, Berg, Portillo, Vavra (IMF, CNB)
... But it has only limited relevance for EMs

- FX market interventions (and not interest rates) are the main mechanism affecting the ex rate
- Including the ex rate into the Taylor reduces the autonomy in setting the policy rates and limits their volatility
- Policy transmission mechanism remains the same as in the standard IT model
Modeling ex rate management via ex rate rules has similar problems

\[
\hat{q} = \rho \hat{q}_{-1} + (1 - \rho) (\alpha \hat{\pi} + \delta \hat{y}), \tag{4}
\]

\[
s^T = \rho s^T_{-1} + (1 - \rho) (\alpha \hat{\pi} + \delta \hat{y}). \tag{5}
\]
Model Objectives

- FX interventions as a systematic instrument of a central bank, working independently of an interest rate instrument;
- FX interventions as an instrument capable of stabilizing the exchange rate fluctuations in a given stochastic band;
- Mechanism of removing a stochastic trend from the exchange rate;
- Balance sheet (liquidity) effects of interventions as a new channel of monetary policy transmission.
Key Features of the Solution

- Standard SOE NK model with changes in the behavior of
  - Households
  - Central bank
  - Banking Sector

- two central bank policy rules: one for interest rates, the other for foreign exchange reserves;

- optimizing banking sector;

- balance sheet effects of FX reserve accumulation;

- two endogenously derived risk premiums ensuring steady state determinacy of financial stocks and the exchange rate.
## Financial Sector Balance Sheets

<table>
<thead>
<tr>
<th>Central Bank</th>
<th>Banking Sector</th>
<th>Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F$</td>
<td>$O$</td>
<td>$O$</td>
</tr>
<tr>
<td></td>
<td>$L$</td>
<td>$B$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$L$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$NW$</td>
</tr>
</tbody>
</table>

- where $F$ is stock of FX reserves, $O$ are CB issued securities, $L$ are loans commercial banks provided to households, $B$ is refinancing from abroad, and $NW$ stands for household net worth.
- Note that $NFL = L$, $F = O$
Central Bank

- Two operational targets:
  - Interest rate (Taylor)
  - Ex rate (FX reserves accumulation rule)
- FX reserves accumulation rule

\[
\frac{F}{L} = \frac{\bar{F}}{L} + \omega \left( \frac{S}{S^T} \right).
\] (6)
Commercial Banks

\[
\max_{\{O,L\}} \Pi_{+1} = \exp(j)L + \exp(i)O - O + \exp(i^*) (O + L) \frac{S_{+1}}{S} - \Omega(O,L)
\]

- FOC wrt to O: UIP

\[
\exp(i) = \exp(i^*) \frac{S_{+1}}{S} + \Omega_O(O,L) = \exp(i^*) \frac{S_{+1}}{S} + \theta_O - \theta \sqrt{\frac{L}{O}}
\]

- FOC wrt to L: Credit supply curve

\[
\exp(j) = \exp(i^*) \frac{S_{+1}}{S} + \Omega_L(O,L) = \exp(i^*) \frac{S_{+1}}{S} + \theta_L - \theta \sqrt{\frac{O}{L}}
\]

\[
= \exp(i) + \theta_L - \theta_O - \theta \sqrt{\frac{O}{L}} \left(1 - \frac{L}{O}\right)
\]
Endogenous Risk Premiums/Spreads

- UIP risk premium **increasing** in F/L ratio
  \[ \Theta = \theta_O - \theta \sqrt{\frac{L}{F}} \]
- Credit rate spread falling in F/L ratio
  \[ \theta_L - \theta_O - \theta \sqrt{\frac{O}{L}} \left( 1 - \frac{L}{O} \right) \]
Households

- **Modified Budget Constraint**

\[ PC - L = -\exp(j_{-1})L_{-1} + \Pi - \Psi(L), \Psi'(L) > 0, \Psi''(L) > 0 \quad (7) \]

- **Modified Euler:**

\[ \frac{\lambda}{\lambda_{+1}} (1 - \Psi'(L)) = \beta \exp(j), \quad (8) \]

- \( \Psi'(L) \) is variable risk premium/discount factor (a la, SGU, 2003)
Closing of the Model in the Steady State

- Real variables and NFL fixed through
  \[
  \frac{\lambda}{\lambda+1} (1 - \Psi'(L)) = \beta \exp(j),
  \]

- Financial stocks fixed through
  \[
  \exp(i) = \exp(i^*) \frac{S+1}{S} + \Omega_O(O,L) = \exp(i^*) \frac{S+1}{S} + \theta_O - \theta \sqrt{\frac{L}{O}}
  \]

- Exchange rate fixed through
  \[
  \frac{F}{L} = \frac{\overline{F}}{L} + \omega \left( \frac{S}{S^T} \right).
  \]
Intervention Mechanism

- FX intervention rule
  \[
  \frac{F}{L} = \frac{\bar{F}}{L} + \omega \left( \frac{S}{S^T} \right)
  \]  \hspace{1cm} (9)

- UIP
  \[
  \exp(i) = \exp(i^*) \frac{S_{+1}}{S} + \theta_0 - \theta \sqrt{\frac{L}{F}}
  \]  \hspace{1cm} (10)

- Controls for stochastic behavior of the exchange rate
Two Risk Premiums

- Euler: $\Psi'(L)$
- UIP: $\theta_0 - \theta \sqrt{\frac{L}{F}}$

Necessary for closing the model
- UIP risk premium has to be increasing in the stock FX reserves for a stable solution

Simple way of introducing balance sheet effects and portfolio choice into an otherwise standard model
- Many additional applications of this approach, e.g. Loan-to-Deposit, Loan-to-Capital ratios
Foreign Interest Rate Shock

- Nicely illustrates different responses under various ways of fixing exchange rate
- Four regimes distinguished

<table>
<thead>
<tr>
<th>Regime/parameter</th>
<th>$\chi$</th>
<th>$\omega$</th>
</tr>
</thead>
<tbody>
<tr>
<td>float</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>fixed via taylor</td>
<td>$\infty$</td>
<td>0</td>
</tr>
<tr>
<td>fixed via interventions</td>
<td>0</td>
<td>$\infty$</td>
</tr>
<tr>
<td>managed</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>
Simulations

Foreign Interest Rate Shock

Inflation

Consumption

Labor X

Policy Rate

Ex Rate

FX Reserves in USD

FX Reserves/NFL

NFL/NGDP

- Pure IT
- Fixed via Interventions
- Fixed via Int Rate
- IT - Managed Float
Simulations

Problems fixing the exchange rate through interest rates

- In float, interest rates react to fight inflation (under relatively stable economy)
- In fixed through Taylor, they rise despite falling inflation and economy
- Fixing through interventions gives room to use interest rates in limiting the economic and inflation decline
- This mechanism is also used by managed exchange rate
Conclusions

- Modeling framework for monetary policy using interventions as an independent instrument
- Useful for hybrid IT, crawling pegs, and ex rate corridors, including ERM II mechanism
- Balance sheet effects needed to make the interventions working
  - Two rules necessary to close the model
  - Introduced in a very simple and malleable way (using a simple banking sector)