Exchange Rate Determination and Optimal FXI Policy: The Role of Portfolio and Liquidity Shocks

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Los puntos de vista expresados corresponden a los autores y no reflejan necesariamente la posición del BCRP

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Motivation

- Exchange rate dynamics remains a complex subject in International Macro.
- First, for the study of FX determination...

$$\mathcal{L} = \mathbb{E}\left[\frac{1+i^{m}}{1+\pi}\right] - \mathbb{E}\left[\frac{1+i^{*,m}}{1+\pi}\frac{s'}{s}\right] \tag{1}$$

- Recent literature has adapted several explanations for the UIP/CIP deviations to GE models.
- Bigio, Bianchi & Engel (2022), Itskhoki & Mukhin (2021), Gabaix & Maggiori (2015), Chang (2019).

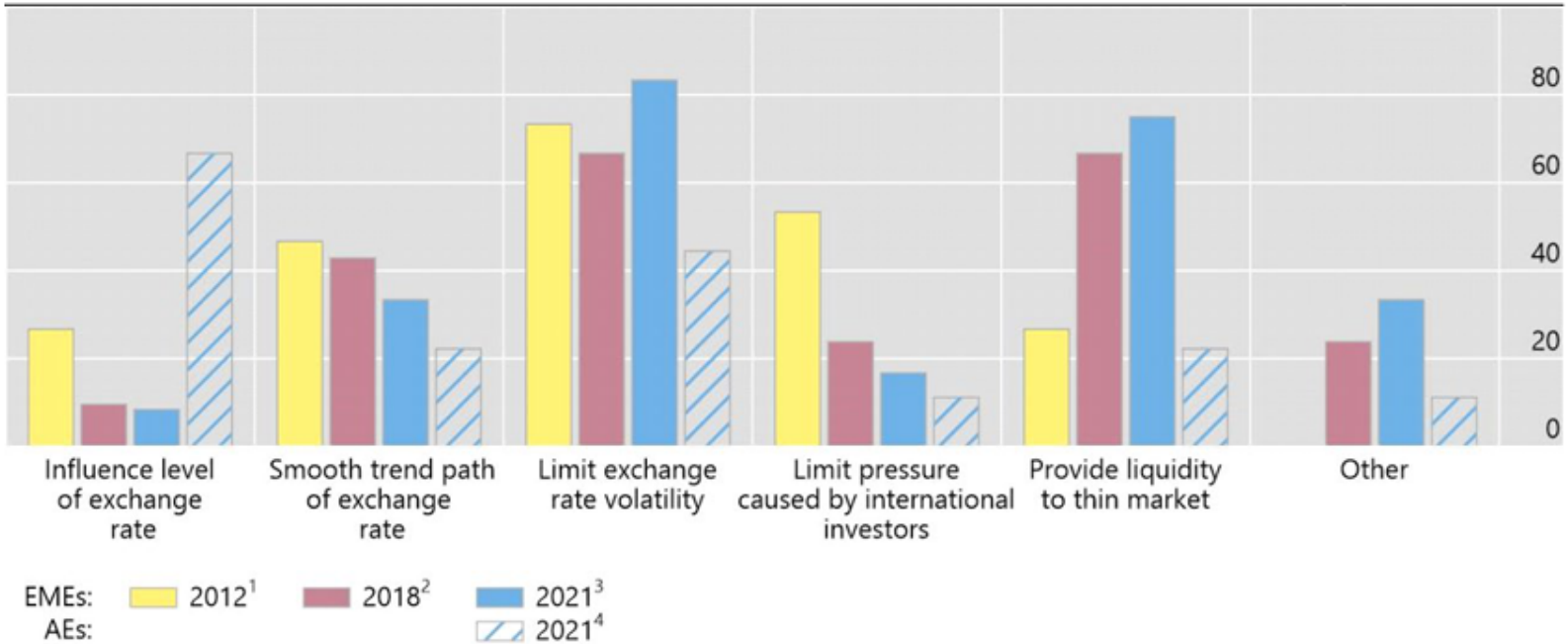
Motivation

- However, there is a gap regarding the motives and the way in which FXI operates.
- BIS (2022) survey: Central banks report as intermediate objectives:
  1. Influence level of exchange rate,
  2. Smooth the path of the exchange rate,
  3. Limit exchange rate volatility,
  4. Limit the pressure caused by international investors,
  5. Provide liquidity to a thin market.

FXI: CB intermediate objectives

Limiting FX volatility and providing liquidity are the most important intermediate objectives

As a percentage of respondents



[1] 15 central banks. [2] 19 central banks. [3] 12 EME central banks. [4] 9 AE central banks.

Sources: BIS surveys on FX intervention 2012, 2018 and 2021.

Source: BIS (2022)

Motivation

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Motivation

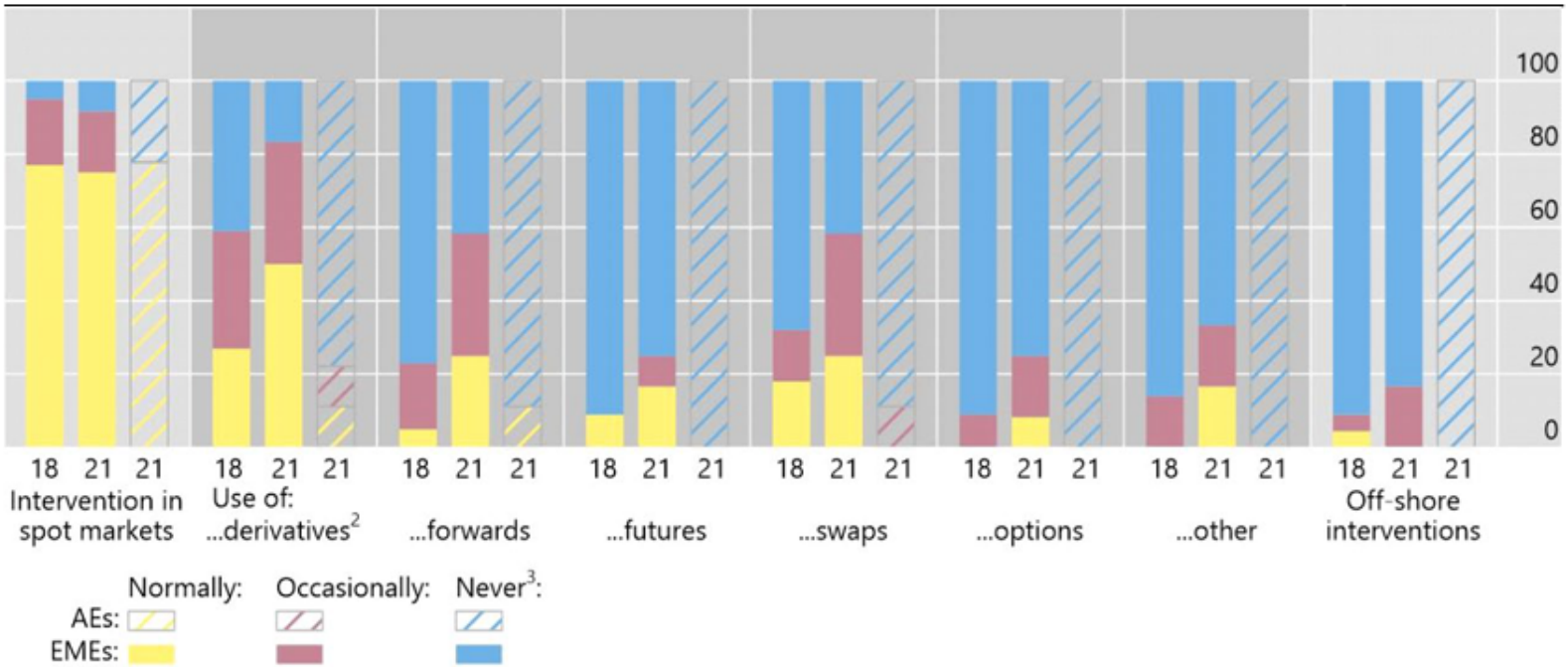
- There is a gap in the literature regarding the choice of FXI instruments.
- Optimal FXI: Cavallino (2019), Montoro & Ortiz (2023).
- BIS (2022) survey:
  - Although most economies use spot interventions, half of central banks in EMEs regularly use derivatives and an additional 30 % use them occasionally.
  - Additionally 50 % use forwards and swaps, either regularly or occasionally.

"The choice of whether to intervene in the spot or derivative markets can depend on a range of factors. A central bank seeking to smooth exchange rate volatility might intervene in spot or derivative markets depending on the source of FX pressure. For example, if market participants struggle because of a dollar liquidity shortage, it may be better to use spot interventions. But if market participants struggle to hedge FX positions, then using derivatives may be more suitable"

FXI: CB instruments

Spot market interventions remain most common but most EME central banks rely also on derivatives[1]

As a percentage of respondents



[1] Based on the responses of nine AE and twelve EME central banks, regardless of whether or not they intervened over the last three years. [2] Use of at least one derivative instrument. [3] Categories for which a response is lacking are assumed to constitute a "Never".

Sources: BIS surveys on FX intervention 2018 and 2021.

Source: BIS (2022)

NDFs vs spot FXI

- We focus our attention in two instruments:
  - Non deliverable forwards (NDFs).
  - Spot interventions.
- Intuition:
  - Non deliverable forwards: impact over portfolio shocks since provide insurance over exchange rate movements. (Hedge)
  - Spot interventions: similar to NFDs for hedge, additionally change the currency composition of liquidity (although, central banks can sterilize to maintain LC liquidity unaffected.)

Motivation

- Finally, we still need more work regarding FX determination.
- Empirical CIP: Cerutti et al. (2021); Du et al. (2018); Mancini-Griffoli & Ranaldo (2012); Bazán, Ortiz, Terrones & Winkelried (2023).
- UIP deviations: Kalemli-Ozcan and Varela (2021), Ramírez-Rondán and Terrones (2019) and Engel et al. (2021).

CIP Deviations: Du, Tepper and Verdelhan (2021)

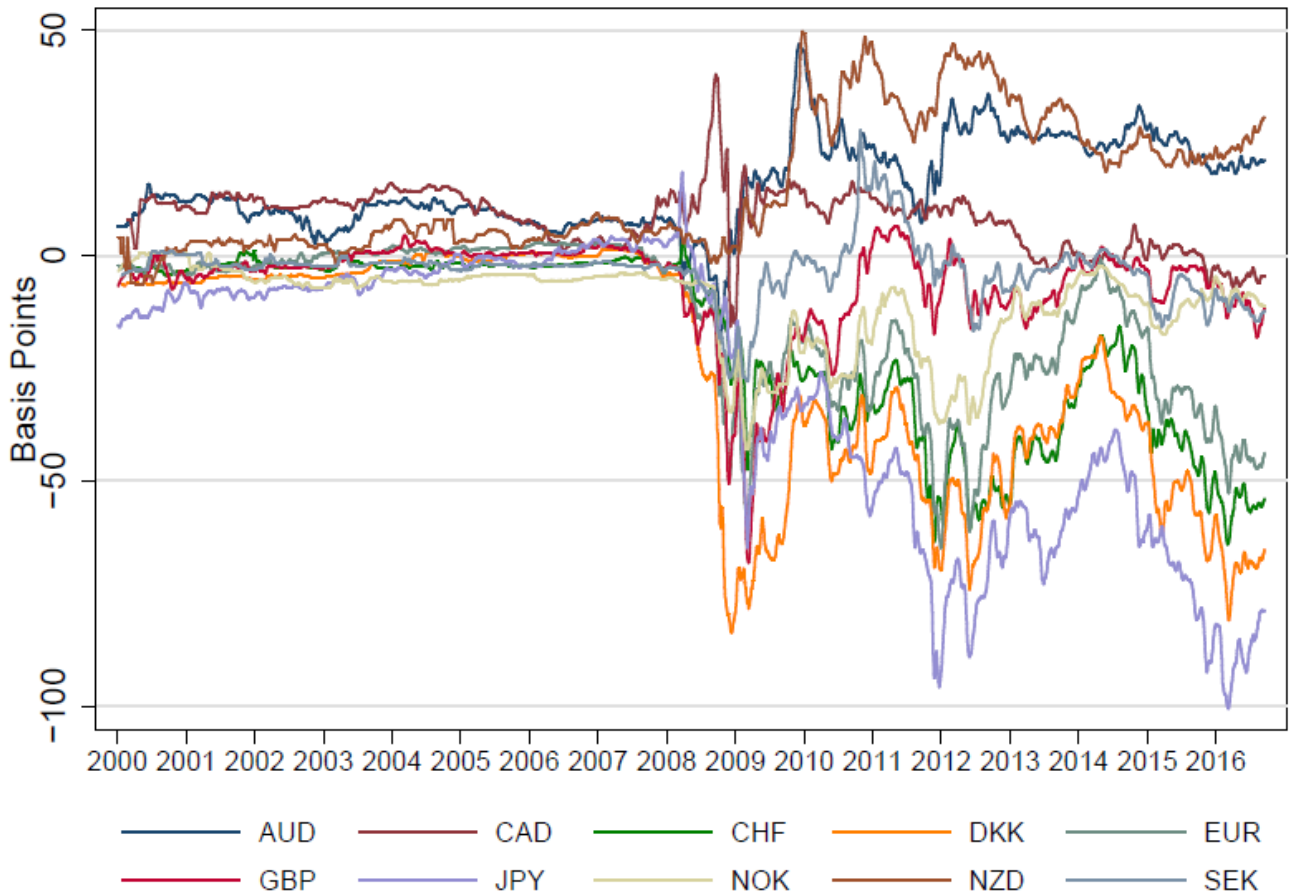


Figure 5: **Long-Term Libor-Based Deviations from Covered Interest Rate Parity**: This figure plots the 10-day moving averages of the five-year Libor cross-currency basis, measured in basis points, for G10 currencies. The covered interest rate parity implies that the basis should be zero. One-hundred basis points equal one percent.

What do we do?

- We present a small open economy with a financial sector that faces a non-trivial decision on liquidity holdings due to *settlement frictions*.
- *Market segmentation* in international financial markets generate a role for aggregate shocks changing the financial sector portfolio and liquidity.
- We introduce these mechanisms into a general equilibrium framework to analyze optimal FXI with both spot and derivatives as instruments.

What do we find?

- UIP deviations are driven by both hedging and liquidity motives.
- Liquidity behind CIP deviations.
- Spot interventions are more effective under stressed liquidity in markets.
- Identification for optimal policy needs to consider a financial channel for liquidity shortages.

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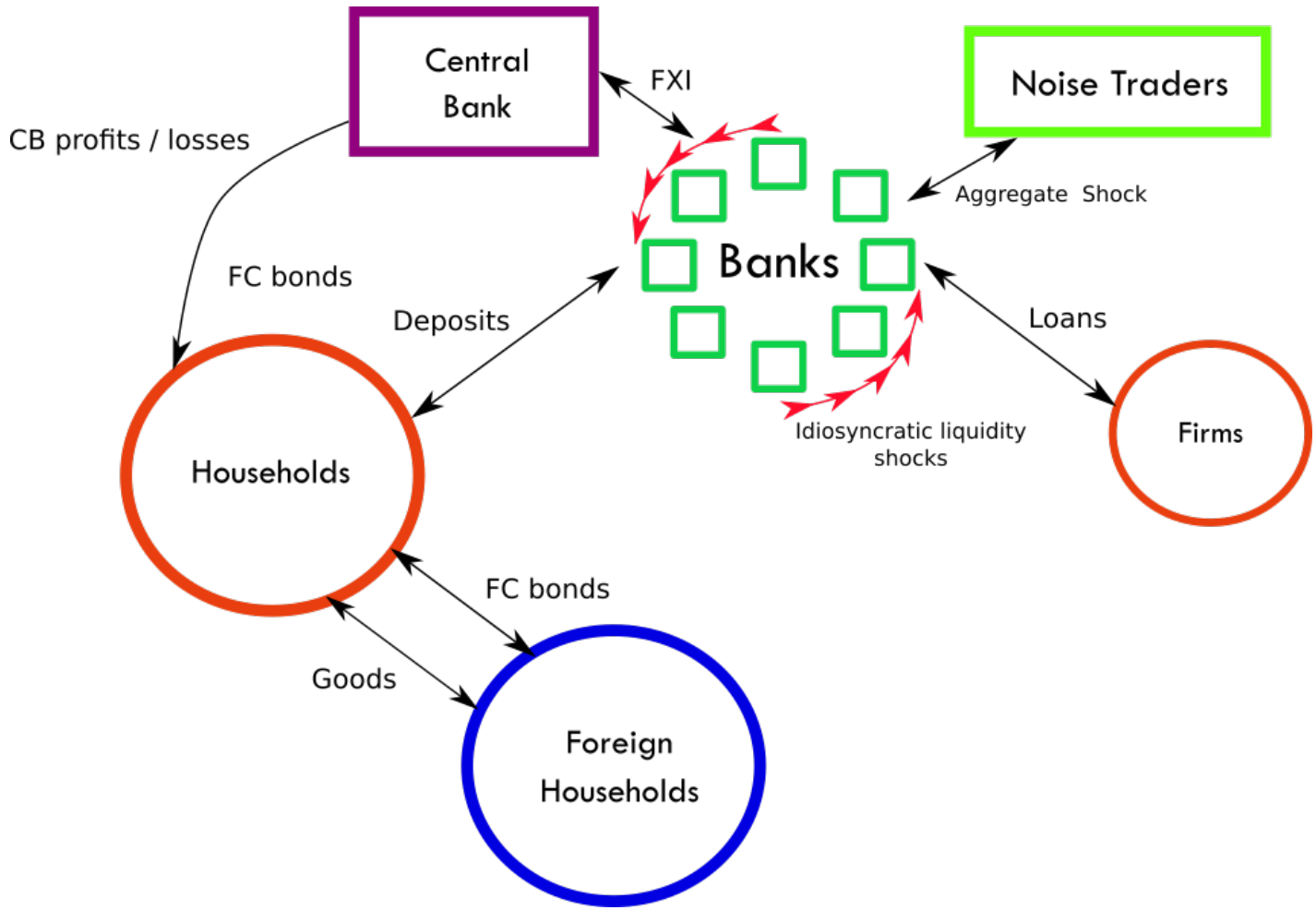
Features of the model

- **Banks:** Banks maximize the peso value of their one period ahead portfolios with a CARA utility function.
- **Timing convention:** Follows Lagos & Wright (2005); Afonso & Lagos (2015) and Bianchi, Bigio & Engel (2022). *Lending stage* and *balancing stage*.
- **Settlement frictions:** Banks face a penalty when liquidity falls below a threshold.
- **Portfolio shocks:** Foreign demand for peso assets puts pressure on financial intermediaries' portfolio position.
- **Portfolio/liquidity shocks:** Domestic/Foreign agents through capital inflows/outflows put pressure on portfolio and liquidity.

Features of the model



Banks

- In each period, banks' will maximize the value of the expected profits given by:

$$\mathbb{E}_{n^*,\Delta x_{t+1}}\left[-\frac{1}{\omega}\exp\left(-\frac{\omega}{P_{t+1}}\pi_{t+1}\right)\right]$$

- where $\omega \geq 0$ is the risk-aversion parameter, π_t represent the total profits of banks, P is the price level and Δ is the percentage change.
- Banks face uncertainty about the next period's realization of the exchange rate x_{t+1} and the amount of capital flow they will have to intermediate n^*.
- At the bank level, a positive foreign portfolio flow increases foreign currency liquidity in exchange for the creation of a local currency deposit.
- The evolution of excess foreign and domestic reserves are given by:

$$s_t(n_t^*) = \tilde{m}_{t+1}^* + n_t^* - \rho^* d_{t+1}^* \tag{2}$$

$$s_t(x_t n_t^*) = \tilde{m}_{t+1} - \rho(d_{t+1} + x_t n_t^*) \tag{3}$$

Lending stage

- During the lending stage banks choose a portfolio of loans, reserves and deposits in local and foreign currency. Lending stage banks will maximize:

$$\max_{\{\tilde{b},\tilde{m},\tilde{d},\tilde{b}^*,\tilde{m}^*,\tilde{d}^*\}} \mathbb{E}_{n^*,\Delta x_{t+1}} U\left[\pi\left(\tilde{b}_{t+1},\tilde{m}_{t+1},\tilde{d}_{t+1},\tilde{b}^*_{t+1},\tilde{m}^*_{t+1},\tilde{d}^*_{t+1}\right)\right]$$

$$s.t.$$

$$\tilde{b}_{t+1} + \tilde{m}_{t+1} - \tilde{d}_{t+1} + \tilde{po} = 0$$

$$\tilde{b}^*_{t+1} + \tilde{m}^*_{t+1} - \tilde{d}^*_{t+1} - po^{lc}_{t+1} = 0$$

- When banks decide about their portfolio of assets and liabilities they define an investment in FC position $\tilde{po}_{t+1} = \tilde{b}^*_{t+1} + \tilde{m}^*_{t+1} - \tilde{d}^*_{t+1}$ and an investment in LC position.
- The open investment position in foreign currency mirrors the investment position in domestic currency $\tilde{po}^{lc}_{t+1}$.

Balancing stage

- During the balancing stage, deposits and reserves can be freely exchanged while loans remain fixed. There is no decision making in this stage but it is profitable for banks to participate in the interbank market since the interest rate (i^f_{t+1}) will satisfy $i^m_{t+1} \leq i^f_{t+1} \leq i^w_{t+1}$ in both currencies.
- The equilibrium in both LC and FC interbank markets, affected by settlement frictions, will deliver the values of reserves in domestic and foreign currencies and the window facilities.

Portfolio Problem

- Total profits are given by:

$$\pi_{t+1} = \frac{x_t}{P_{t+1}}\Big(\Big[\left(1 + i^*_{t+1} + \chi^* w^{s,*}\right)(1 + \Delta x_{t+1}) + \dots$$
$$.. - (1 + i_{t+1} + \chi w^s)]\tilde{po}_{t+1} - n^*_t[(1 + \Delta x_{t+1})(1 + \chi^*_t) - \rho(1 + \chi_t)]\Big) \quad (4)$$

- Banks' profits/losses consider the effects of the open position in financial assets and in liquidity generated by portfolio shocks occurred during the balancing stage.

Modified UIP condition

- These features yield the following modified Uncovered Interest Rate Parity condition:

$$E[\Delta x_{t+1}] = i^{m,*}_{t+1} - i^{m}_{t+1} - E_w[\chi^*_t] + E_w[\chi_t] - \frac{x_t P^*_{t+1} R^{n,*}}{P_{t+1}} \omega \sigma^2_{\Delta x_{t+1}} \psi_t$$

- Where:
  - Δx: change in the nominal exchange rate.
  - χ^*: dollar liquidity premium.
  - χ: peso liquidity premium.
  - ψ: capital flows / hedging demand.
  - $i^m, i^{m,*}$: peso/ dollar interest rates in the interbank markets.

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$$E[\Delta x_{t+1}] = i^{m,*}_{t+1} - i^{m}_{t+1} + \underbrace{E_w[\chi_t] - E_w[\chi^*_t]}_{\text{CIP deviation.}} - \frac{x_t P^*_{t+1} R^{n,*}}{P_{t+1}} \omega \sigma^2_{\Delta x_{t+1}} \psi_t$$

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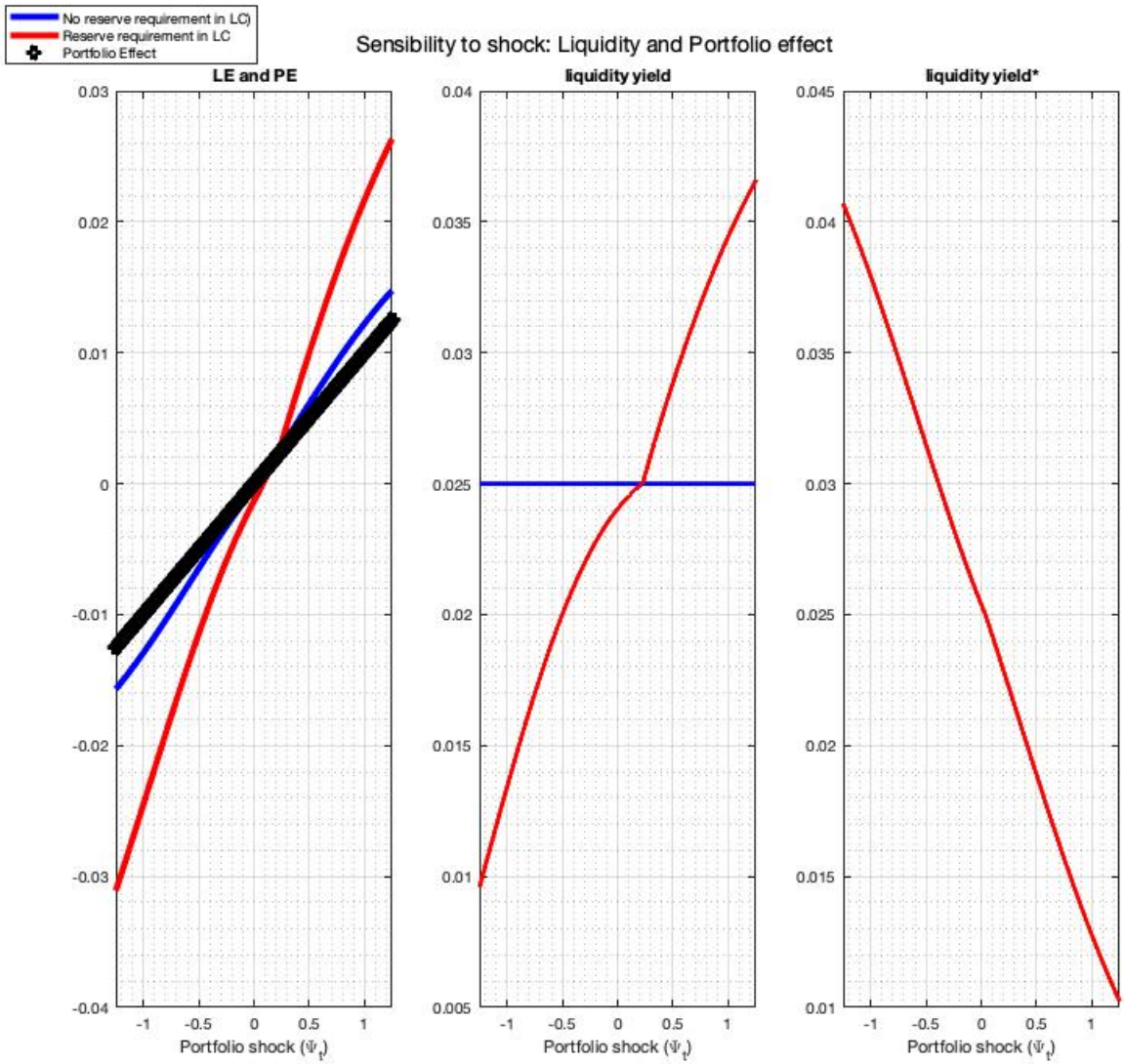
  - $i^m, i^{m,*}$: peso/ dollar interest rates in the interbank markets.

Numerical Analysis: Portfolio and Liquidity

$$E[\Delta x_{t+1}] = \underbrace{i^{m,*}_{t+1} - i^{m}_{t+1} + E_w[\chi_t] - E_w[\chi^*_t]}_{\text{Liquidity Effect}} - \underbrace{\frac{x_t P^*_{t+1} R^{n,*}}{P_{t+1}} \omega \sigma^2_{\Delta x_{t+1}} \psi_t}_{\text{Portfolio Effect}}$$

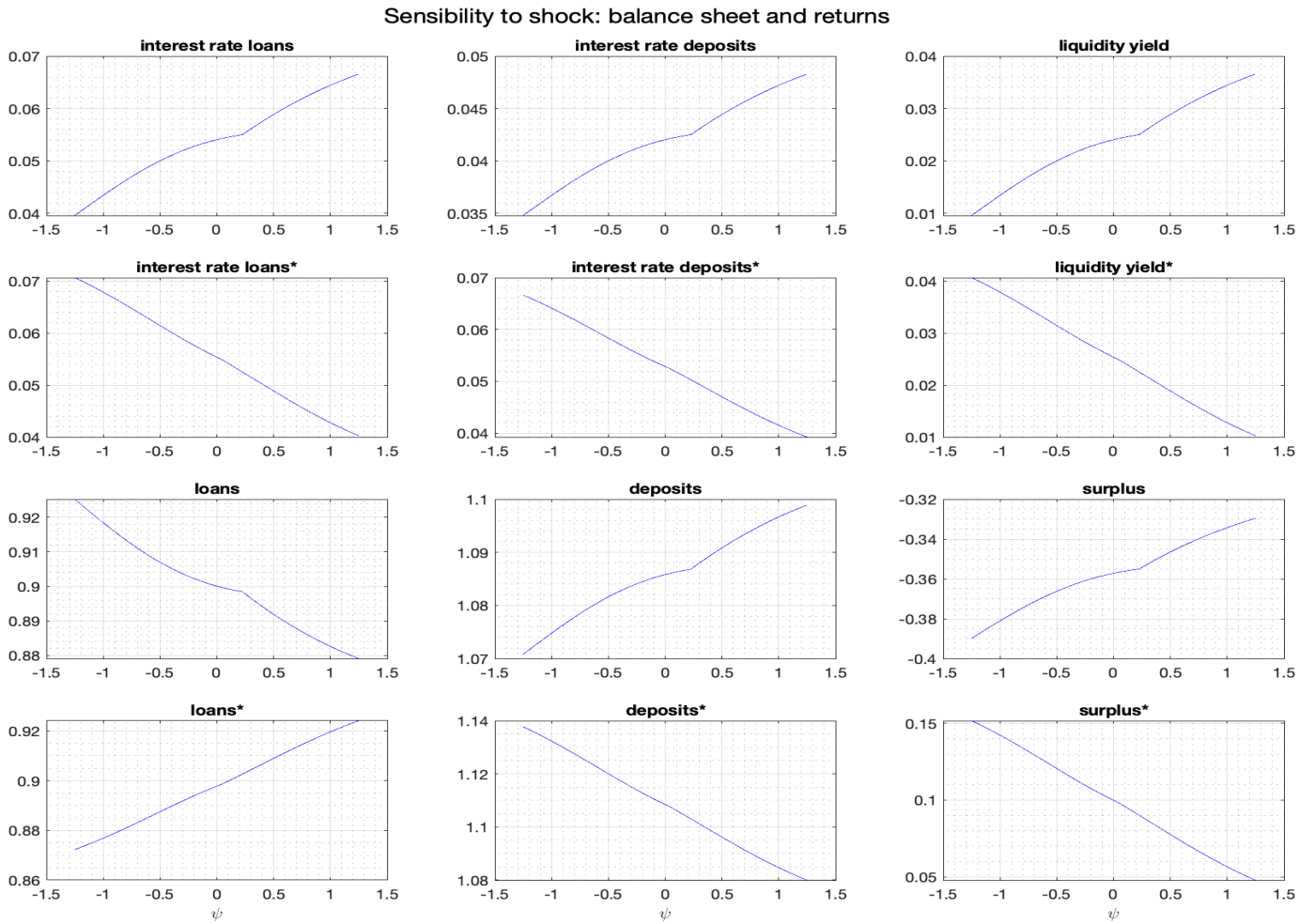
Numerical Analysis: Portfolio and Liquidity



Model: banks

- The movements in liquidity yield affect the equilibrium in deposits and loans markets.
- When the liquidity yield in LC increases:
  - Interest rates in loans in LC increase.
  - Interest rates in deposits in LC fall.
- Surplus (measured before the idiosyncratic shock) works as a insurance to the liquidity shocks.
  - Banks anticipating to the increase in capital flows:
    - Increase their surplus in LC. Since reserves will be more needed.
    - Reduce their surplus in FC. Since reserves in FC will be less needed.
    - However the effect of the agregate liquidity shock is greater than the self-insurance.
    - If banks were fully insurance then liquidity yield would be flat.

Model: banks


Sensibility to shock: balance sheet and returns
interest rate loans
interest rate deposits
liquidity yield
interest rate loans*
interest rate deposits*
liquidity yield*
loans
deposits
surplus
loans*
deposits*
surplus*
ψ

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GE with explicit banking sector

- The domestic financial sector will create dollar liquidity (eurodollars) but will simultaneously hold a dollar position with the rest of the world.
- The domestic economy position will be held by banks, thus, after a shock that endogenously creates an entry of dollars via the financial account, the net foreign asset position of the economy will improve.
- The size of the position absorbed by the financial intermediaries will be a combination of the endogenous capital flows entry and the currency preferences of households and firms for holding dollars.
- We can define net foreign assets (B_t^{nfa}) as the overall difference between assets and liabilities loans and deposits.

$$D_t + x_t D_t^* = L_t + x_t L_t^* + M_t + x_t M_t^* + B_t^{nfa} \tag{5}$$

GE with explicit banking sector

- Portfolio shock ψ_t does not change directly B_t^{nfa} since it simply changes the currency composition but will affect the position of financial intermediaries. Thus we can define B_t^{nfa} as the sum of:

$$B_t^{nfa} = N_t + x_t F_t^* \tag{6}$$

- while B_t^{nfa} is determined by the current account, portfolio shocks will matter for the composition of net foreign assets.
- The currency imbalance in portfolios (O_t), affecting the exchange rate is given by:

$$O_t + x_t D_t^* = x_t L_t^* + x_t M_t^* + x_t F_t^* \tag{7}$$

Households portfolio

- We assume an imperfect substitution between peso and foreign currency deposits. In particular:

$$\tilde{D}_t = (x_t D_t^*)^{\alpha^d} (D_t)^{1-\alpha^d} \tag{8}$$

- The optimal portfolio is given by:

$$\frac{(1 + i_{t+1}^d)}{(1 + i_{t+1}^{d,*}) \frac{x_{t+1}}{x_t}} = \frac{(1 - \alpha^d) x_t D_t^*}{(\alpha^d) D_t} \tag{9}$$

Firms' portfolio

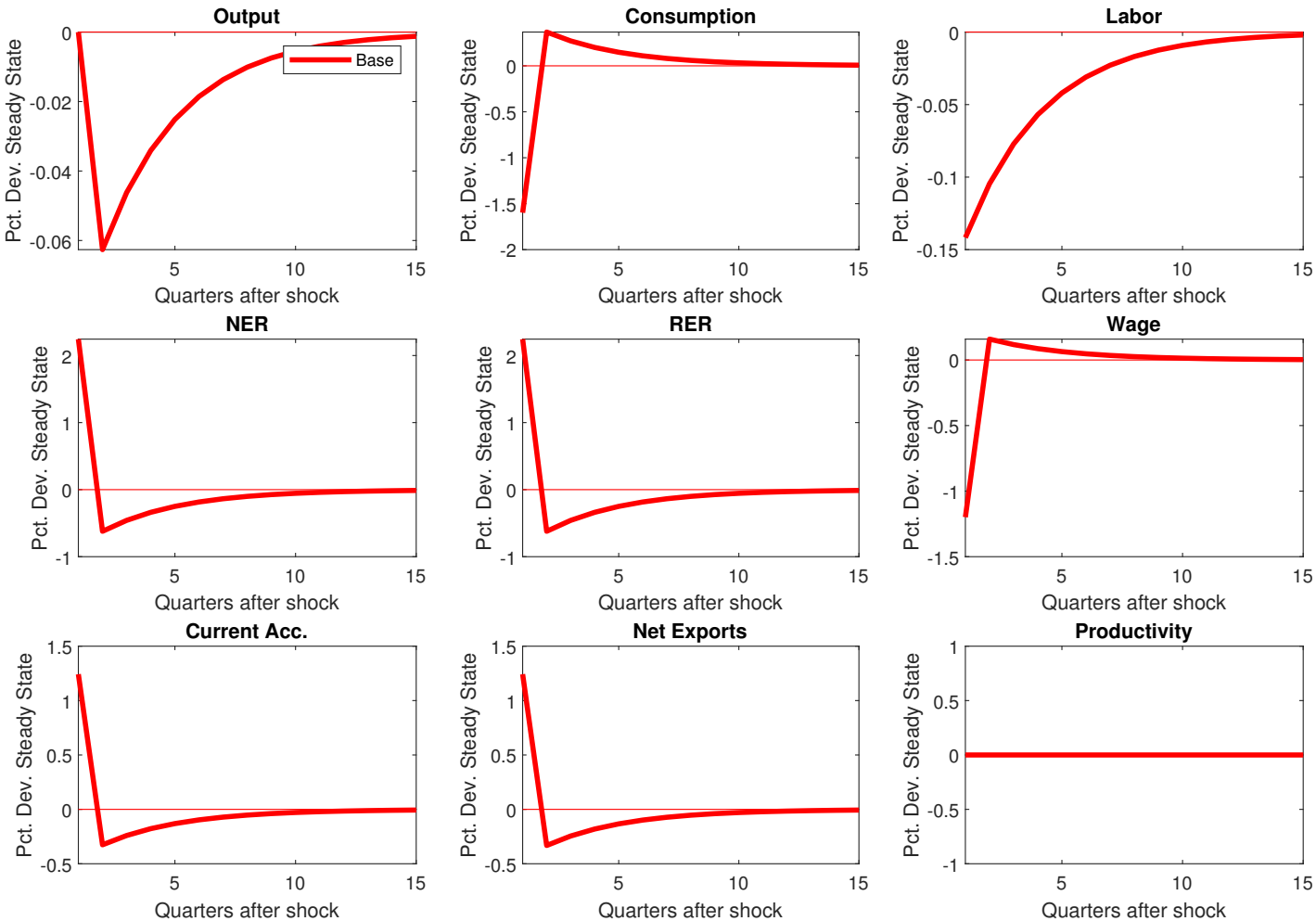
- Firms finance their working capital using borrowing in the following portfolio:

$$\tilde{B}_t = \left(x_t B_t^{d,*}\right)^{\alpha^b} (B_t)^{1-\alpha^b} \tag{10}$$

$$\frac{1 + i_{t+1}^b}{\left(1 + i_{t+1}^{b,*}\right) \frac{x_{t+1}}{x_t}} = \frac{(1-\alpha^b) x_t B_t^*}{\alpha^b B_t} \tag{11}$$

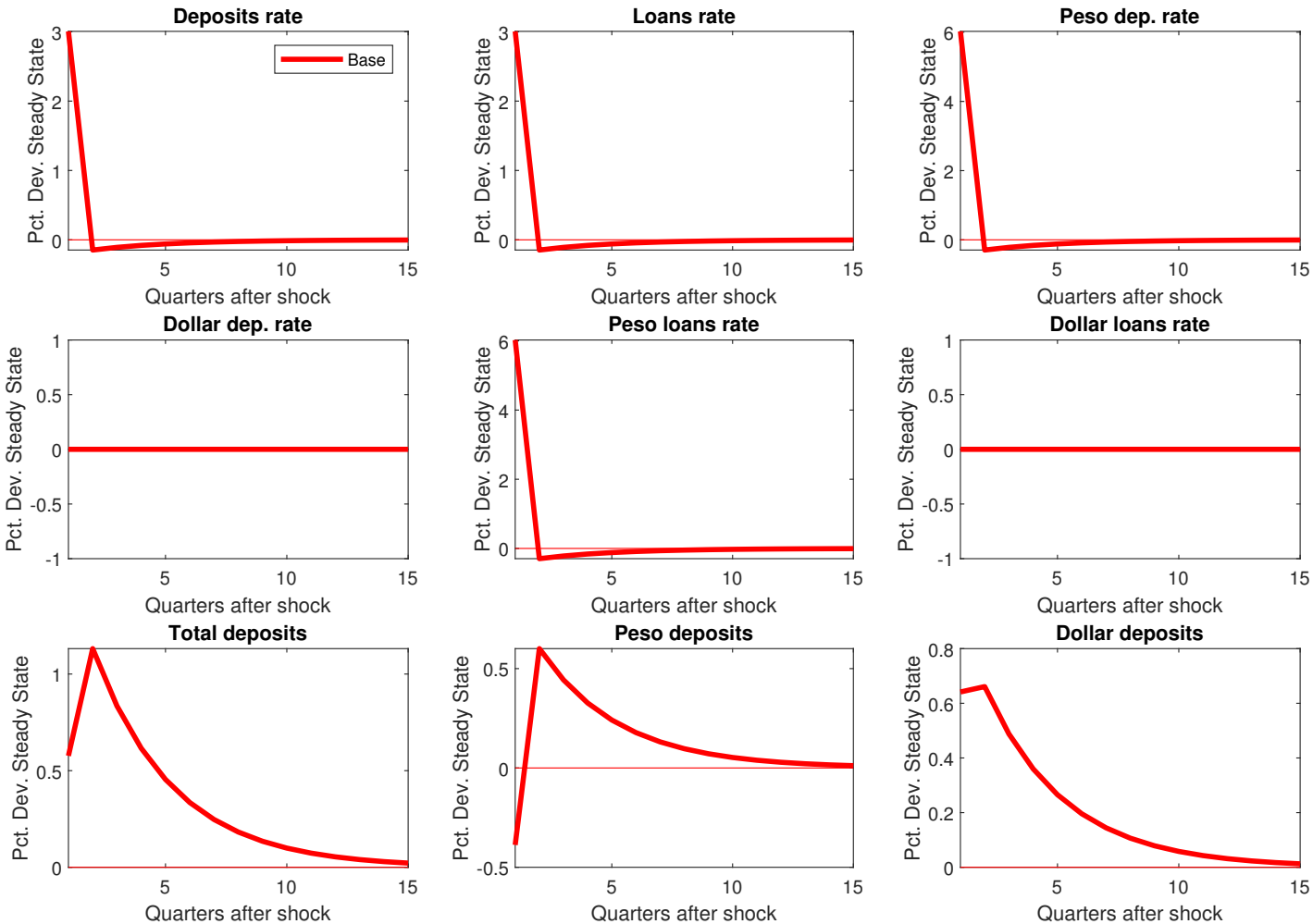
Portfolio shock

Figura: Response to a 1 % standard deviation portfolio shock (1)



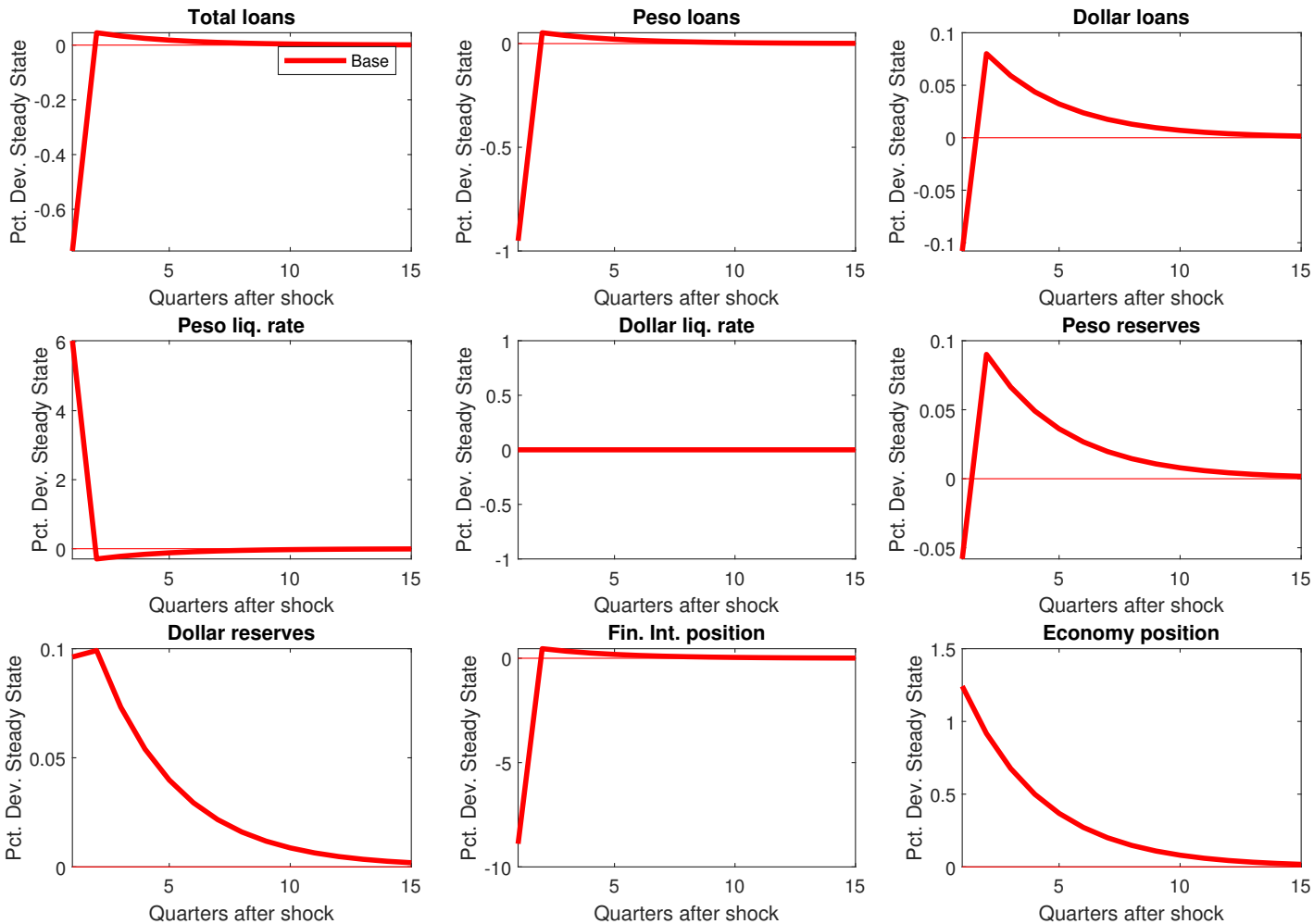
Portfolio shock (2)

Figura: Response to a 1 % standard deviation portfolio shock (2)



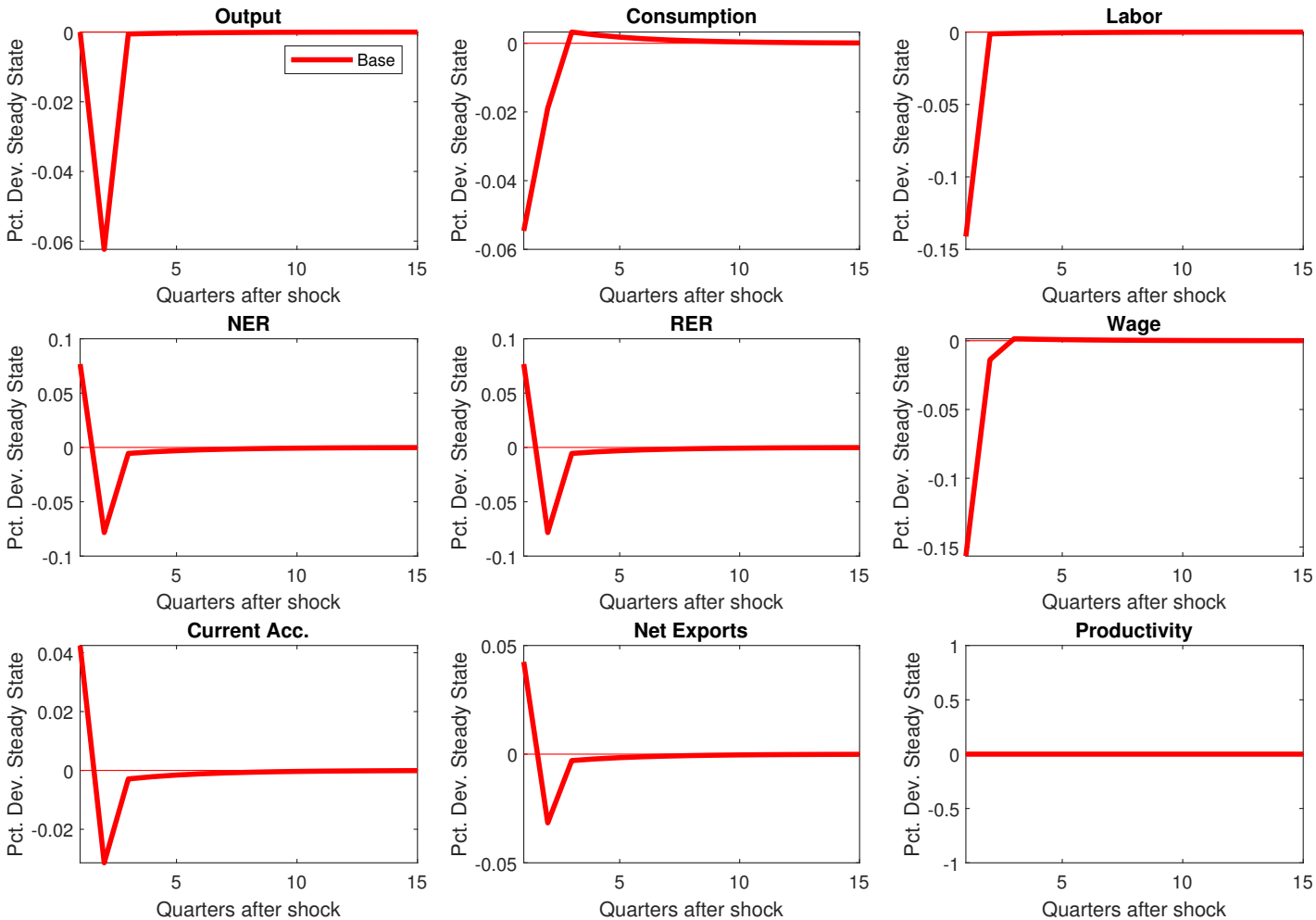
Portfolio shock (3)

Figura: Response to a 1 % standard deviation portfolio shock (3)



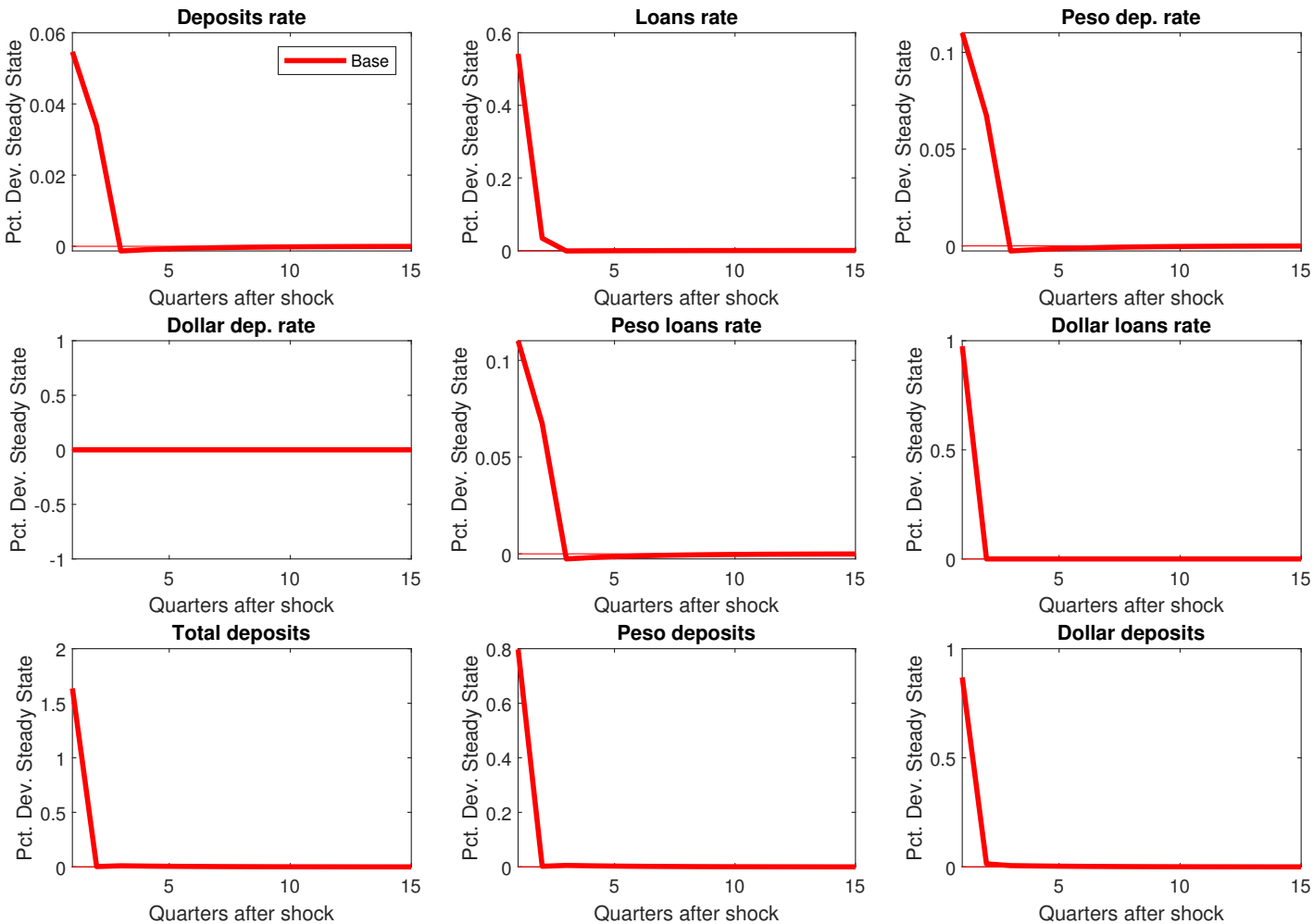
Dollar liquidity shock

Figura: Response to a 1 % standard deviation dollar liquidity shock (1)



Dollar liquidity shock (2)

Figura: Response to a 1 % standard deviation dollar liquidity shock (2)



Dollar liquidity shock (3)

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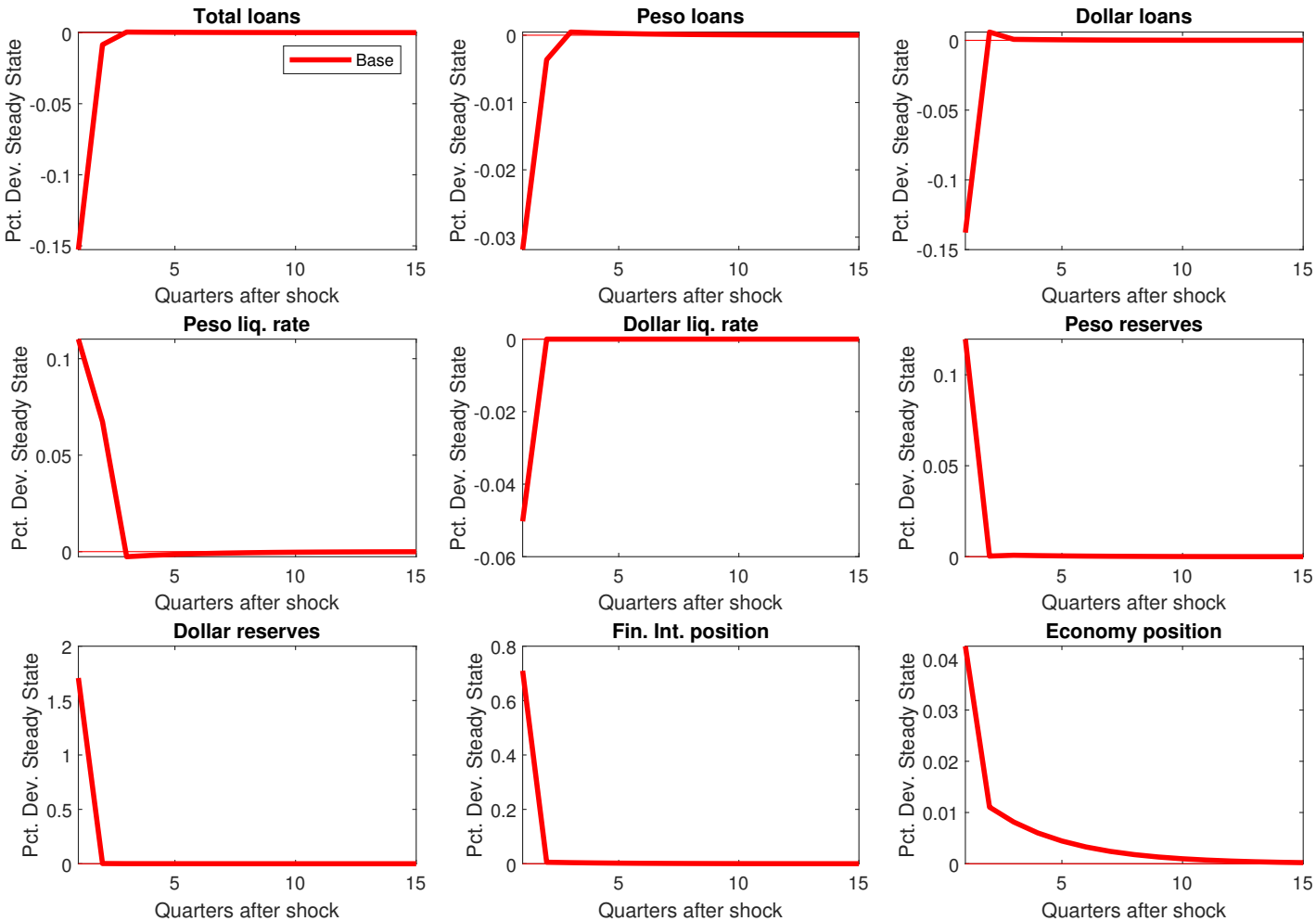

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Optimal FXI Policy Analysis

- We take the mechanism to a GE framework that exhibits an endogenous deviation in the UIP as in Itskhoki & Muhkin (2022) and Ortiz & Montoro (2020).
- Financial account flows will (endogenously) affect the demand for hedging.
- Additionally, we assume an exogenous liquidity shock in dollars that affects the UIP and acts as a tax in financial intermediation (cost in real resources).
- The central bank can intervene in both spot and derivatives markets.
- Only spot FX interventions affect the liquidity premium.

Optimal FXI Policy Analysis (2)

- LQ analysis: A second order approximation to the constrained central planner objective yields:

$$\mathbb{W} = -\sum_{t=0}^{\infty} \beta^t \left[\Phi_1 \lambda_t^2 + (1-\beta^d) \left(\Phi_2 \left(b_{t+1}^{cb,d} \right)^2 + \Phi_3 \left(b_{t+1}^{cb,s} \right)^2 \right) + \Phi_4 \left[\chi_t^* - b_{t+1}^{cb,s} \right]^2 \right] + \mathcal{O}(\|a\|^3) + t.i.p.$$

- where:
  - λ: Backus-Smith wedge.
  - $b^{cd,d}$: Derivatives FXI.
  - $b^{cd,s}$: Spot FXI.
  - χ^*: Liquidity premium.
  - β^d: Share of foreign FX dealers.

Optimal FXI Policy Analysis (3)

- Constrained central planner solves:

$$\mathcal{L}_t = \underset{\{\lambda_t, b_{t+1}, b_{t+1}^{cb,s}, b_{t+1}^{cb,d}, \chi_t^*\}}{\max} E_t \Bigg[-\beta^t \Bigg\{ (1-\gamma)\frac{1}{2}\lambda_t^2[1+\gamma+\gamma^2] - \frac{1}{2}\left(-(1-\beta^d)\frac{\partial E_w[\cdot]}{\partial b^{cb,s}} - 2\omega\sigma^2(1-\beta^d) \right)(b_{t+1}^{cb,s})^2 +$$

$$- \omega\sigma^2(1-\beta^d)(b_{t+1}^{cb,d})^2 - \Phi_4\left(\chi_t^* - b_{t+1}^{cb,s}\right)^2 + \mu_t^{BG}\left(b_{t+1} - \frac{b_t}{\beta} - \lambda_t\right) +$$

$$+ \mu_t^{EU}\left(\lambda_{t+1} - \lambda_t - \frac{\omega\sigma_e^2}{m}\left(-YE_w[\chi_t^* - b_{t+1}^{cb,s}] - \bar{Y}b_{t+1} - \bar{Y}b_{t+1}^{cb,s} - \bar{Y}b_{t+1}^{cb,d} - n\psi_t\right)\right)\Bigg\}\Bigg]$$

First order conditions are given by:

$$\lambda_t : E_t\{(1-\gamma)\lambda_t[1+\gamma+\gamma^2] - \mu_t^{BG} + \mu_t^{EU}(-1) + \beta^{-1}\mu_{t-1}^{EU}\} = 0$$

$$b_{t+1}^{cb,s} : E_t\left\{ \left((1-\beta^d)\frac{\omega\sigma^2}{m}\frac{\partial E_w[\cdot]}{\partial b^{cb,s}} + \frac{\omega\sigma^2}{m}(1-\beta^d) \right)(b_t^{cb,s}) + \mu_t^{EU}\frac{\sigma_e^2\omega}{m}\bar{Y}\left[1 + \frac{\partial E_w[\cdot]}{\partial b^{cb,s}}\right] \right\} + 2\Phi_4(\chi_t^* - b_{t+1}^{cb,s}) = 0$$

$$b_{t+1}^{cb,d} : E_t\left\{ -\frac{\omega\sigma^2}{m}(1-\beta^d)b_t^{cb,d} + \mu_t^{EU}\frac{\sigma_e^2\omega}{m}\bar{Y} \right\} = 0$$

$$b_{t+1} : \mu_t^{BG} - E_t\mu_{t+1}^{BG} + \mu_t^{EU}(-1)\frac{\sigma_e^2\omega}{m}(-\bar{Y}) = 0$$

$$\chi_t^* : -2\Phi_4\left(\chi_t^* - b_{t+1}^{cb,s}\right) - \mu_t^{EU}\frac{\sigma_e^2}{m}\bar{Y}\frac{\partial E_w[\cdot]}{\partial \chi^*} = 0$$

Findings

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Findings

- When the liquidity premium is present, spot interventions are more effective.
- However, the cost is proportional to the effect (volatility of resource constraint).
- Central bank could use spot or derivatives to close the "Backus-Smith wedge".
- Need a different welfare loss source for identification.
- We introduce a reduced form element on production: Cúrdia & Woodford (2006).

Optimal FXI Policy Analysis

- We solve for different cases:
  - **No cost for FXI** $\left(\beta^d = 1\right)$**:** Central bank fully stabilizes the liquidity shock with spot FXI and the Backus-Smith wedge with either type of intervention.
  - **No cost for FXI and no additional effect of liquidity stress** $\Phi_4 = 0$**:** Central bank eliminates exchange rate deviations with either instrument.
  - **No cost for FXI and lower bound on spot interventions:** Central bank uses spot for liquidity deviations and derivatives for portfolio wedge.
  - **Costly FXI and no additional effect of liquidity stress:** Central bank eliminates exchange rate deviations with a mix of both instruments.

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Conclusions

- We present a theoretical framework to study the interactions between liquidity and portfolio effects encompassing recent developments in the literature.
- Perform an LQ analysis to derive policy recommendations relative to interventions with spot and derivatives.
- Spot interventions are more effective when liquidity is a consideration.
- Need additional channels through which liquidity affects the economy to obtain a clear policy recommendation between instruments.

Conclusions

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- Perform an LQ analysis to derive policy recommendations relative to interventions with spot and derivatives.
- Spot interventions are more effective when liquidity is a consideration.
- Need additional channels through which liquidity affects the economy to obtain a clear policy recommendation between instruments.
- Comments welcome!

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Model(s)

- We present two ways of obtaining a modified UIP that considers:
  - Portfolio motives.
  - Liquidity motives.
- In the first one retail FX dealers act as intermediaries to obtain the liquidity needed for bonds (a CIA motive). [Forthcoming]
- In the second one, banks act as intermediaries to obtain funds in different currency.
- Then we conduct an LQ exercise where portfolio and liquidity motives influence exchange rate determination.
  - The LQ exercise it is used to study under what conditions both instruments are useful.

Model: Retail dealers (Teaser)

- **Timeline**

1. Households and foreign investors choose their demand for bonds.
2. Retail dealers demand liquidity in LC and FC.
3. Retail dealers receive orders.
4. They settle their position into inter-dealer market.

Model: Retail Foreign Exchange Dealers (Teaser)

Environment:

- Foreign investors are modeled as noise traders as in Itskhoki and Muhkin(2017).
- We assume a CIA constraint to obtain bonds.
- RFEDs act by providing the liquidity needed to acquire bonds.
  - They are risk adverse.
  - Demand money in LC and FC and have a zero capital strategy.
  - Receive orders for changing one currency for another.
  - They fulfill these orders: *Liquidity service provision (Stoll, 1978).*
- There is a inter-dealer market where they trade short-term loans.
  - The inter dealer market is OTC and is determined by a matching functions.
  - The dealers who don't find the liquidity needed have to pay a punishment interest rate.
- The Central bank provides liquidity in LC and FC, and can interviene in the bond market.