FX intervention and monetary policy design: a market microstructure analysis
Carlos Montoro (BIS) & Marco Ortiz (BCRP & LSE)

Presented by:
Marco Ortiz

Fourth BIS CCA Research Conference
Santiago de Chile, Chile
marco.ortiz@bcrp.gob.pe

All views expressed in this presentation are those of the author and do not necessarily represent the views of the Central Reserve Bank of Peru.
Table of Contents

Introduction

The Model

Results

Heterogeneous Information

Conclusions
MOTIVATION

- Many central banks (EMEs/AEs) have reacted with FX (sterilised) interventions to capital inflows.

FX intervention: 2009 - 2012

(As a percentage of average foreign exchange reserve minus gold)

AR² - Argentina; BR³ - Brazil; CH⁹ - Switzerland; CL⁴ - Chile; CO⁶ - Colombia; JP - Japan; MX - Mexico; PE - Peru.

Sources: National data; BIS calculations.
MOTIVATION

Questions that need to be addressed

- How sterilised intervention affects the transmission mechanism of monetary policy?
- Which channels are at work (portfolio/signaling channel)?
- Are there benefits for intervention rules?
- What should be the optimal monetary policy design?
What other authors have done? (1)

- Lyons (2001): ”the exchange rate determination puzzle”.
- **FX microstructure.** Evans & Lyons (2002) and others: short-run exchange rate volatility is related to order flow.
- **Information heterogeneity.** Bacchetta & van Wincoop (2006): exchange rates in the short run closely related to order flow (little with fundamental).
What do we do?

1) We extend an SOE New Keynesian model, including:

- A market of risk averse FX dealers.
- An explicit role for exchange rate volatility.
- The interaction of FX intervention with monetary policy.
- Extension: information heterogeneity across FX dealers.

What do we find?

FX intervention...

- strong interactions between FX intervention and monetary policy,
- the source of exchange rate movements matters for the effectiveness of interventions,
- rules can make FX interventions more effective as a stabilisation instrument (expectations channel),
- overall, the control over the exchange rate variance reduces the importance of non-fundamental shocks in the economy,
- this results are still valid under heterogeneous information, where interventions can restore the connection with observed fundamentals.
The model (1)

- Standard NK-SOE DSGE model with an FX market run by risk averse dealers.
- Each dealer $d$ receive FX market orders from households, foreign investors and the central bank.
- Dealers are short-sighted and maximise:

$$\max -E_t e^{-\gamma \Omega_{t+1}^d}$$

where $\Omega_{t+1}^d = (1 + i_t) B_t^d + (1 + i_t^*) S_{t+1} B_t^{d*}$ is total investment after returns.
The model (2)

The demand for foreign bonds by dealer $d$:

$$B_t^{d*} = \frac{i_t^* - i_t + E_t^d s_{t+1} - s_t}{\gamma \sigma^2}$$

where $\sigma^2 = \text{var}_t (\Delta s_{t+1})$ is the time-invariant variance of the depreciation rate.
The model (3)

▶ Aggregating over dealers: modified UIP (similar to B&vW 2006)

\[ \overline{E}_t s_{t+1} - s_t = i_t - i_t^* + \gamma \sigma^2 (\overline{\omega}_t^* + \overline{\omega}_t^*,cb) \]

- \( \overline{E}_t \): average rational expectation across all dealers.
- \( \overline{\omega}_t^* \): capital inflows
- \( \overline{\omega}_t^*,cb \): CB intervention (FX sales).

▶ In our baseline case, under perfect information, \( E_t(x) = \overline{E}_t(x) \).
Monetary authority (1)

- Central bank implements monetary policy by setting the nominal interest rate according a Taylor rule:

$$\hat{i}_t = \varphi_\pi(\pi_t) + \varepsilon_{int}$$

- Three different strategies of FX intervention
  - Pure discretional intervention:
    $$\omega^{*cb}_t = \varepsilon^{cb1}_t$$
  - Exchange rate rule:
    $$\omega^{*cb}_t = \phi_s \Delta s_t + \varepsilon^{cb2}_t$$
  - Real exchange rate misalignments rule:
    $$\omega^{*cb}_t = \phi_{rer rer} r_{er} + \varepsilon^{cb3}_t$$
Other equations of interest

- **Aggregate demand**
  
  \[ y_t = \phi_C(c_t) + \phi_X(x_t) - \phi_M(m_t) \]

- **Aggregate supply**
  
  \[
  \begin{align*}
  \pi_t &= \psi \pi_t^H + (1 - \psi) \pi_t^M \\
  \pi_t^H &= \kappa_H m_c + \beta E_t \pi_{t+1}^H
  \end{align*}
  \]

- **Current account**
  
  \[
  \phi_{\varpi} \left( b_t - \beta^{-1} b_{t-1} \right) = t_{t}^{def} + y_t - \phi_C c_t + \phi_{\varpi} / \beta \left( i_{t-1} - \pi_t \right)
  \]
Perfect Information: Results (1) - Rules vs. Discretion

(a) Int. Rule 1

(b) Int. Rule 2
Results (2) - Interaction with Monetary Policy

Figure: Reaction to a 1% Monetary Policy Shock - Rules vs. No Intervention

- GDP
- Inflation
- Interest rate
- Depreciation rate
- Real exchange rate
- Exports

Marco Ortiz April 2013
Results (3) - Contribution of Shocks under FX Intervention

(a) $\Delta s$ rule
(b) $RER$ rule

Figure: Variance Decomposition
Results (4) - Effect of FX Intervention Rules

Ratio of volatilities: non-fundamental capital flows (no intervention = 1)

**FX intervention rule**

<table>
<thead>
<tr>
<th>FX intervention rule</th>
<th>Ratio of volatilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Int.</td>
<td></td>
</tr>
<tr>
<td>$\phi_{\Delta s} = 0.25$</td>
<td></td>
</tr>
<tr>
<td>$\phi_{\Delta s} = 0.5$</td>
<td></td>
</tr>
<tr>
<td>$\phi_{RER} = 0.15$</td>
<td></td>
</tr>
<tr>
<td>$\phi_{RER} = 0.30$</td>
<td></td>
</tr>
</tbody>
</table>

(a) $\omega^*$ shock

Ratio of volatilities: foreign interest rate shock (no intervention = 1)

**FX intervention rule**

<table>
<thead>
<tr>
<th>FX intervention rule</th>
<th>Ratio of volatilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Int.</td>
<td></td>
</tr>
<tr>
<td>$\phi_{\Delta s} = 0.25$</td>
<td></td>
</tr>
<tr>
<td>$\phi_{\Delta s} = 0.5$</td>
<td></td>
</tr>
<tr>
<td>$\phi_{RER} = 0.15$</td>
<td></td>
</tr>
<tr>
<td>$\phi_{RER} = 0.30$</td>
<td></td>
</tr>
</tbody>
</table>

(b) $i^*$ shock
Results (5) - Effect of FX Intervention Rules (2)

(c) $y^*$ shock

(d) $\pi^*$ shock
Heterogeneous information structure (1)

- Foreign investor exposure equals average + idiosyncratic term:
  \[
  \omega_{td}^* = \omega_t^* + \varepsilon_{td}
  \]

- \(\omega_t^*\) is unobservable and follows an AR(1) process
  \[
  \omega_t^* = \rho \omega_{t-1}^* + \varepsilon_t^* 
  \]

where \(\varepsilon_t^* \sim N(0, \sigma_{\omega^*}^2)\). The assumed autoregressive process is known by all agents.
Heterogeneous information structure (2)

- Now dealers observe past and current fundamental shocks, while also receive private signals about some future shocks.
- At time $t$, dealer $d$ receives a signal about the foreign interest rate one period ahead:
  \[ v_t^d = i_{t+1}^* + \epsilon_t^v \]
  where $\epsilon_t^v \sim N(0, \sigma_{vd}^2)$ is independent from $i_{t+1}^*$ and other agent’s signals. We also assume that the average signal received by investors is $i_{t+1}^*$, that is $\int_0^1 v_t^d \, dd = i_{t+1}^*$.
- For the solution we extend Townsend (1983) and Bacchetta and van Wincoop (2006) to a DSGE model. 

Marco Ortiz
April 2013
19/22
Results (6) - The Effects of HI

(e) Reaction to a $i_{t+1}^*$ - CK

(f) Reaction to a $i_{t+1}^*$ - HI

(g) Difference (HI-CK)

(h) Reaction to a $\omega_t^*$ - CK

(i) Reaction to a $\omega_t^*$ - HI

(j) Magnification (HI-CK)
Results (7) - FX Intervention under HI

(k) $\Delta s$ rule

(l) $RER$ rule

Figure: Regression of $\Delta s_t$ on unobservable and fundamental shocks
Conclusions

▶ We present an alternative model of exchange rate determination in general equilibrium that can be useful:
  ▶ to explain puzzles in the new international economy literature.
  ▶ for policy analysis (central banks).

▶ Our results of FX intervention in general equilibrium:
  ▶ Effective as an instrument in face of financial shocks, but not so much in face of real shocks or nominal external shocks;
  ▶ FX intervention rules can have stronger stabilisation power than discretion as they exploit the expectations channel;
  ▶ with heterogeneous information, FX intervention can help restore connection between exchange rate and fundamentals.

▶ Additional exercises: welfare analysis (eg welfare frontiers for different rules), robustness exercises, informative content in interventions, interventions under noisy/imperfect information.
FX intervention and monetary policy design: a market microstructure analysis
Carlos Montoro (BIS) & Marco Ortiz (BCRP & LSE)

Presented by:
Marco Ortiz

Fourth BIS CCA Research Conference
Santiago de Chile, Chile
marco.ortiz@bcrp.gob.pe

All views expressed in this presentation are those of the author and do not necessarily represent the views of the Central Reserve Bank of Peru.
Computational Strategy (1)

We divide the system of log-linearised equations in 2 blocks.

Solving the first block

- We take into account all the equations, except the modified UIP condition.
- We solve this system of equations by the perturbation method, taking the depreciation rate ($\Delta s_t$) as an exogenous variable.
- The system of log-linear equations become:

$$A_0 \begin{bmatrix} X_t \\ E_t Y_{t+1} \end{bmatrix} = A_1 \begin{bmatrix} X_{t-1} \\ Y_t \end{bmatrix} + A_2 \Delta s_t + B_0 \epsilon_t$$
Computational Strategy (2)

Solving the second block

- The second block corresponds to the modified UIP condition:

\[
\overline{E_t} \Delta s_{t+1} = i_t - i^*_t + \gamma \sigma^2 (\varpi^*_t + \varpi^*_t, cb)
\] (1)

- Based on Townsend (1983) and Bacchetta and van Wincoop (2006), we adopt a method of undetermined coefficients conjecturing the following equilibrium equation for \( \Delta s_t \):

\[
\Delta s_t = A(L)\varepsilon^*_t + B(L)\varpi^*_t + D(L)\zeta'_t
\] (2)

where \( A(L) \), \( B(L) \) and \( D(L) \) are infinite order polynomials in the lag operator \( L \).
Computational Strategy (3)

Solving the second block

- We use the solution in the first block to find a $MA(\infty)$ representation of the endogenous variables (eg $i_t, \omega_t^* c^b$) as a function of the shocks and replace it in equation (1).

- **Signal extraction.** Dealers extract information from the observed depreciation rate ($\Delta s_t$) and signal ($\Delta v_t^{d*}$) to infer the unobservable shocks ($\varepsilon_{t+1}^i, \varepsilon_{t}^\omega^*$):

\[
\begin{bmatrix}
\Delta s_t^* \\
\Delta v_t^{d*}
\end{bmatrix} = \begin{bmatrix}
a_1 & b_1 \\
1 & 0
\end{bmatrix} \begin{bmatrix}
\varepsilon_{t+1}^i \\
\varepsilon_{t}^\omega^*
\end{bmatrix} + \begin{bmatrix}
0 \\
\varepsilon_v^d
\end{bmatrix}
\]

- **Undetermined coefficients:** the coefficients in the conjectured equation (2) need to solve the modified UIP condition (1).