Effectiveness of Sterilized Foreign Exchange Intervention under Imperfect Financial Markets

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Sterilized FXI

- FXI as a policy tool available to central banks
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- selling (or buying) foreign reserves to control the movements of the exchange rate
- **a consequence:** decrease in the money supply, increase in the interest rates
- **sterilized** FXI solves this:
  - buying back (or selling) an equivalent amount of gov. issued bonds
  - keeps money supply and policy rate unchanged by intervention
  - changes the **composition of assets** held by banks

UIP

The interest rate parity (UIP):

$$\Delta \mathbb{E}_t Q_{t+1} = r_t - r_t^* \tag{1}$$

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In reality:

$$\Delta \mathbb{E}_t q_{t+1} = r_t - r_t^* + \mu_t^* \tag{2}$$

A large literature on the UIP puzzle starting with [Fama, 1984], [Froot and Frankel, 1989]. . .
Violations of UIP matter for the implications of FXI on welfare!

Motivation

- Empirical literature finds sizable spillover effects of U.S. monetary shocks on EM variables
  - deviations from **u**ncovered **i**nterest **p**arity [Giovanni et al., 2017], [Kalemli-Özcan, 2019]

$$r_t - (r_t^* + \mathbb{E}_t\{\Delta Q_{t+1}\}) > 0 \text{ countercyclical, } \uparrow \text{ when US tightens}$$

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- The global financial cycle and amplifying effects of U.S. monetary shocks [Miranda-Agrippino and Rey, 2020], [Akinci et al., 2022]

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- The global financial cycle and amplifying effects of U.S. monetary shocks [Miranda-Agrippino and Rey, 2020], [Akinci et al., 2022]
- Widespread use of sterilized FXI in EMs [Fratzscher et al., 2019]
- Are the actions of policymakers justified? Is intervention effective?
  - **Theory:** Sterilized FXI has no real macroeconomic effects [Backus and Kehoe, 1988], [Gali and Monacelli, 2005]
  - **Practice:** Sterilized FXI common practice

What I Do

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  - dollar dependency, countercyclical UIP premium
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    - Reduced long term net exports
    - permanent fall in foreign reserves

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    - permanent fall in foreign reserves
  - (Spill-back) US incurs deeper recession (short run), US welfare loss (slightly)

The Model: Overview

- A New Keynesian 2-country Open-Economy model: Home (EM) and Foreign (US)
- **Home Agents:** Households, Capital Producers, Private Bank, Central Bank
- **Foreign Agents:** Households, Capital Producers, Central Bank (complete markets)
- Trade in goods and financial flows
- Prices sticky *a la Calvo*
- Home banks have a default risk agency friction and cross-border institution friction (θ_r, γ)
- Sterilized FXI in Home

Central Bank

- Foreign Reserve Accumulation
- Sterilization Equation
- Taylor Rule

Dollar Reserve Accumulation

The Home central bank accumulates foreign reserves as follows:

$$R_t^{\$} = \left(R_{t-1}^{\$}\right)^{\eta} \left(\frac{1}{E_t^{\gamma_e}}\right)^{1-\eta}, \eta \in (0,1)$$

where E_t is the nominal exchange rate, $R_t^{\$}$ dollar reserves held by the Home central bank.
η - the sensitivity of reserve levels to previous levels
γ_e - the response in reserve levels to nominal exchange rate

Sterilization

The Home central bank sterilizes changes in FXI, in real terms, as follows:

$$Q_t(R_t^{\$} - R_t^* R_{t-1}^{\$}) = S_t^b - R_t S_{t-1}^b$$

where Q_t is the real exchange rate (price of foreign currency), S_t^b is the sterilized bonds issued by the central bank to Home banks, and R_t^* real return rate on Foreign assets[1].

[1] The return rates R_{t-1} and R_{t-1}^* are set at time $t-1$ and are realized at time t

Taylor Rule

The central bank engages in a Taylor rule and sets the nominal interest rate, R^n with inflation targeting defined as follows:

$$R^n_{t+1} = (R^n_t)^{\gamma_r} \left(\beta^{-1} {\pi_t}^{\gamma_\pi}\right)^{1-\gamma_r}$$

where γ_π is the response to producer price inflation, $\pi_t = \frac{P_{Ht}}{P_{Ht-1}}$.

Private Bank

- Balance Sheet
- Budget Constraint
- Agency Friction

Balance Sheet

The banks' Balance Sheet (BS) identity is:

$$q_t S_t + S_t^b = D_t + Q_t D_t^* + N_t$$

D_t- Deposits from Home households
D_t^*- Deposits from Foreign households
q_t- price of capital
N_t- Bank's Net Worth
S_t- Capital Purchases financed by the bank

Budget Constraint

The budget constraint (BC), in real domestic currency:

$$q_t S_t + S_t^b + R_t D_{t-1} + R_t^* Q_t D_{t-1}^* \leq R_{Kt} q_{t-1} S_{t-1} + R_t S_{t-1}^b + D_t + Q_t D_t^*$$

where the left-hand side is banks' uses of funds and the right-hand size is the banks' source of funds.

R_t- Home real interest rate

R_t^*- Foreign real interest rate

R_{Kt}- real return on capital assets

Agency Friction

- **Moral Hazard** [Gertler and Kiyotaki, 2010] after issuing deposits in period t, bank chooses to
  - operate honestly: meet deposit obligations at time $t + 1$ or
  - divert funds for personal use
- if divert, bank obtains:

$$\theta_r \left(D_t + (1 + \gamma) Q_t D_t^* \right)$$

  and creditors force bankruptcy in $t + 1$ and recover remaining funds
- $\gamma > 0$: foreign loans harder to enforce than domestic loans
- θ_r: exogenous default risk prob.

- endogenous net worth evolution

$$N_t = (R_{Kt} - R_t)q_{t-1}S_{t-1} + \left(R_t - R_t^* \frac{Q_t}{Q_{t-1}}\right)Q_{t-1}D_{t-1}^* + R_t N_{t-1} \tag{3}$$

- s.t. incentive compatibility (IC)

$$N_t \geq \Theta(x_t)(q_t S_t + S_t^b)$$

$$x_t = \frac{Q_t D_t^*}{q_t S_t + S_t^b}$$

$$\Lambda_{t,t+1} = \text{household's SDF}$$

$$\Theta(x_t) = \theta_r \left(1 + \frac{\gamma}{2} x_t^2\right)$$

- Defining the credit and UIP spread [2]

$$\mu_t = \mathbb{E}_t \left[\Lambda_{t,t+1} \Omega_{t+1} (R_{Kt+1} - R_{t+1}) \right] \tag{4}$$

$$\mu_t^* = \mathbb{E}_t \left[\Lambda_{t,t+1} \Omega_{t+1} (R_{t+1} - R_{t+1}^* \frac{Q_{t+1}}{Q_t}) \right] \tag{5}$$

- Optimal solution when (IC) binds:

$$\mu_t^* = y_t \mu_t \left(\frac{\Theta(x_t)}{\Theta'(x_t)} - x_t \right)^{-1}$$

μ_t^* - UIP spread

μ_t - Credit spread

y_t - Asset choice in capital

$$= \frac{q_t S_t}{q_t S_t + S_t^b}$$

[2] $\Lambda_{t,t+1} \Omega_{t+1}$ is the augmented SDF accounting for the marginal value of funds.

Market Clearing, BOP

- Market clearing for home good:

$$Y = (C_H + I_H) + \frac{1-n}{n}(C_H^* + I_H^*) + \frac{\psi_I}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2 I_t$$

- Evolution of capital stock:

$$\begin{aligned} K_{t+1} &= (1-\delta)K_t + I_t \\ &= S_t \end{aligned}$$

- Balance of payments (BOP):

$$Q_t(D_t^* - R_t^* D_{t-1}^* - (R_t^{\$} - R_t^* R_{t-1}^{\$})) = C_t + I_t + p_H \frac{\psi_I}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2 I_t - p_H Y_t$$

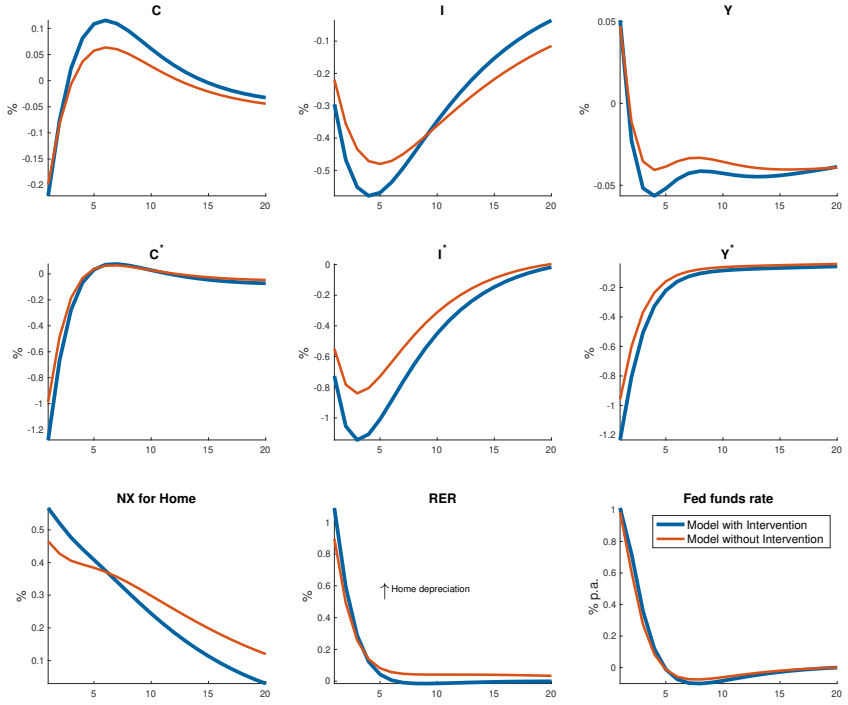
▸ capital producers

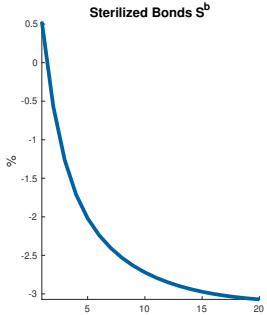
Assumptions

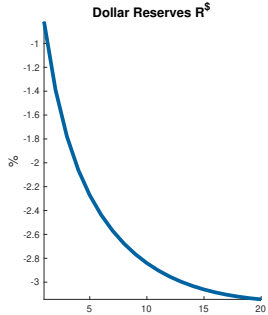
- financial market segmentation that violates the UIP
- banks forced to hold sterilized bonds (e.g. a reserve requirement)
- $\beta < \beta^*$: US more patient (incentive to invest overseas)
- $\gamma > 0$: financial contracts less enforceable across borders

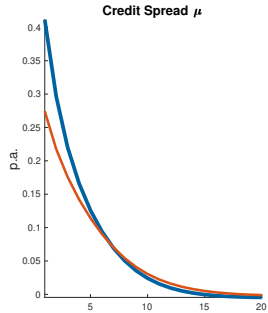
▸ calibration

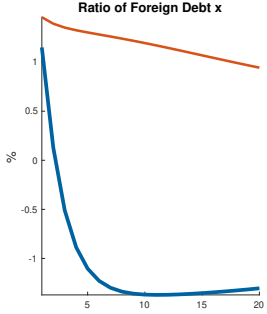
Simulations and Results

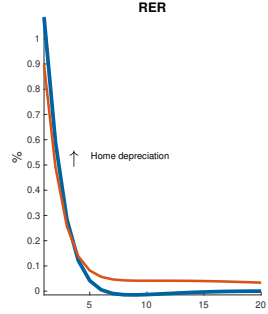

C
I
Y
C*
I*
Y*
NX for Home
RER
Fed funds rate
%
% p.a.
Home depreciation
Model with Intervention
Model without Intervention

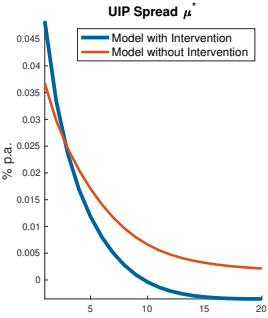

Sterilized Bonds S^b
%
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
5
10
15
20


Dollar Reserves $R^\$$
%
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-2.4
-2.6
-2.8
-3
5
10
15
20


Credit Spread μ
p.a.
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
5
10
15
20

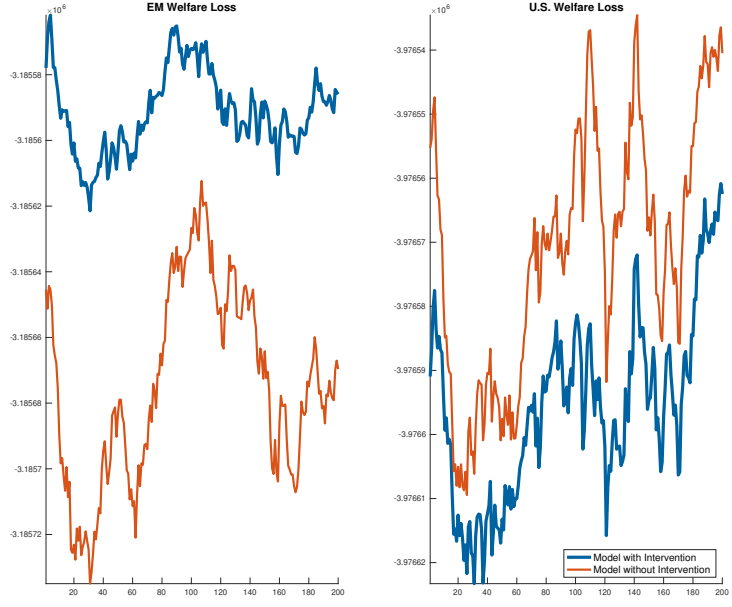

Ratio of Foreign Debt x
%
1
0.5
0
-0.5
-1
5
10
15
20


RER
%
Home depreciation
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20


UIP Spread μ^*
Model with Intervention
Model without Intervention
% p.a.
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
5
10
15
20

What about Welfare Implications?

$$\mathcal{W}_t = \frac{C_t^{1-\sigma}}{1-\sigma} - \chi_0 \frac{L_t^{1+\chi}}{1+\chi} + \beta \mathcal{W}_{t+1} \tag{6}$$



Next Steps

- dominant currency pricing (DCP), turning off the expenditure switching channel

Capital Producers

The representative capital producer solves:

$$\max_{\{I_{t+j}\}_{j=0}^{\infty}} \mathbb{E}_t \left\{ \sum_{j=0}^{\infty} \Lambda_{t,t+j} \left[q_{t+j} I_{t+j} - \frac{P_{Ht+j}}{P_{t+j}} \phi_{It+j} \right] \right\}$$

where

$$\phi_{It} = \frac{\psi_I}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 I_t$$

$$I = \left[\omega^{\frac{1}{\theta}} I_H^{\frac{\theta-1}{\theta}} + (1-\omega)^{\frac{1}{\theta}} I_F^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}$$

back

Calibration

Parameter	Description	Value	
α	output elasticity of capital	0.33	
β	Home consumer's discount rate	0.9970	
β^*	Foreign consumer's discount rate	0.9975	
χ	inverse labor supply elasticity	3.79	Justiniano et al. '10
δ	capital depreciation rate	0.025	
η	$ reserve inflexibility to nominal exchange rate	0.82	
γ	Home bias in bank funding	2.58	Akinci-Queralto '18
γ_e	response in reserve accumulation to nominal exchange rate	2.09	
γ^π	response in taylor rule to inflation	2.09	
γ_r	Foreign Taylor rule inertia coefficient	0.82	Justiniano et al. '10
n	Home country size ratio	1/3	
ω	weight given to Home good in Home consumption	0.80	Akinci-Queralto '18, Blanchard et al. '16
ω^*	weight given to Home good in Foreign consumption	0.20/3	Akinci-Queralto '18, Blanchard et al. '16
ψ_I	investment adjustment cost	2.85	Justiniano et al. '10
ρ_r	persistence of Foreign monetary shock	0.25	Akinci-Queralto '18
σ	inverse elasticity of substitution	1.00	
σ_b	banks' survival rate	0.95	Akinci-Queralto '18
σ_r	standard deviation of Foreign monetary shock	0.20/100	Akinci-Queralto '18
θ	trade price elasticity	0.90	
θ_p	net price markup	0.20	
θ_r	banks' default probability	0.41	Akinci-Queralto '18
ξ_b	transfer rate to entering banks	0.07	Akinci-Queralto '18
ξ_p	price stickiness	0.84	Justiniano et al. '10

▸ back

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