# Foreign Exchange Intervention Redux

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# Introduction and Motivation

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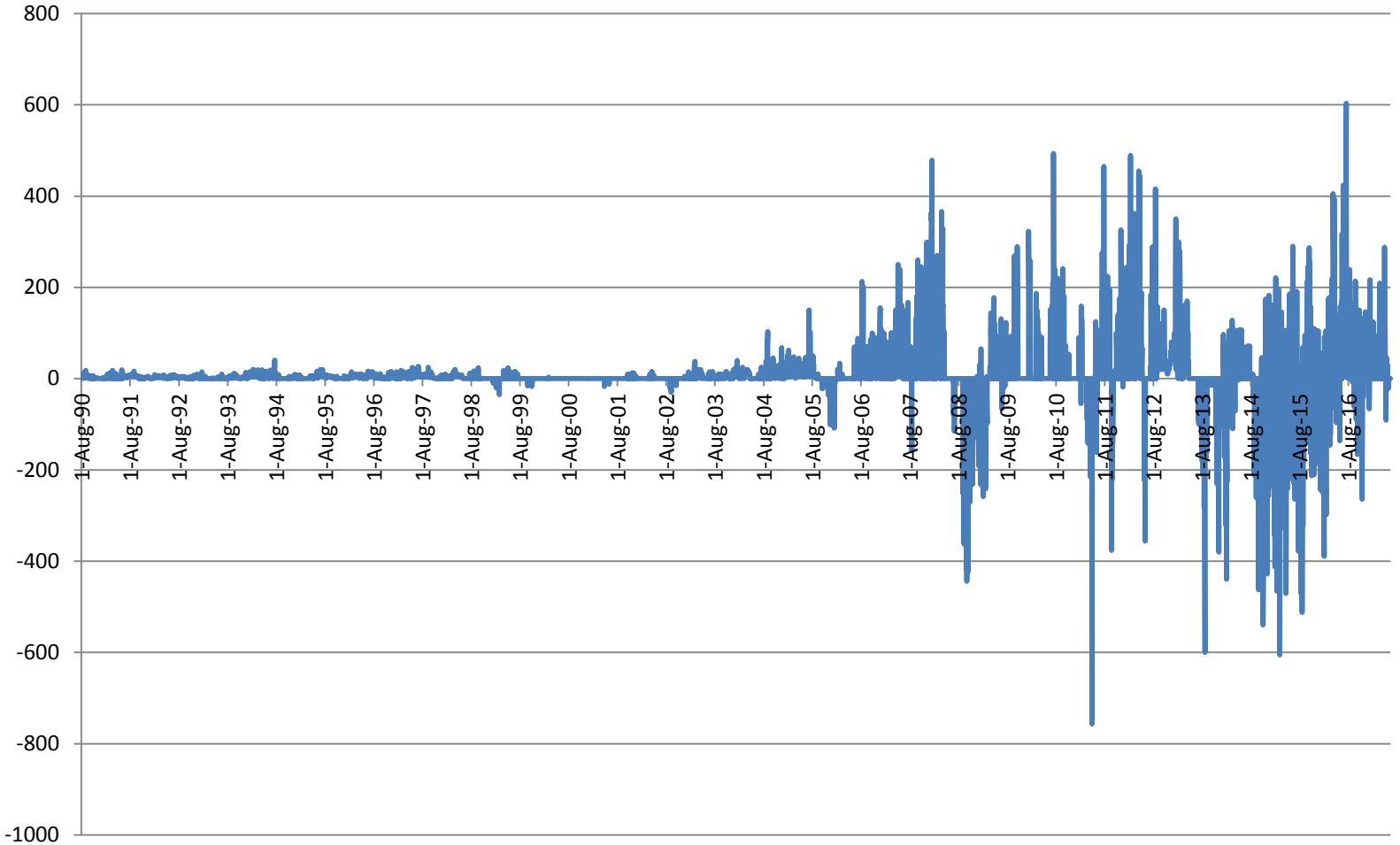
Polar views about foreign exchange intervention:

- Academic research: empirical evidence on sterilized FX intervention is mixed and inconsistent, which accords with the theory (e.g. Backus and Kehoe 1989).
- Central bankers intervene frequently and often, and believe that FX intervention is beneficial and effective (Adler and Tovar 2011, Chutasripanish and Yetman 2015).

## Peru: FX Intervention (Daily, US$ Millions)




Source: Central Bank of Peru

Table 1. Stylized Facts of Foreign Exchange Purchases, 2004–10

| | Frequency (Percent of working days) | Intensity | | | |
|---|---|---|---|---|---|
| | | Cumulative intervention as percent of GDP[1,2] | Daily average (Millions of U.S. dollars)[1] | Daily maximum (Millions of U.S. dollars)[1] | Has there been active FX intervention in 2011? |
| Chile | 6 | 3.8 | 50 | 50 | yes |
| Colombia | 32 | 10.3 | 34 | 733 | yes |
| Guatemala | 19 | 1.6 | 9 | 332 | yes |
| Mexico[3] | 1 | 0.6 | 600 | 600 | yes |
| Peru | 39 | 36.1 | 55 | 494 | yes |
| **Latin America[4]** | **19** | **10.5** | **150** | **442** | |
| Others | | | | | |
| Australia[5] | 62 | 2.5 | 15 | 377 | n.a. |
| Israel | 24 | 22.3 | 84 | 300 | no[6] |
| Turkey | 66 | 12.5 | 61 | 4966 | yes |

Source: Adler and Tovar (2011)

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- Point of departure: FX intervention is a particular *unconventional* central bank policy (Céspedes, Chang, and Velasco 2017)
- To analyze FX intervention, then, it is crucial to allow for financial frictions, here external debt limits
- But to be consistent with the empirical evidence, the debt limits are taken to bind only *occasionally*

# How FX Intervention "Really" Works

A typical central bank balance sheet:

| **Assets** | **Liabilities** |
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- In the absence of financial frictions, banks borrow an offsetting amount from abroad, and credit to the private sector does not need to change
- But if there a limit to external credit, it can be reached, and sterilization crowds out domestic loans

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- In addition, the treatment here is much simpler and clarifies what is essential about sterilized FX intervention.

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- Is *not* about policy signaling
- Does depend on financial frictions and institutions
- Has a close connection with the problem of *reserves accumulation* and fiscal policy (*quasi-fiscal deficits*)

# Lessons on Intervention and Reserves Accumulation

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# Lessons on Intervention and Reserves Accumulation

- FX intervention policy can be effective only if it occurs at times of binding financial constraints
- The *accumulation of FX reserves* involves a trade-off: large stocks of reserves allow the central bank to relax financial constraints if they become binding, but increase financial vulnerability
- Accumulation of FX reserves can be excessive and lead to a *credit crunch*

# FX Intervention Rules

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- A superior FX intervention policy: to respond to *credit spreads*

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- If there are nominal rigidities, FX intervention policy is irrelevant in a local approximation of the model.
- FX intervention can be an independent instrument, but one must take nonlinearities into account

# The Model

# Commodities and Demand

Small open economy, $t = 0, 1, 2, ...$

Two traded goods, home and foreign

Price of foreign goods fixed at one in terms of an international currency (*dollar*)

Domestic consumption a Cobb Douglas function of home and foreign goods, with price in *pesos* (the CPI):

$$P_t = P_{ht}^{\alpha} E_t^{1-\alpha}$$

where $P_{ht}$ is the price of domestic output and $E_t$ the *nominal exchange rate*

Define the *real* exchange rate by

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$==>$ Total demand for domestic output:

$$y_t = \alpha e_t^{1-\alpha} c_t + \varkappa e_t^{\chi}$$

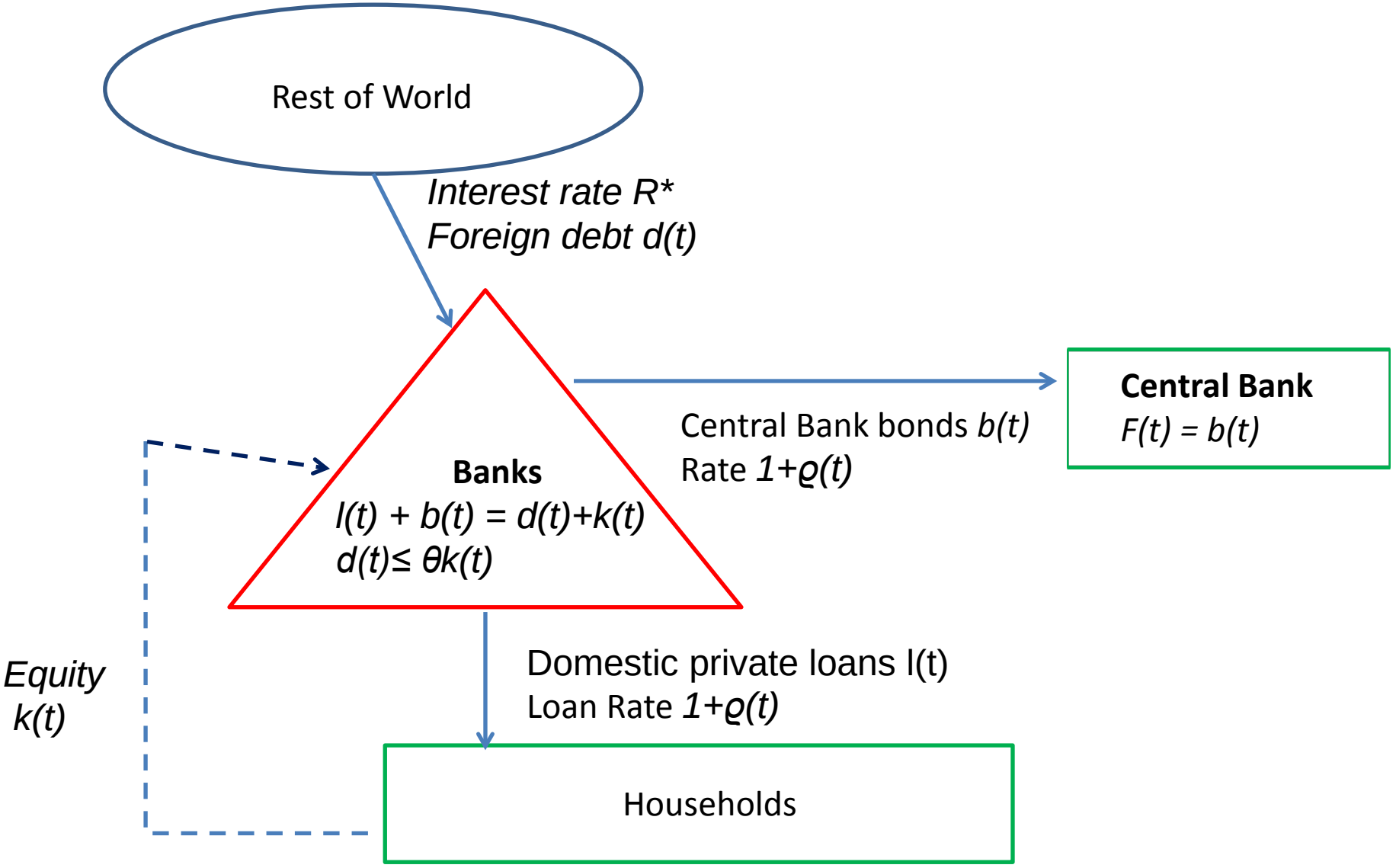
# Production

The home good is the usual Dixit Stiglitz aggregate

Firm $i$ has technology $y_{it} = A_t n_{it}$

Assuming *flexible prices* for now, usual markup rule leads to

$$P_{ht} = \left(1 - \frac{1}{\epsilon}\right) MC_t = \left(1 - \frac{1}{\epsilon}\right) \frac{W_t}{A_t}$$




**Financial Flows**

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- Loans and bonds are perfect substitutes and carry the same interest rate $\varrho_t$ (everything in *dollars*, for now).
- Banks' flow constraint:

$$b_t + l_t = k_t + d_t$$

The bank's profits are

$$\begin{aligned}\pi_{t+1} &= (1+\varrho_t)(l_t+b_t) - R_t^* d_t \\ &= R_t^* k_t + (1+\varrho_t - R_t^*)(l_t+b_t)\end{aligned}$$

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$==>$ Optimal policy:

- If $1+\varrho_t > R_t^*$, $d_t = \theta k_t$, and so credit supply is $b_t + l_t = (1+\theta)k_t$
- If $1+\varrho_t = R_t^*$, indeterminate as long as $b_t + l_t = k_t + d_t$ and $d_t \leq \theta k_t$

# The Central Bank

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==> Same as Benes et al., Vargas et al., Cavallino, CCV
==> Crucial: sterilization bonds are financed by domestic banks, which can be subject to the external credit limit

Between periods, the central bank invests official reserves at the external interest rate $R_t^*$.

$==>$ In period $t$, the central bank has a *quasifiscal deficit:*

$$T_t = (1 + \varrho_{t-1} - R_{t-1}^*) b_{t-1}$$

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We assume that $T_t$ is financed with a lump sum tax on households (but the role of the quasifiscal deficit is an open and interesting issue)

# Households

Standard utility function which depends on consumption and labor effort.

Households borrow from banks and also can hold equity in banks, subject to the equity constraint:

$$k_t \leq \widetilde{k}$$

They receive an endowment of dollars $z_t$ (e.g. copper income).

The budget constraint, in dollars:

$$\begin{aligned} & e_t^{-\alpha} c_t + k_t - l_t \\ = \quad & (1+\omega_{t-1}) R^*_{t-1} k_{t-1} - (1+\varrho_{t-1}) l_{t-1} \; + e_t^{-\alpha} w_t n_t + v_t + z_t - T_t \end{aligned}$$

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$==>$ The equity constraint binds in equilibrium if and only if the external constraint binds, so wlog we set $k_t = \tilde{k}$

Euler equation:

$$c_t^{-\sigma} = \beta E_t c_{t+1}^{-\sigma} R_{t+1}$$

where:

$$R_{t+1} = (1 + \varrho_t) \left( \frac{e_{t+1}}{e_t} \right)^{\alpha}$$

# The External Cost of Credit

Debt elastic interest rate (Schmitt Grohé-Uribe 2003):

$$\begin{aligned} R_t^* &= \bar{R}^* + \tilde{\Psi}(e^{l_t - \bar{l}} - 1) \\ &= \bar{R}^* + \tilde{\Psi}(e^{d_t - b_t - (\bar{d} - \bar{b})} - 1) \end{aligned}$$

where the world interest rate is $\bar{R}^*$

# Equilibrium With Flexible Prices

Aggregate Supply:

$$e_t^{-(1-\alpha)} c_t^{-\sigma} = (1 - \frac{1}{\epsilon})\eta y_t^{\phi} / A_t^{1+\phi}$$

External balance:

$$(1-\alpha)e_t^{-\alpha} c_t - [z_t + \varkappa e_t^{\chi-1}] = d_t - b_t - R_t^*(d_{t-1} - b_{t-1})$$

Collateral constraints:

$$\begin{aligned} d_t &= \theta \tilde{k} \quad \text{if} \quad 1 + \varrho_t > R_t^* \\ d_t &\leq \theta \tilde{k} \quad \text{if} \quad 1 + \varrho_t = R_t^* \end{aligned}$$

Equilibrium is defined once we specify an *FX intervention policy*, i.e. a rule for choosing $b_t$

# FX Intervention and Reserves Accumulation

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Proposition: *FX intervention can affect equilibria if and only if it affects binding financial constraints* or *makes the constraints bind in states of nature in which they would have not*

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==> Similar to Backus and Kehoe (1989)
==> But, in contrast to BK, we explore what happens if FX intervention *does* matter

For a precise statement: rewrite all equilibrium conditions, except the collateral constraints, in terms of a vector of variables that excludes $d_t$ and $b_t$.

The collateral constraints then can be rewritten as:

$$\begin{aligned} l_t &= (1+\theta)\tilde{k} - b_t \quad \text{if} \quad 1+\varrho_t > R_t^* \\ l_t &\leq (1+\theta)\tilde{k} - b_t \quad \text{if} \quad 1+\varrho_t = R_t^* \end{aligned}$$

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- If constraint does not bind at $t$, a change in $b_t$ does not affect equilibria (unless it leads to a violation of the inequality)
- To affect equilibria, a change in $b_t$ must take place when constraint binds, or must make a nonbinding constrait bind.

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- This reflects sterilization: selling reserves reduces the quantity of central bank bonds, making room for private credit
- If $b_t$ cannot be negative, this can be seen as a *benefit* of reserves accumulation
- Large average values of $b_t$, however, make it more likely that the collateral constraint binds, which can be seen as a *cost* of reserves accumulation

# FX Intervention and Exchange Rates

Recall that in equilibrium:

$$c_t^{-\sigma} = \beta E_t c_{t+1}^{-\sigma} R_{t+1}$$

where:

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- Then real *consumption based* interest rate must adjust
- This requires changes in the loan interest rate as well as real exchange rates

# Numerical Illustrations

# Calibration and Numerical Approximation

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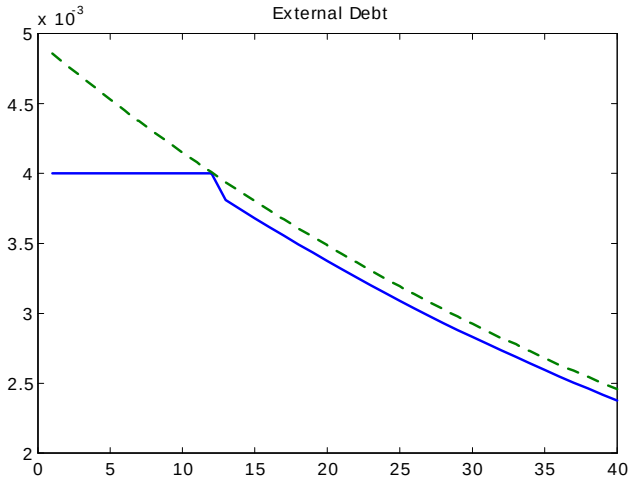
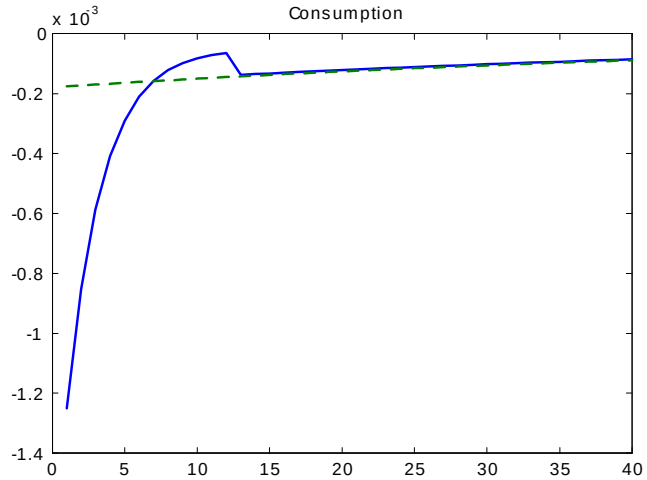
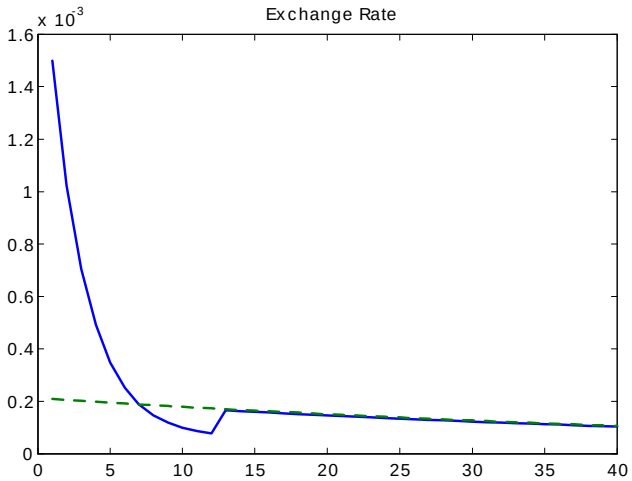
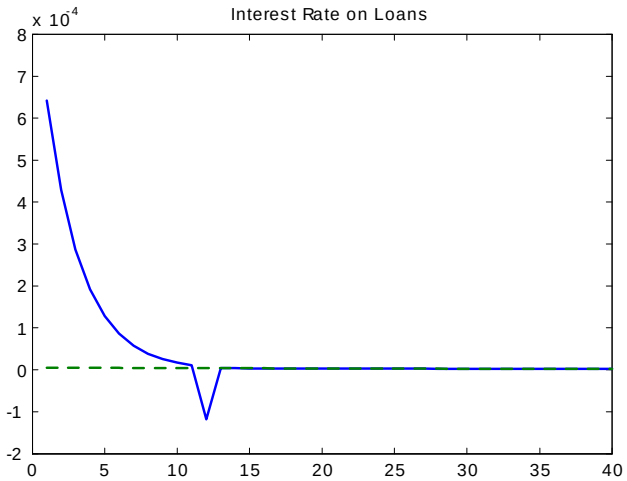
- Numerical solution: `occbin` (Guerrieri and Iacovello)
- One cost: will not be able to talk about macroprudential issues




# A Transitory Fall in $z$

Consider a simple intervention policy of the form:

$$b_t = Max\{\bar{b} + \rho_b(b_{t-1} - \bar{b}) + \varepsilon_{bt}, 0\}$$

with $\bar{b} \geq 0$ the ss value of official reserves, and $0 \leq \rho_b < 1$

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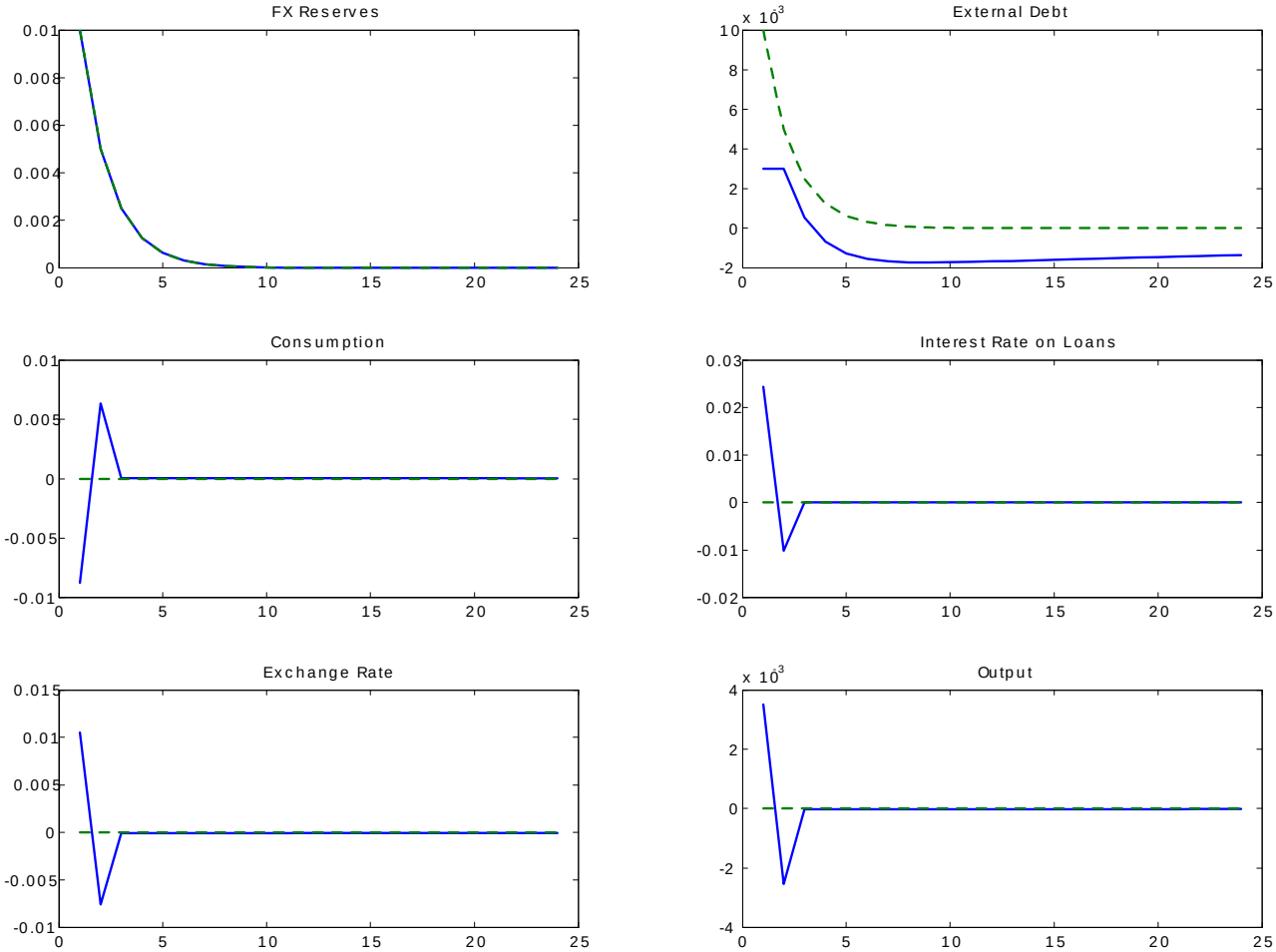
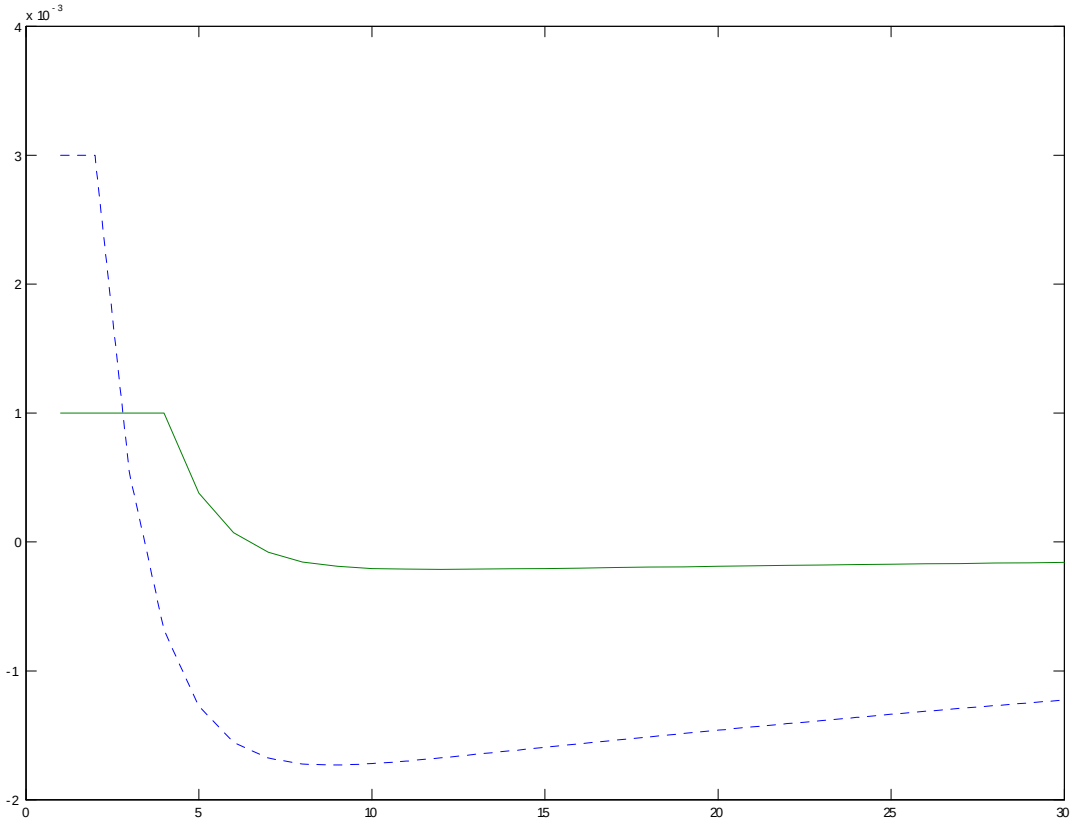
$==>$ Small $\varepsilon_{bt}$ do not affect real allocations (they are matched one for one by changes in $d_t$)
$==>$ A sufficiently negative value of $\varepsilon_{bt}$ leads to the exhaustion of FX reserves
$==>$ A large, positive $\varepsilon_{bt}$ brings the economy to the constrained region




# A Large Purchase of FX Reserves

The average value of reserves, $\bar{b}$, affects the probability that financial constraints bind




# Low vs High Reserves

Response of $d(t)$ to the same shock to FX rule

Solid line: High $\bar{b}$. Dashed line: Low $\bar{b}$

# Exchange Rate Stabilization and FX Intervention

Consider now a rule of the form:

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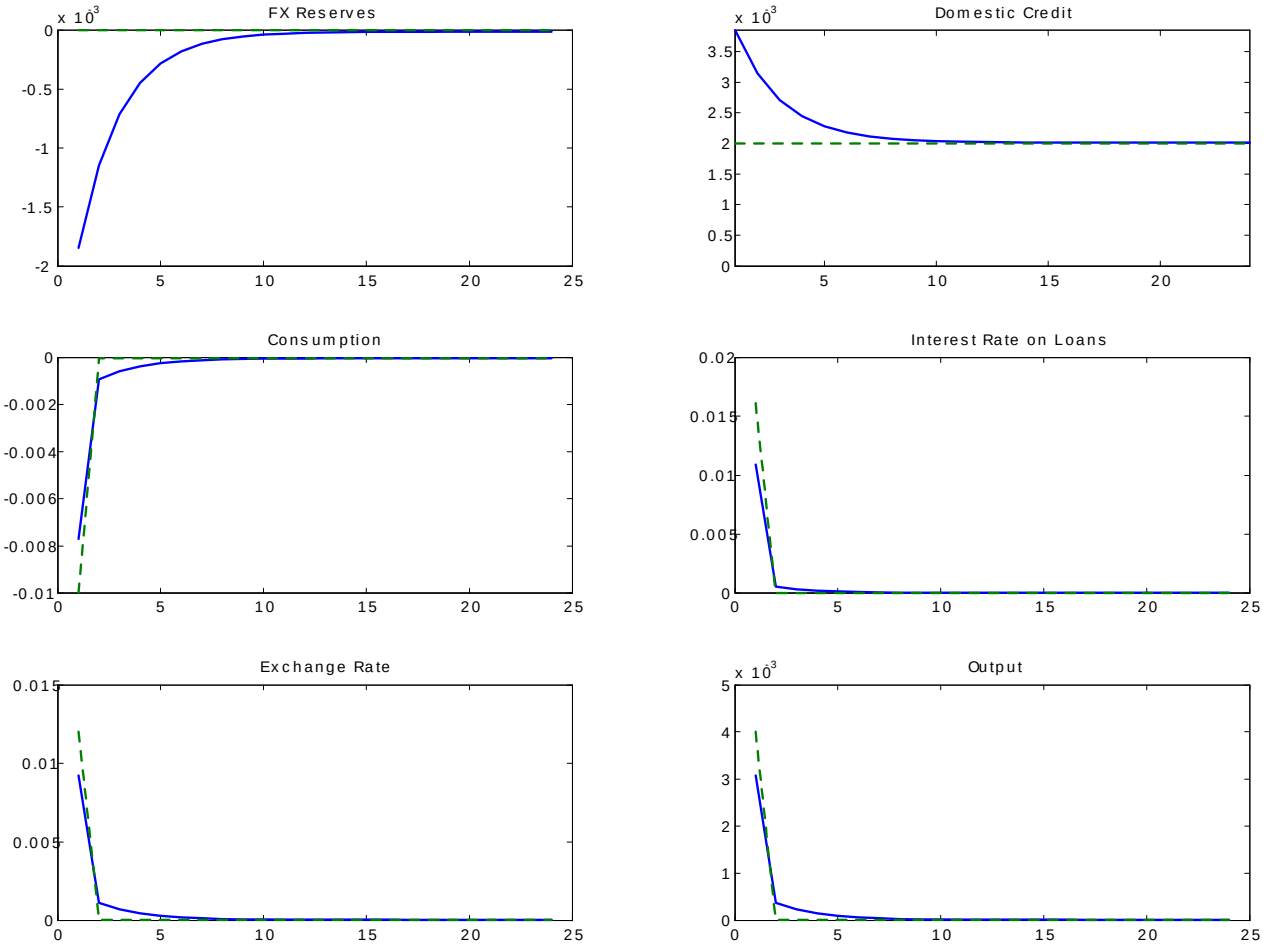
2. In "normal " times i.e., if financial constraints do not bind, this policy does not affect equilibria as long as shocks and $v_e$ are small enough
3. In fact, if $v_e$ is too large, the policy may have perverse effects.

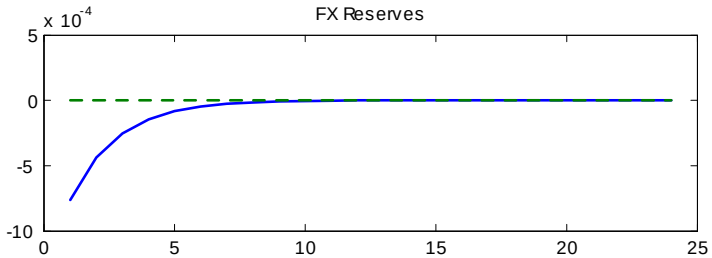


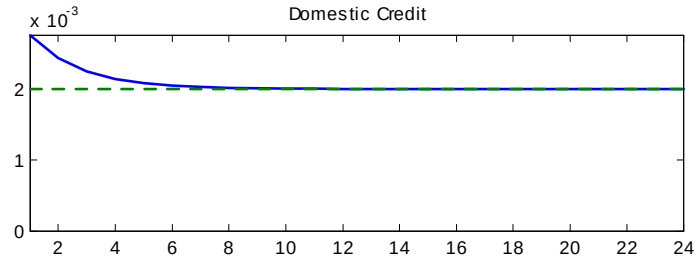

# Intervention and Exchange Rate Stabilization

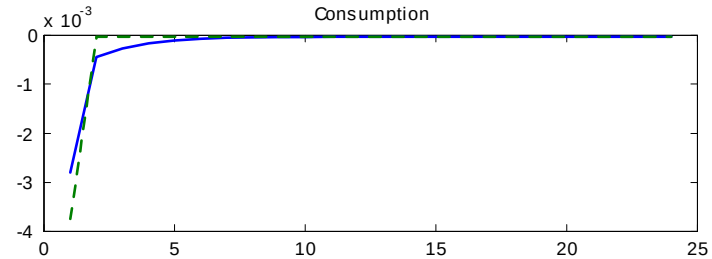
A policy that depends on the credit spread:

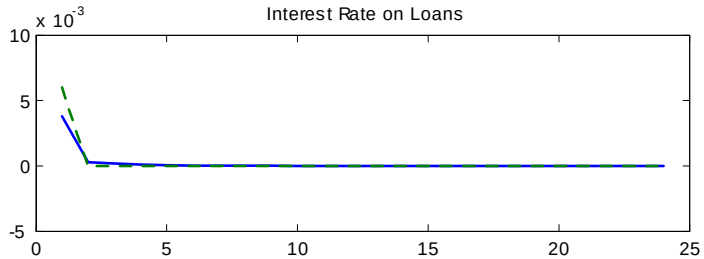
$$b_t - \bar{b} = \rho_b(b_{t-1} - \bar{b}) - v_\varrho(1 + \varrho_t - R_t^*)$$

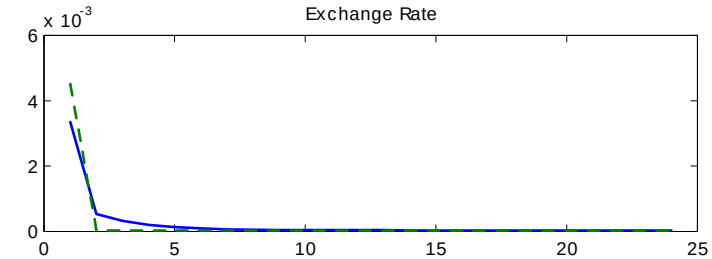
is superior, in that it prescribes intervention only when financial constraints bind.

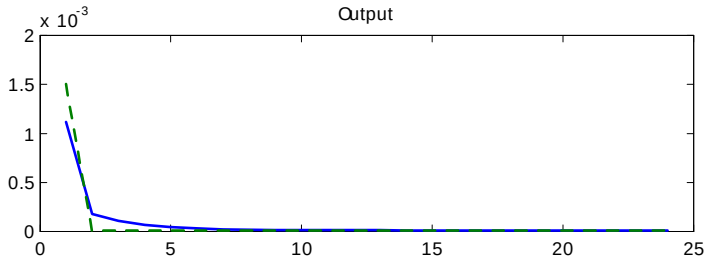



# FX Intervention and Credit Spreads Stabilization

# Nominal Rigidities

# Introducing Price Rigidities

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- Marginal costs are

$$\begin{aligned} mc_t &= \frac{MC_t}{P_{ht}} = \frac{(W_t / A_t)}{P_{ht}} \\ &= \eta e_t^{1-\alpha} c_t^{\sigma} y_t^{\phi} / A_t^{1+\phi} \end{aligned}$$

# Monetary Policy

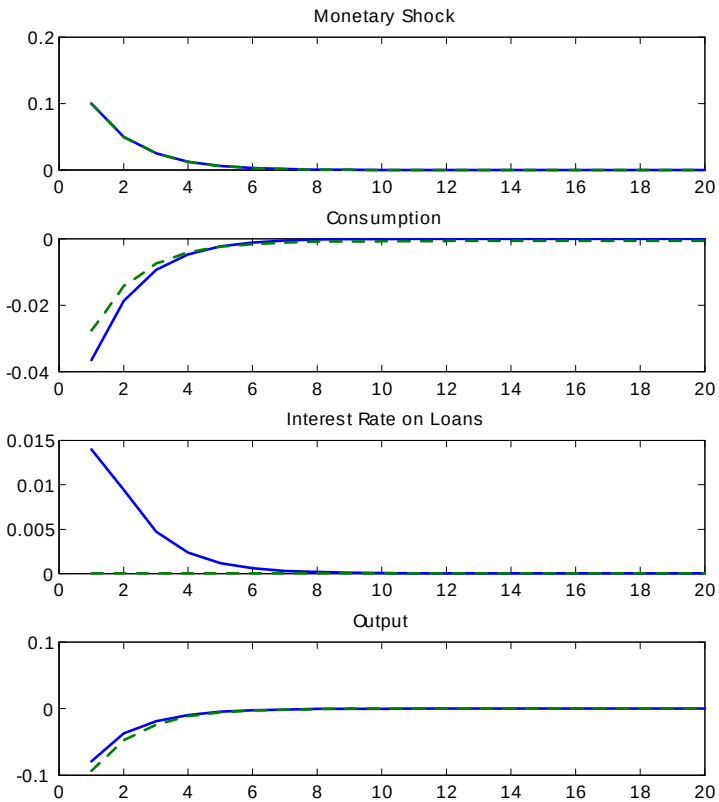
To close the model we need to specify a monetary policy rule.

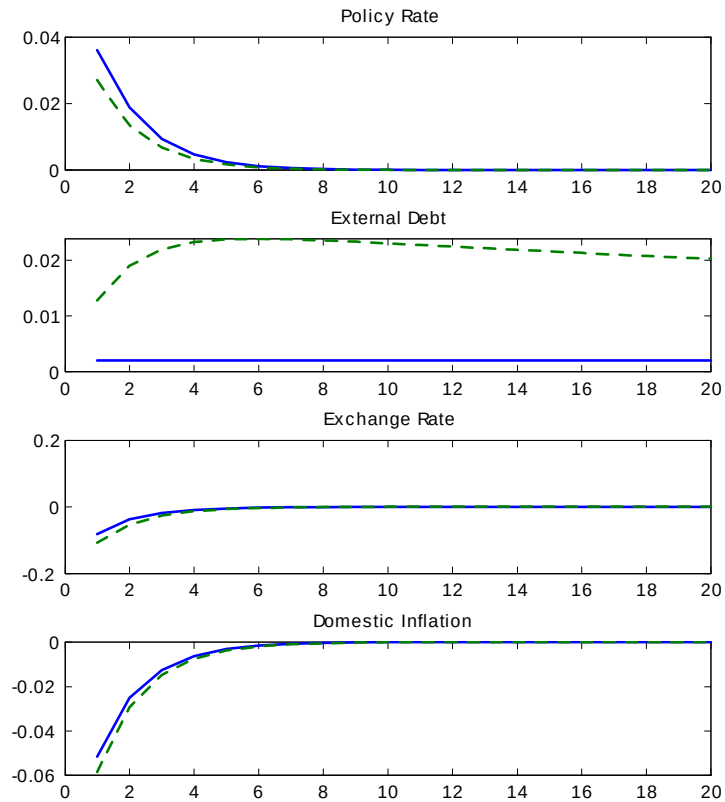
For the time being, assume that the policy instrument is the expected consumption based interest rate:

$$i_t \equiv E_t R_{t+1} = E_t(1+\varrho_t)\left(\frac{e_{t+1}}{e_t}\right)^{\alpha}$$

And start with a Taylor rule such as:

$$i_t = \log R_t^* + \phi_\pi \pi_t + u_{mt}$$




# A (Large) Monetary Policy Contraction

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- Here FX **is** an independent policy tool
- But nonlinearities are essential, and alter the analysis in significant ways

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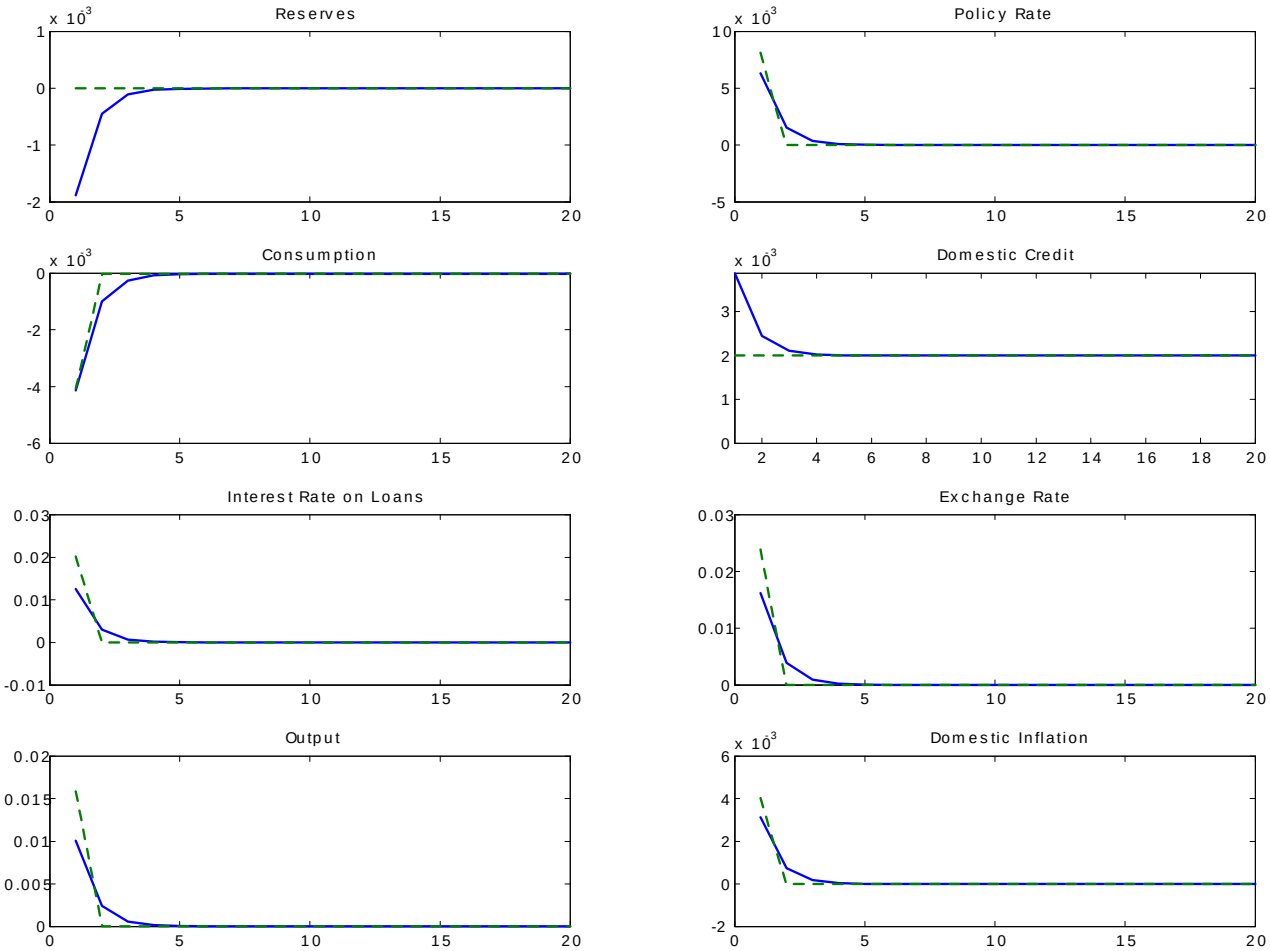
2. In particular, FX intervention plays no useful role responding to shocks that imply an exchange rate *appreciation*
3. Selling official reserves does play a beneficial role in response to an adverse shock that makes constraints bind
4. An FX intervention rule that responds to credit spreads is better than one that responds to the exchange rate

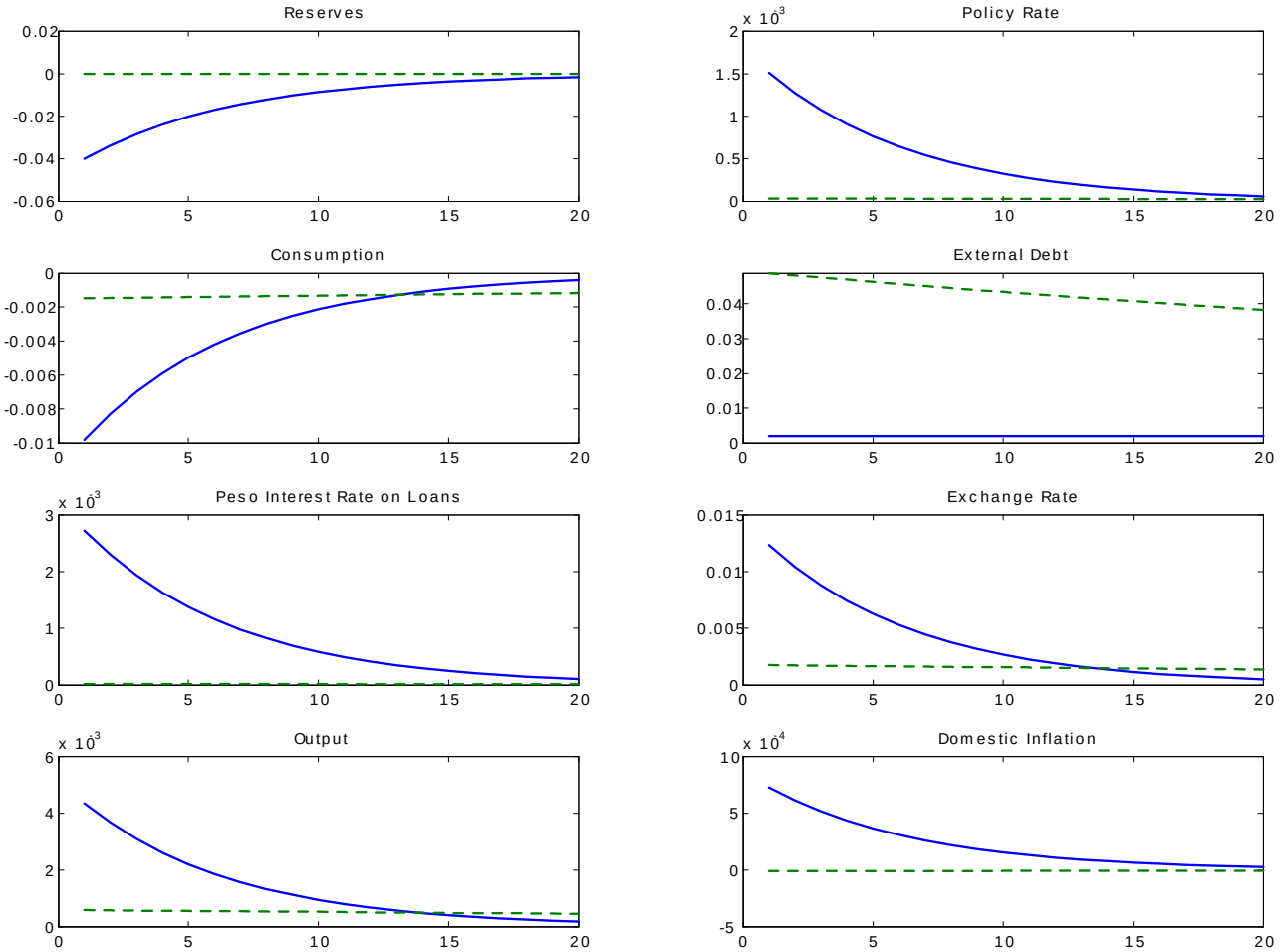



# Monetary Policy and Active FX Intervention

# The Role of Currency Denomination and Mismatches

# The Role of Currency Denomination

- We have assumed that the economy is "financially dollarized "
- But it is not too hard to introduce assets in domestic currency
- The model looks almost the same if domestic loans and central bank debt are denominated in pesos




# Allowing for Peso Securities

# Currency Mismatches

- Our discussion on the effectiveness of FX intervention has not relied on the interaction between currency mismatches and balance sheet effects
- Clearly, one can add such effects in this model
- For instance, the equity constraint may be denominated in pesos, implying that $e_t^{\alpha} k_t \leq \tilde{k}$ rather than $k_t \leq \tilde{k}$
- In that case, a real depreciation tightens the debt limit

# Final Remarks

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- This perspective may explain e.g. why empirical evidence on the impact of foreign exchange intervention has been elusive
- The effectiveness of FX intervention is tied to the degree of financial frictions and details of financial institutions
- No "competitiveness" rationale for reserves accumulation
- As mentioned, no discussion of macroprudential issues
- Lots of room for further research, especially optimal policy, quasifiscal policy, and empirical issues