Foreign capital flows, credit growth and macroprudential policy in a DSGE model with traditional and matter-of-fact financial frictions

WORK IN PROGRESS – PRELIMINARY RESULTS

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The views expressed in this work do not necessarily represent those of the Central Bank of Brazil or its members

Purpose

- Investigate and assess the effects of macroprudential instruments and policies on the Brazilian economy
  - Reserve requirements
  - Capital requirement
  - Sectoral risk weights on banks' assets for capital adequacy computation

Methodology

- Dynamic stochastic general equilibrium model (DSGE) with a relevant role of the banking system
- Theoretical improvements to existing DSGE models to better represent the Brazilian banking system
- Open economy model with detailed balance of payments
- Bayesian estimation with Brazilian data

Motivation

- Brazil: active use of Reserve Requirements and CAR Risk Weights as policy instruments
- Brazilian agenda of convergence to the Basle-3
- Mainstream literature focuses on advanced economies
  - Full collateralization of loans through capital or housing
  - Unremunerated reserve requirements

Our main contributions

- Risky retail loan concessions based on expected labor income, not on physical collateral
- Ample and realistic set of reserve requirements
  - Time deposits, demand deposits, savings accounts, additional requirements.
- Bank liquidity buffer and preferences for bank leverage.
- Detailed balance of payment equation
  - Spillover from foreign capital flows into domestic credit market via risk premium and UIP.

The theoretical model

Households

- Savers
- Borrowers (modified BGG with labor income as collateral)

Entrepreneurs (BGG financial accelerator)

Firms

- Intermediate goods
- Retailers/Distributers
- Final goods: private consumption, government consumption, investment, exports, capital and housing
- Exporting and importing firms

Government (Fiscal, Monetary, Macroprudential and FER policies

Investment fund

Bank conglomerate

- Wholesale branch (Assets and liabilities management)
- Deposit branches (time deposits, savings accounts, demand deposits)
- Lending branches (retail loans, investment loans, housing loans)

External Sector

- Capital flows
- Foreign interest rates, inflation, risk premium, demand for exports

Model for the Banking System

- Representative bank supplies consumer, commercial and housing loans subject to default risk (modified BGG financial accelerator).
- It supplies riskless working capital loans to exporters.
- Funding from demand, savings and time deposits.
- No exposure to exchange rate risk or foreign funding.
- Liquid assets buffer for precautionary purposes.
- Concerns about the leverage ratio.
- Adjustment costs on time deposits.
- Subject to prudential regulation (capital requirements and reserve requirements)

Bank Optimization Problem (simplified)

$$\max E_0 \left\{ \sum_{t \geq 0} \beta_{bank}^{t} \left[\frac{1}{1-\sigma_B} \left(C_{B,j,t} \right)^{1-\sigma_B} \right] \varepsilon_t^{\beta,B} \right\}$$

Balance sheet: $L_{j,t} + Bonds_{j,t} + RR_{j,t} = D_{j,t} + K_{j,t}^{bank}$

Capital Accumulation: $K_{j,t}^{bank} = K_{j,t-1}^{bank} + CF_{j,t} - P_{C,t} C_{B,j,t} + K_{j,t}^{bank} \varepsilon_t^{K^{bank}}$

Reserve Requirement: $RR_{j,t} = \tau_{RR,t} D_{j,t}$

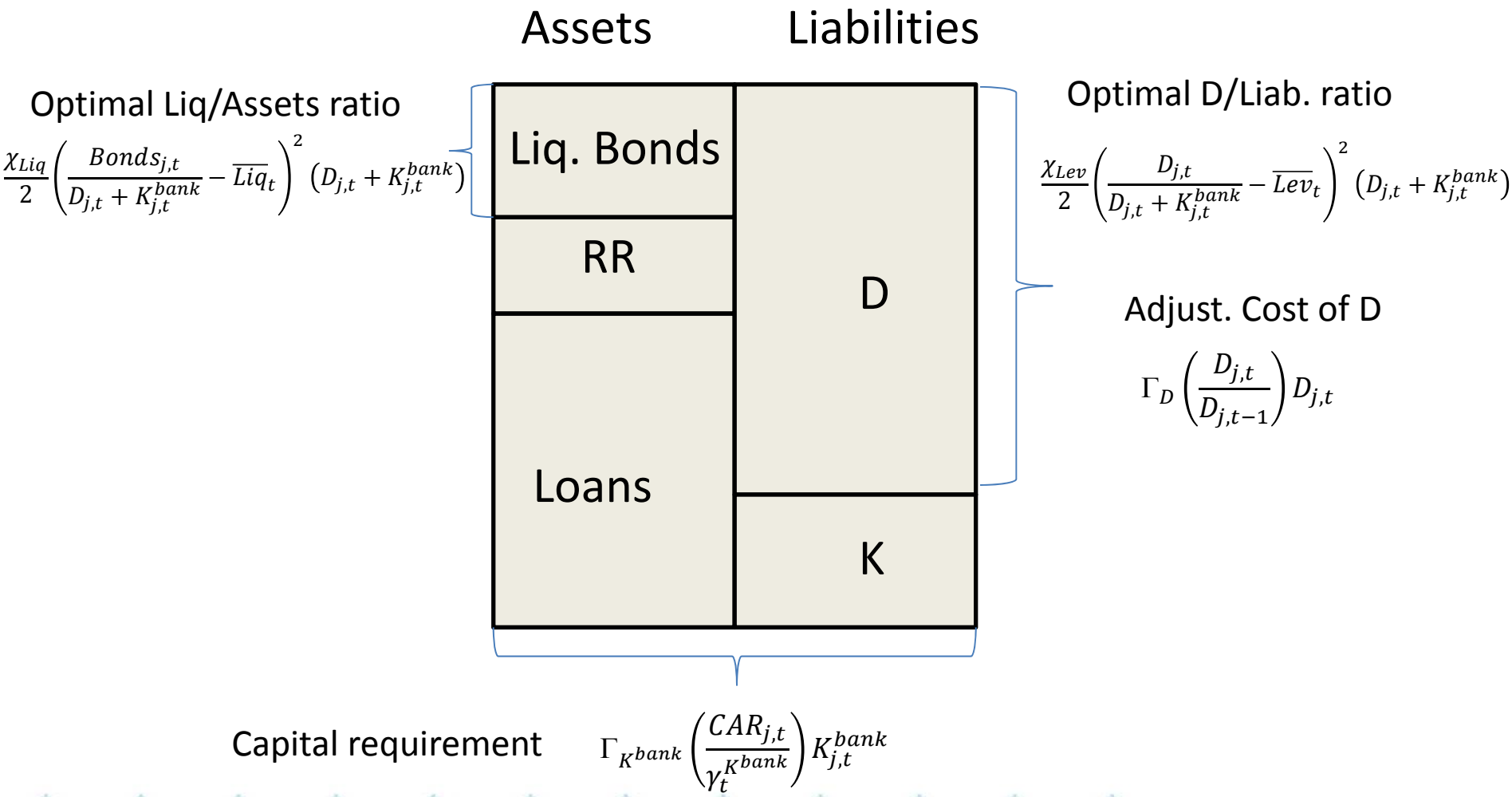
Loan Demand (plus Calvo Rigidity in interest rates): $L_{j,t} = \left(\frac{R_{j,t}^{L}}{R_t^{L}} \right)^{\frac{\mu_L}{1-\mu_L}} \mathrm{L_t}$

Capital Adequacy Ratio: $CAR_{j,t} = K_{j,t}^{bank} / (\tau_{L,t} D_{j,t})$

Operational cash flow:

$$\begin{aligned} CF_{j,t} = {} & R_{j,t-1}^{L} L_{j,t-1} - L_{j,t} + R_{t-1}^{RR} RR_{j,t-1} - RR_{j,t} \\ & + R_{t-1} Bonds_{j,t-1} - Bonds_{j,t} - R_{t-1} D_{j,t-1} + D_{j,t} \\ & - \Gamma_{K^{bank}} \left(\frac{CAR_{j,t}}{\gamma_t^{K^{bank}}} \right) K_{j,t}^{bank} - \Gamma_D \left(\frac{D_{j,t}}{D_{j,t-1}} \right) D_{j,t} \\ & - \frac{\chi_{Liq}}{2} \left(\frac{Bonds_{j,t}}{D_{j,t} + K_{j,t}^{bank}} - \overline{Liq_t} \right)^2 \left(D_{j,t} + K_{j,t}^{bank} \right) \\ & - \frac{\chi_{Lev}}{2} \left(\frac{D_{j,t}}{D_{j,t} + K_{j,t}^{bank}} - \overline{Lev_t} \right)^2 \left(D_{j,t} + K_{j,t}^{bank} \right) \end{aligned}$$

Frictions in the Banking Model



Capital Requirement and Bank Funding Cost

We relate bank capital to a internal funding cost associated to bank leverage. The higher the bank capital excess over prudential requirement, the lower this internal funding cost.

A rationale for this can be found in Van den Heuvel (2007):

– if bank capital falls below regulatory minimum, the regulator prevents banks from distributing dividends or making new loans.

– in order to avoid that, banks accumulate capital in excess over regulatory minimum. When this buffer is small, banks are less willing to provide new loans, lest an adverse shock might reduce its capital below that minimum. This would imply in higher lending rates.

Capital Requirement and Bank Funding Cost (ctd.)

This behavior can be represented in reduced form as an internal cost of capital:

$$\Gamma_{K^{bank}}\left(\frac{CAR_t}{\gamma_t^{K^{bank}}}\right)K_t^{bank}$$

where is a quadratic function such that

$$\Gamma'_{K^{bank}}\left(\frac{CAR_t}{\gamma_t^{K^{bank}}}\right)<0,\Gamma''_{K^{bank}}\left(\frac{CAR_t}{\gamma_t^{K^{bank}}}\right)>0$$

$$\frac{CAR}{\gamma^{K^{bank}}}>1 \quad \text{in steady state}$$

Reserve Requirement and the Bank Balance Sheet

In Brazil, both RR and time deposits have basically the same remuneration rate. In this setup, the traditional channel for RR becomes inoperative: the bank may comply costlessly with any increase in RR by issuing more time deposits.

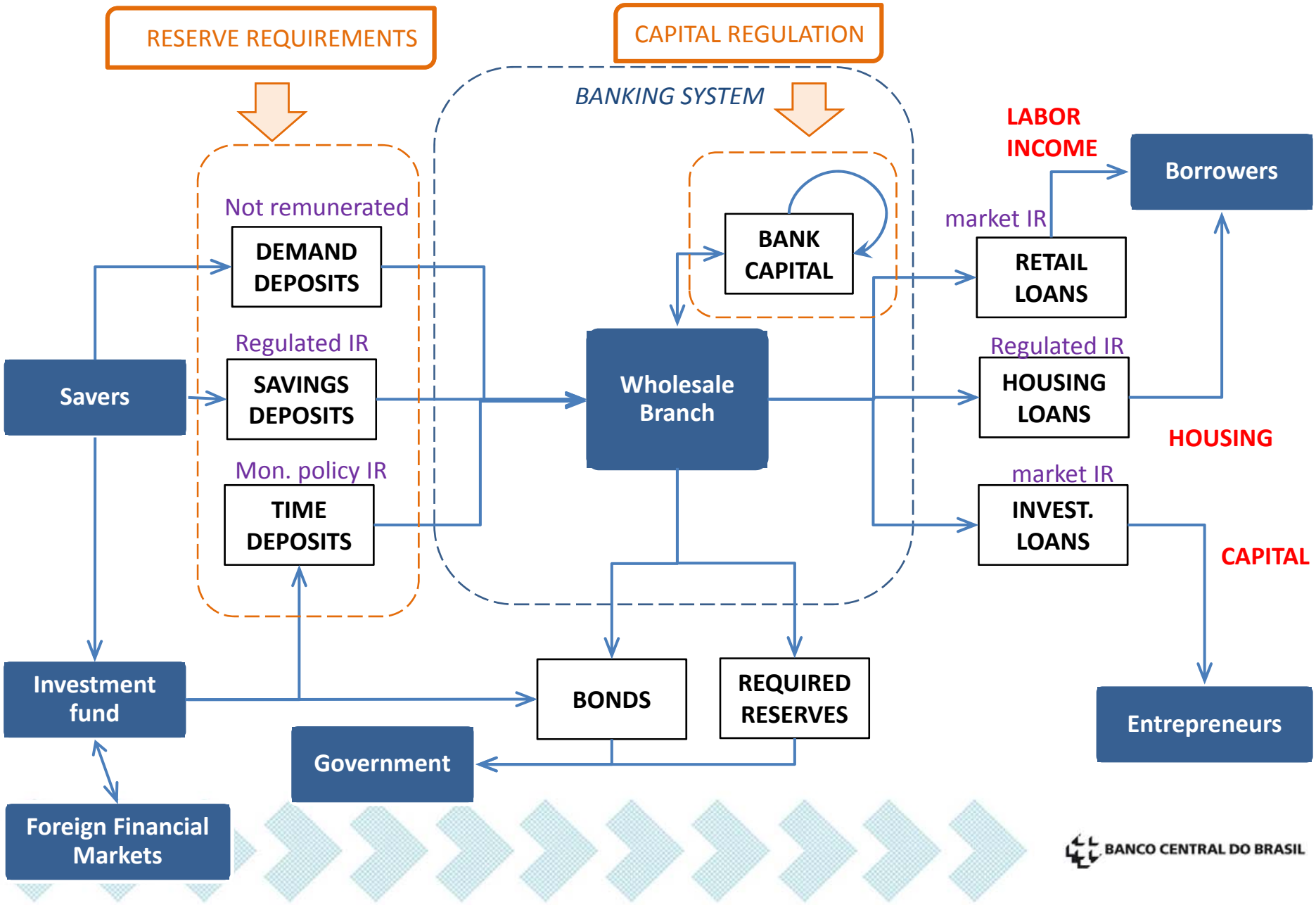
$\Rightarrow$ Frictions associated to Time Deposits introduce sluggishness in deposits and render RR costly to banks.

In Brazil, the first reaction of banks to RR increases is tapping from liquid assets.

$\Rightarrow$ Liquid assets were introduced in the bank model.

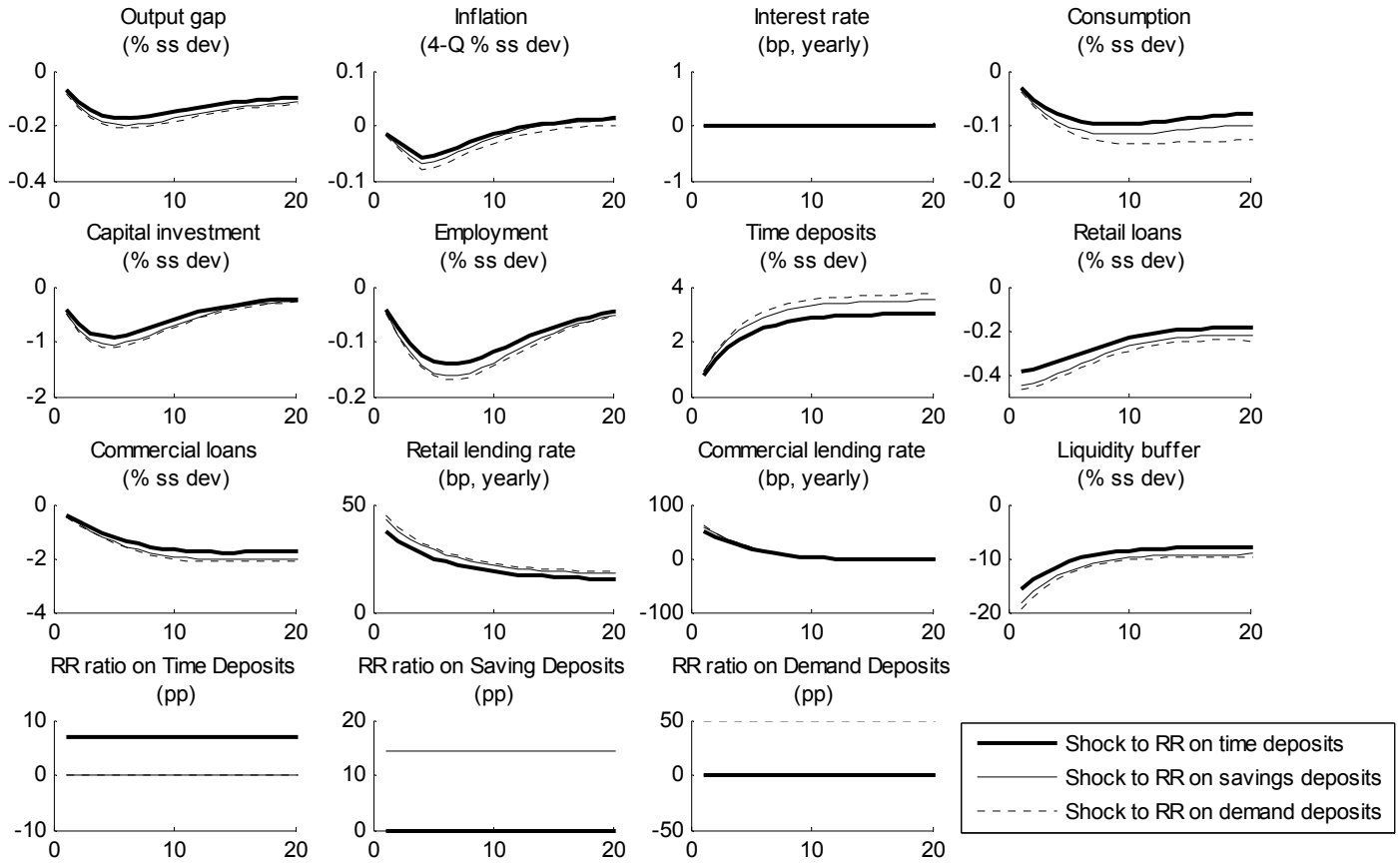
$\Rightarrow$ An additional friction was introduced to liquid assets in order to keep remunerated RR costly.

Bank financial flows in the fully fledged model

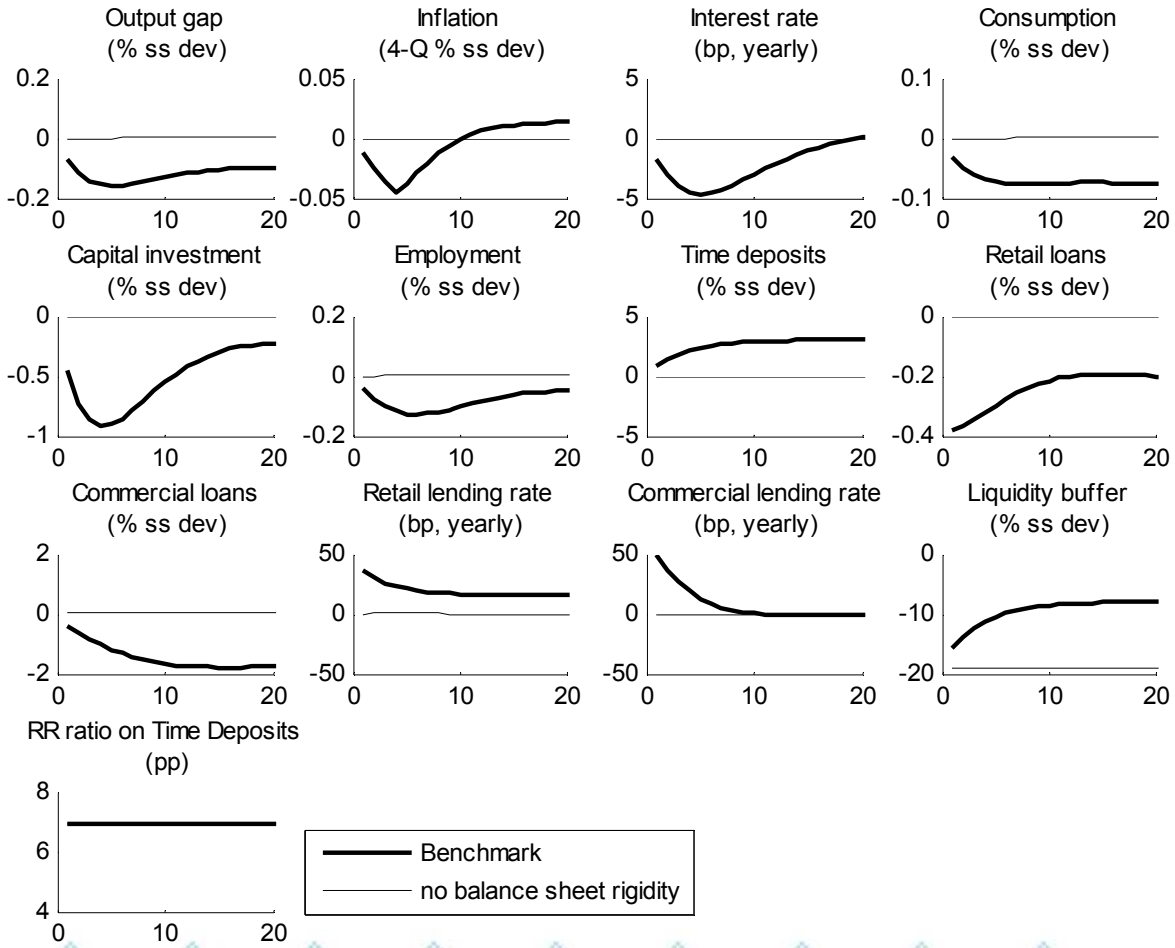


Example:

Same scale shocks to Time, Savings and Demand Deposits Reserve Requirements



Counterfactual Example:
Shock to Time Deposits RR with no Balance Sheet Rigidity



Counter-cyclical capital buffer

Two alternative implementations

- Immediate response

$$\ln(\gamma_t^{Kreq}) = \ln(\overline{\gamma}^{Kreq}) + \ln(\gamma_t^{CCB}) + \varepsilon_t^{Kreq}$$

$$\ln(\gamma_t^{CCB}) = \rho_{CCB} \ln(\gamma_{t-1}^{CCB}) + \chi_{CCB,cred} \ln\left(\frac{b_t^E + b_t^{B,c} + b_t^{B,H}}{b^E + b^{B,c} + b^{B,H}}\right)$$

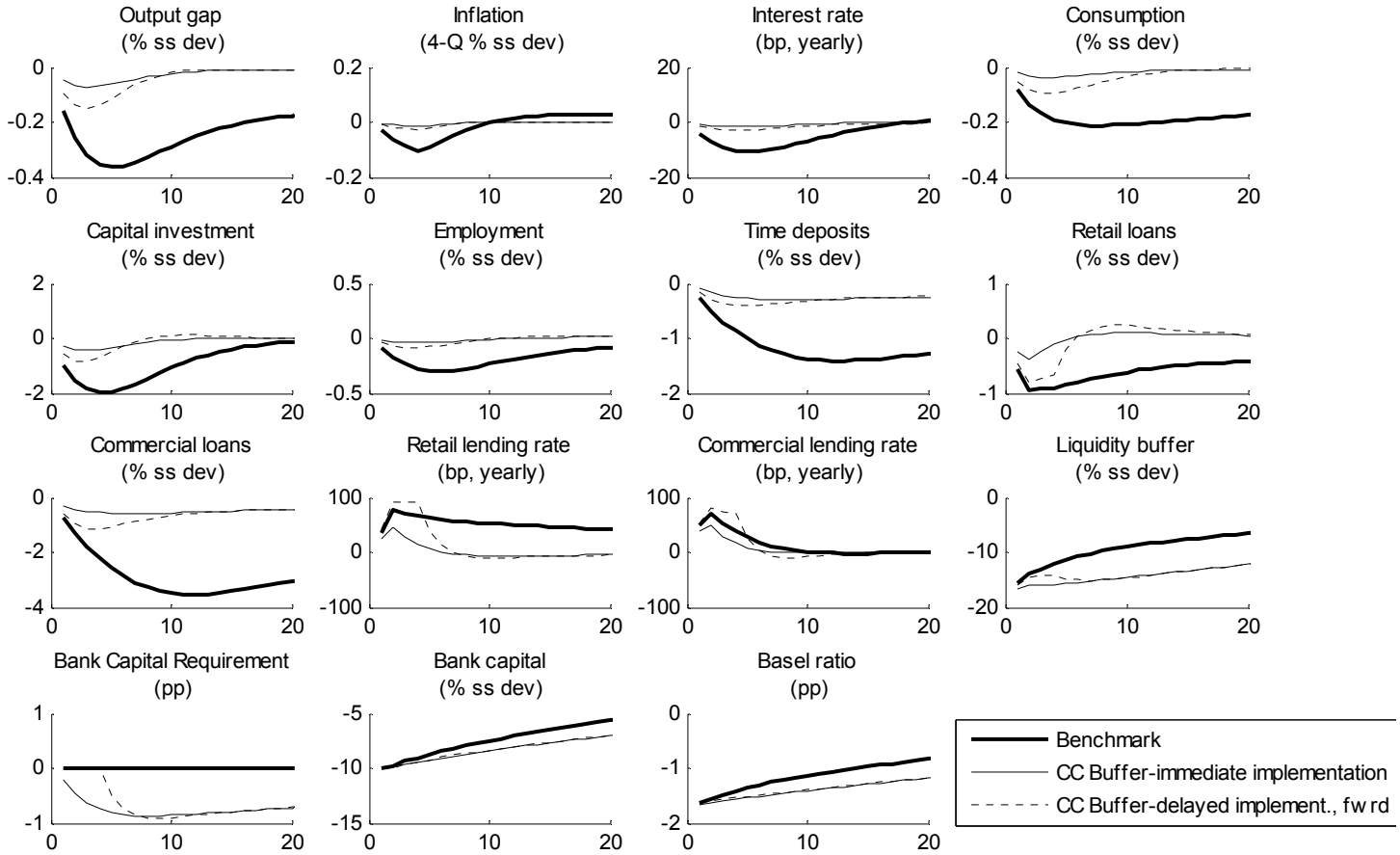
- Delayed response

$$\ln(\gamma_t^{Kreq}) = \ln(\overline{\gamma}^{Kreq}) + \ln(\gamma_{t-4}^{CCB}) + \varepsilon_t^{Kreq}$$

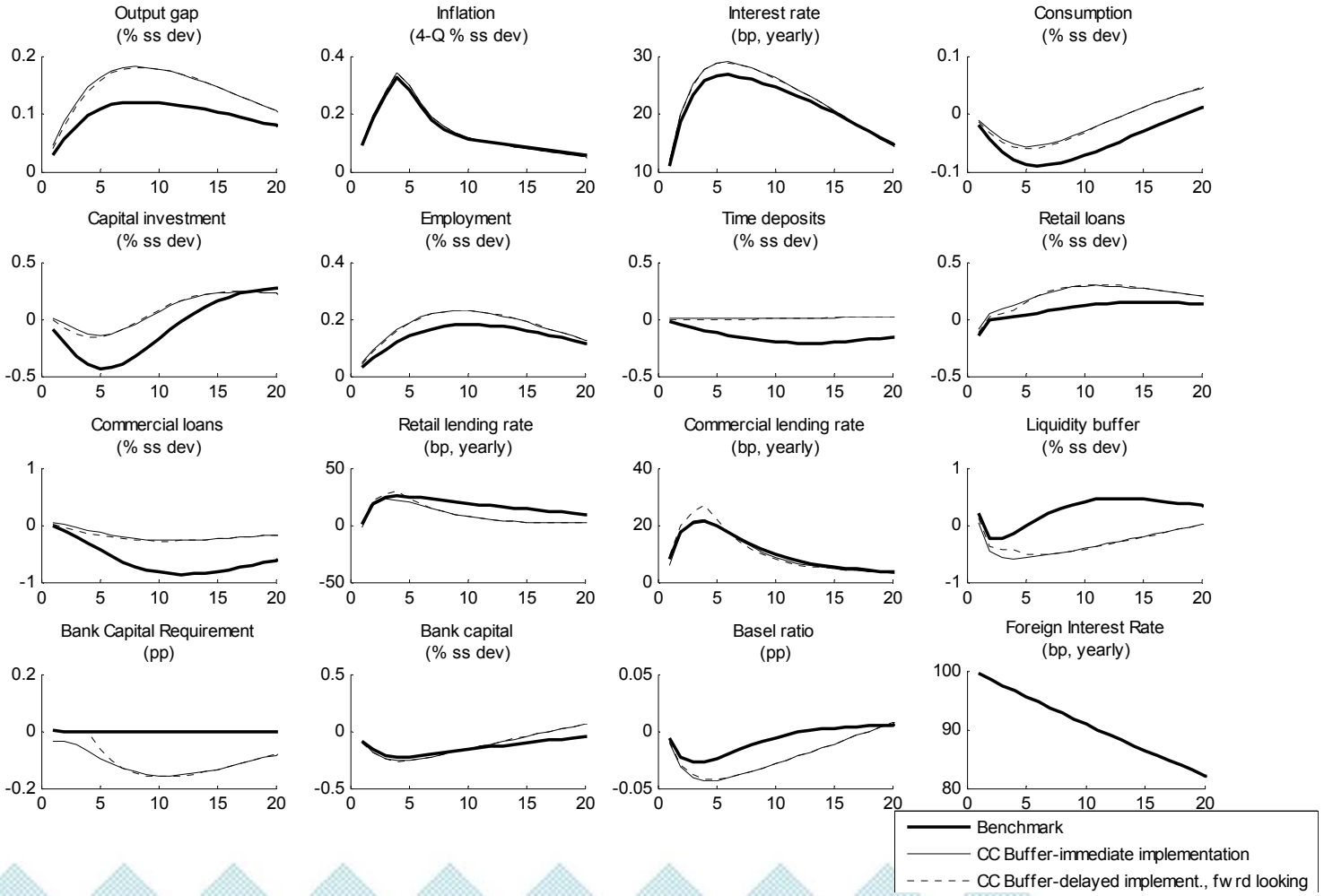
$$\ln(\gamma_t^{CCB}) = \rho_{CCB} \ln(\gamma_{t-1}^{CCB}) + \chi_{CCB,cred} \mathrm{E_t}\left[\ln\left(\frac{b_{t+4}^E + b_{t+4}^{B,c} + b_{t+4}^{B,H}}{b^E + b^{B,c} + b^{B,H}}\right)\right]$$

Example:

Negative shock to Bank Capital with CCB response (immediate x delayed)



Example: Negative Persistent shock to external interest rates with CCB response (immediate x delayed)



Foreign Capital Flows and Domestic Credit Growth

- In Brazil, most of the retail and commercial credit is supplied by domestic banks.
- Prudential regulation prevents banks from having significant exposure to exchange rate risk.
- In such a situation, excessive monetary liquidity abroad cannot be fed directly into banks' balance sheets.
- We introduce indirect transmission channels through which foreign capital flows can impact the real variables and produce spillover effects on bank credit.
  - Risk premium
  - UIP

Balance of Payments

$$B_t^f = R_{t-1}^f B_{t-1}^f + \omega_t^X (R_t \phi_t^* - 1) P_t^{X^*} X_t - \left(P_t^{X^*} X_t - P_t^{M^*} M_t\right) - \mathrm{ULT_t}$$
$$- \left(FDI_t - \frac{\Pi_{t-1}^{E,FDI}}{S_t}\right) - \left(\frac{B_t^{FPI} - R_{t-1}^* B_{t-1}^{FPI}}{S_t}\right) + (B_t^{FER} - R_{t-1}^* B_{t-1}^{FER})$$

We decompose the balance of payments into 6 accounts, according to available data:

- Net exports
- Unilateral transfers
- Foreign direct investment (FDI)
- Foreign portfolio investment (FPI)
- Variation in foreign exchange reserves (FER) held by the government
- Foreign exchange debt owed by domestic agents

Balance of Payments

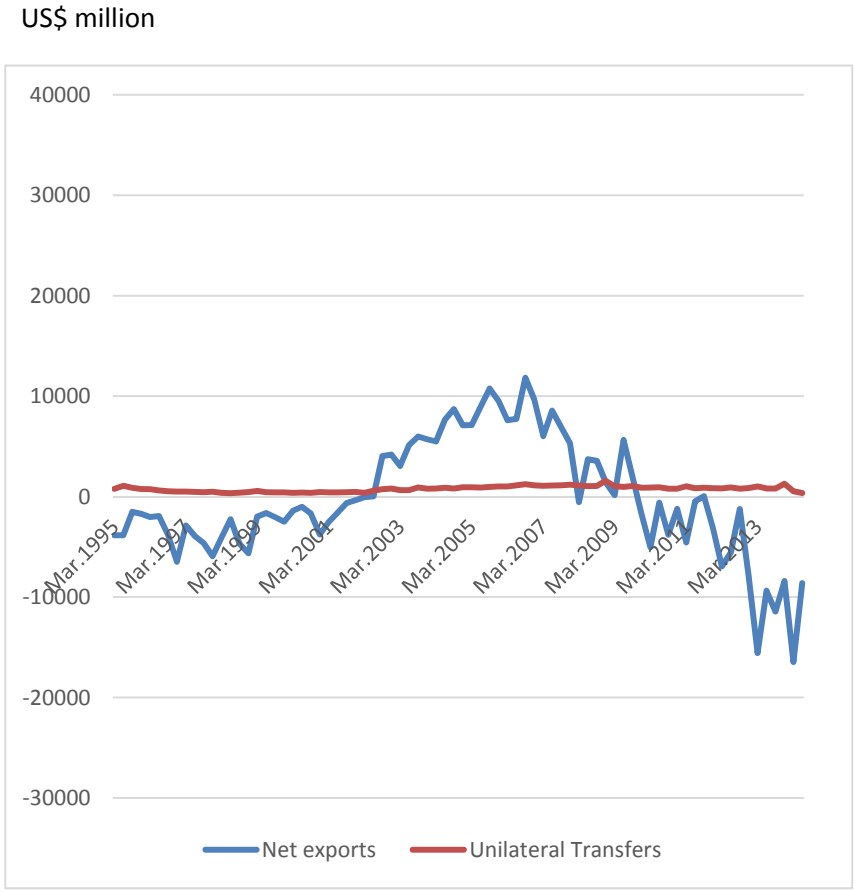
Net Exports

- Imports used as intermediate goods to produce final goods.
- Exporters are price taker subject to adjustment costs on export volumes.
- Net exports depend on prices of imported and exported goods relative to domestic goods prices and costs.

Unilateral Transfers

- Minor component of the BoP. Modeled as a simple AR(1) process.

$$ULT_t = \rho_{ULP} ULT_{t-1} + v_t^{ULT}$$



Balance of Payments

Foreign Direct Investment (FDI)

- Acquisition of domestic productive capital by foreign investors
- Represented as a stake of foreign investors on entrepreneurs' net worth $N_{E,t}$ and revenues Π_t^E.

$$n_{E,t} = n_{E,t}^{FDI} + n_{E,t}^{S}$$

$$\Pi_t^{E,FDI} = \Pi_t^E \frac{n_{E,t-1}^{FDI}}{n_{E,t-1}}$$

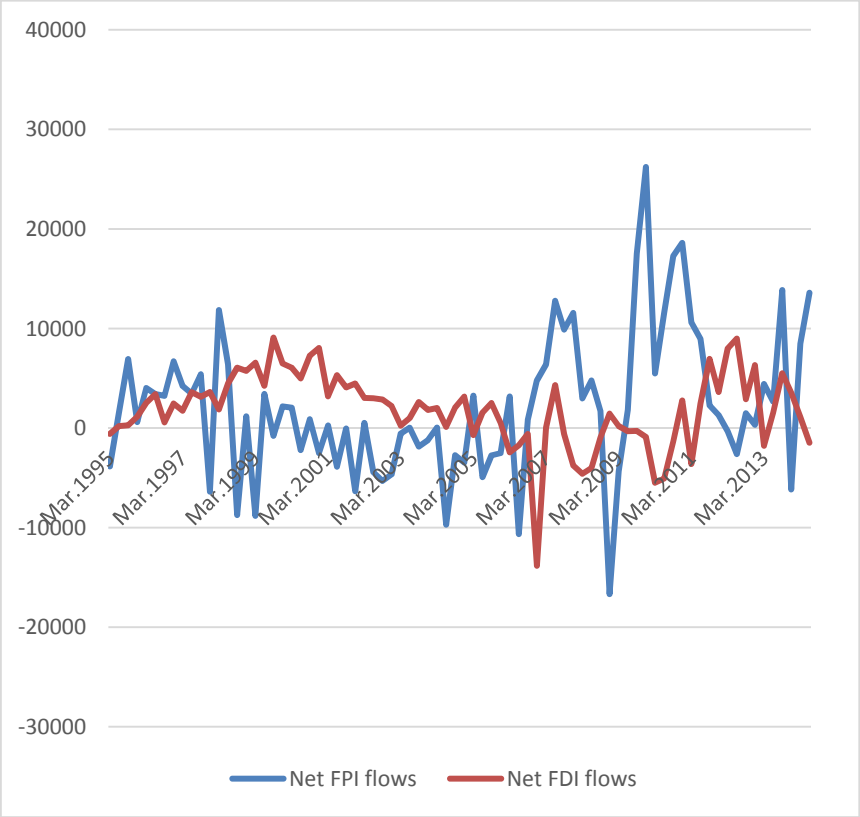
$$n_{E,t}^{FDI} = n_{E,t} \frac{n_{E,t-1}^{FDI}}{n_{E,t-1}} + s_t fdi_t$$

- Modeled as a simple exogenous process, with a stabilizing term.
- FDI decision disentangled from entrepreneurs' investment decisions.

$$fdi_t = -\gamma_{FDI}\left(n_{E,t-1}^{FDI} - \overline{n}_E^{FDI}\right) + \varepsilon_t^{FDI}$$

$$\varepsilon_t^{FDI} = \rho_{FDI}\varepsilon_{t-1}^{FDI} + v_t^{FDI}$$

US$ million



Balance of Payments

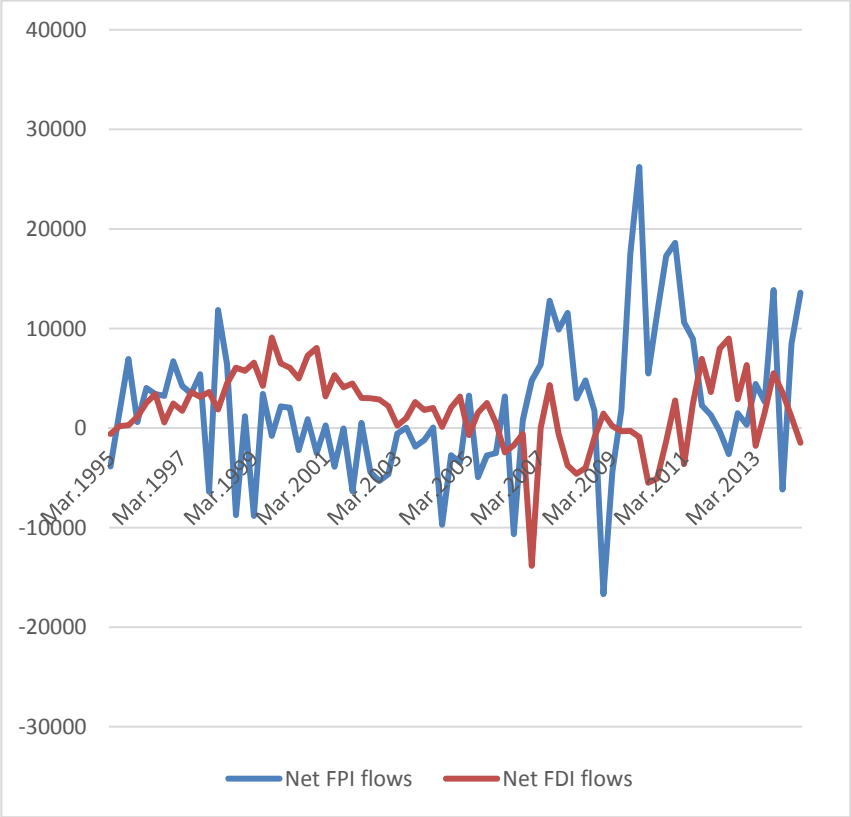
Foreign Portfolio Investment (FPI)

- Acquisition of risk-free domestic government bonds by foreign investors.
- Modeled as a simple exogenous process, which depends on the spread between domestic and foreign real interest rates.

$$ln\left(\frac{b_{FPI,t}}{\overline{b}_{FPI}}\right) = \gamma^{R,FPI} ln\left(\frac{R_t}{\pi_t}\frac{\pi_t^*}{R_t^*\phi_t^*}\right) + \varepsilon_t^{FPI}$$

$$\varepsilon_t^{FPI} = \rho_{FPI}\varepsilon_{t-1}^{FPI} + \upsilon_t^{FPI}$$

US$ million



Balance of Payments

Foreign Exchange Reserve (FER)

- Held by the monetary authority and remunerated at the foreign interest rate R_t^*.
- Negotiated in exchange for domestic government bonds.
- Used as a policy instrument to dampen real exchange rate fluctuations

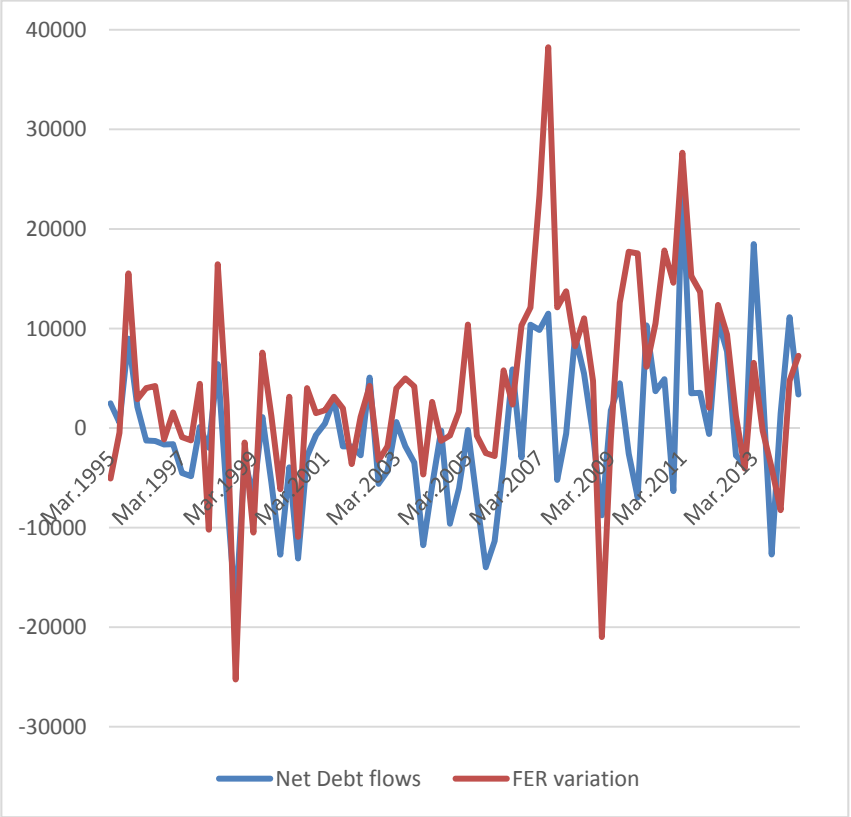
$$ln\left(\frac{b_{FER,t}}{\overline{b}_{FER}}\right) = \gamma^{S,FER} ln\left(\frac{S_t P_t^*}{P_t}\frac{1}{\bar{s}}\right) + \varepsilon_t^{FER}$$

$$\varepsilon_t^{FER} = \rho_{FER}\varepsilon_{t-1}^{FER} + \upsilon_t^{FER}$$

Private Debt

- Held by the investment bank, which takes decision on behalf of the patient households.
- It obtains as the residual of the balance-of-payments equation.

US$ million



Modified UIP

Investment Fund

- Works on behalf of Savers. Introduced to represent their portfolio decisions separately from Savers' optimization problem.
- It issues fund shares to Savers and borrows from abroad. The proceeds are invested in domestic government bonds and bank deposits.
- Adjustment costs are introduced to induce sluggishness in foreign currency debt .

$$\max E_t\left\{R_t^D D_t + B_{F,t}R_t - S_{t+1}R_t^*\phi_t^* B_{F,t}^*\right\} - \frac{\phi_{F,B^*}}{2}\left(\frac{B_{F,t}^*}{\pi_t^* B_{F,t-1}^*} - 1\right)^2$$

$$\text{s.t. } D_t^F = D_t + B_{F,t} - S_t B_{F,t}^*$$

The resulting loglinear modified UIP equation is

$$s_t = E_t\left[s_{t+1} + (r_t^* + \hat{\phi}_t^* - \hat{\pi}_t^*) - (r_t - \pi_t)\right] + \phi_{F,B^*}\left(b_{F,t}^* - b_{F,t-1}^*\right)$$

Therefore, variations in foreign exchange debt may impact the current real exchange rate.

Risk Premium

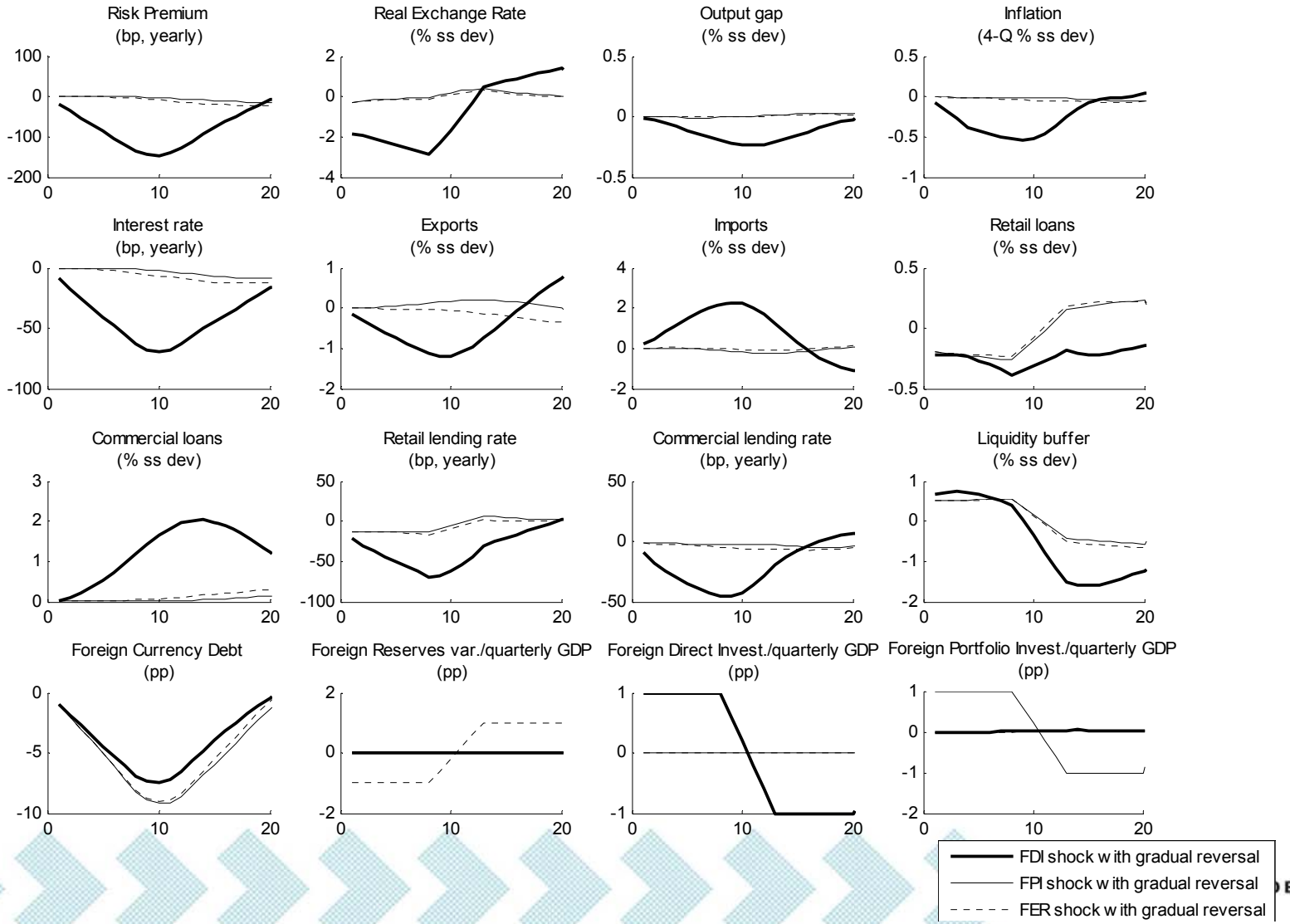
The risk premium depends on the net stock of foreign currency debt, FER and FPI

$$\hat{\phi}_t^* = \kappa_{bf}^{\phi^*} \ln\left[\frac{s_t\left(b_t^f - b_t^{FER}\right) + \kappa_{B^{FPI}}^{\phi^*} b_{FPI,t}}{s\left(\bar{b}^f - \bar{b}^{FER}\right) + \kappa_{B^{FPI}}^{\phi^*} \bar{b}_{FPI}}\right] + \kappa_{risk}^{\phi^*} \widehat{risk}_t + \varepsilon_t^{\phi^*}$$

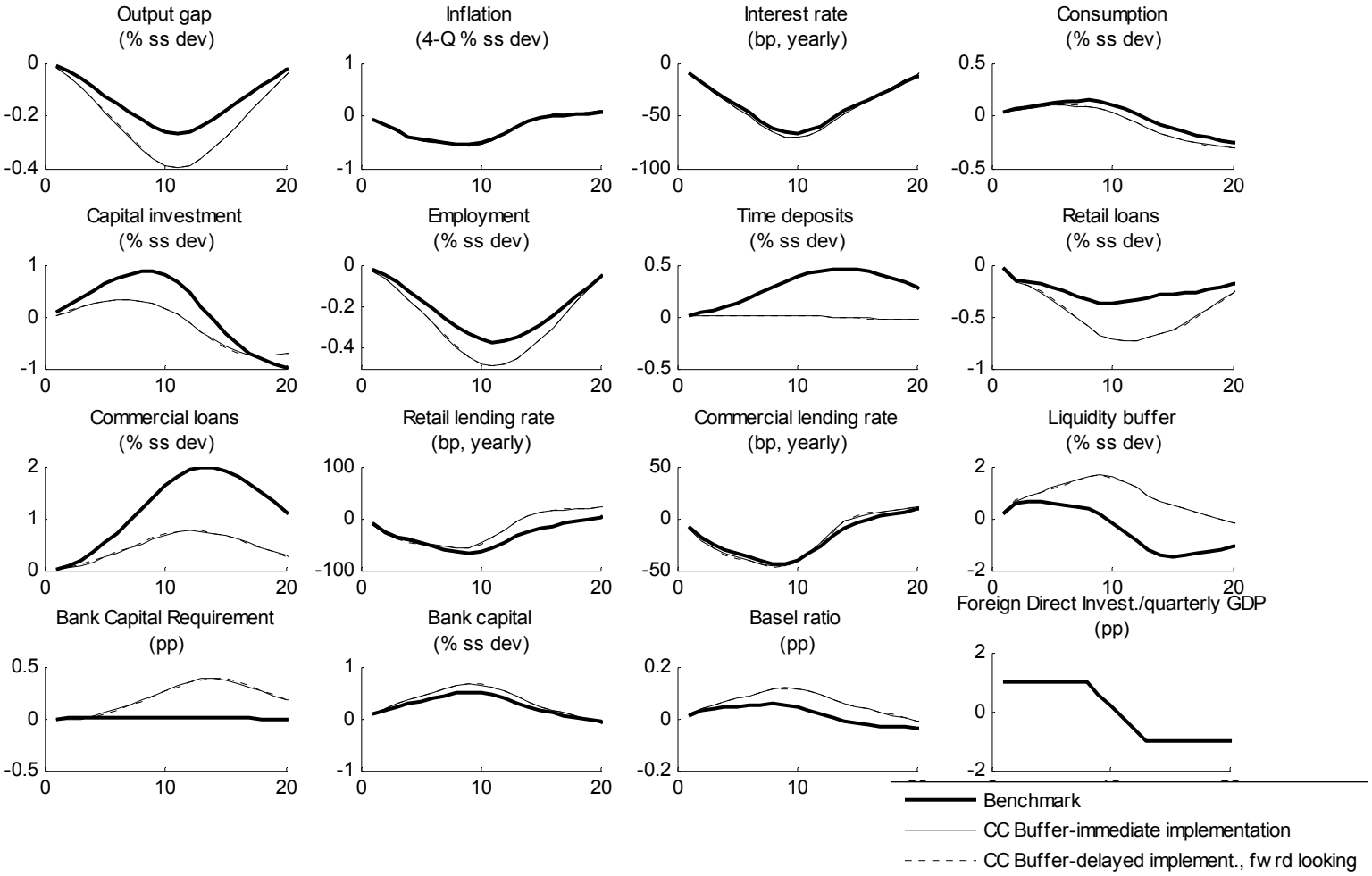
The stock of FDI is not included because it is considered a stable funding source that shall not be withdrawn swiftly.

The role of FPI in the risk premium equations depends on parameter $\kappa_{B^{FPI}}^{\phi^*}$, which was calibrated equal to 1 in the current estimation.

Comparative effects of shocks on FPI, FDI and FER



FDI shock and the Countercyclical Buffer



Next Step

- Introduce foreign exchange credit to firms with limited desired exposure to balance sheet currency mismatch.
  - In the current setup, foreign capital flows are absorbed passively by the saver (via investment fund), with no associated FOC.

Concluding remarks

- Model with financial frictions both on the demand and the supply side of the banking sector
  - Theoretical set-up tailored to Brazil
  - Transmission mechanism of macroprudential policy

- Changes in reserve requirement ratios
  - Sensitize banks' liquidity buffer, affecting lending rates and credit
  - Affect the real economy
  - Impact of remunerated RR (base-effect)

Concluding remarks

- Changes in capital requirement have a smaller yet more prolonged effect on credit-to-GDP with milder impact on output compared to MP shock

- Countercyclical buffer can have an important role in stabilizing output

- Foreign capital flows may affect domestic credit markets, even if they bypass the domestic banking system.

Thank you!

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