External Shocks and FX Intervention Policy in Emerging Economies

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Disclaimer: The views expressed in this paper are those of the authors and do not reflect necessarily the position of the Central Reserve Bank of Peru

Motivation

External shocks (Global Commodity Boom, GFC, LSAP, Taper Tantrum) shape capital flows and exchange rate dynamics in EME's:

- *Capital flows affect the availability of external funds and domestic financial conditions.*
- *Exchange rate dynamics affect currency mismatches to different agents.*

Policy Practice. Many central banks in EME's responded to these events by deploying a policy mix:

> *FX interventions (FXI), macro-prudential measures, capital controls, differentiated reserve requirements.*

In this paper

Questions

1. **What are the main mechanisms through which FXI affect the economy?**
2. **Are FXI effective in stabilizing the impact of external shocks over financial conditions and business cycles?**
3. **Are FXI interventions welfare improving?**

What do we do?

1. We build a Macroeconomic NK model for a **commodity exporting SOE**:
   - Two active monetary policy instruments: *Nominal interest rate and FXI.*
   - Financial Dollarization: *Savings and loans are denominated in two currencies.*
2. Discipline the model with limited information approach.
3. We explore the effectiveness of FXI to mitigate the impact of external shocks.

We don't explore the optimality of the FX reserves accumulation process and the costs associated to it.

Definition of FX interventions

- *The central bank buys/sells FX (dollars) with the banking system in exchange for domestic currency-denominated assets.*
- *But in a way that offsets any change in the supply of domestic liquidity by using domestic bonds issued by the central bank (sterilization leg of any FX intervention operation).*

FXI leans against bank's lending capacity
In our framework: FX intervention is modeled as a "non-conventional" MP tool

- Neutral/not effective: when agents are not constrained in their ability to borrow.
- Non-Neutral/Effective: when agents are constrained to borrow.

Limits to borrowing come from a financial friction in the domestic banking sector as well as for households (transactions costs for saving in foreign currency) such that limits to arbitrage and interest rate spreads emerge in equilibrium.

Endogenous deviations to UIP $\Rightarrow$ FXI are non-neutral

Mechanisms at play
Exchange rate smoothing: FXI mutes RER's responses.
Balance sheet substitution: Sterilization leg of FXI.

could FXI be neutral?

- Banks are not constrained in their ability to borrow.
- Agency problem and industry currency mismatch.
- Households face no limits to participation in FC market.
- UIP condition holds with equality.

The Model

Bank's Balance Sheet:

Assets	Liabilities
l_t	d_t
$e_t l_t^*$	$e_t d_t^* = e_t(d_t^{*,h} + d_t^{*,f})$
b_t	n_t

"Running Away" Problem: After raising funds and buying assets, the banker decides whether to operate honestly or not.

Incentive compatibility constraint (ICC):

$$V_t \geq \Theta(x_t)\left[l_t + \varpi^* e_t l_t^* + \varpi^b b_t\right] \tag{1}$$

where is the continuation value of a banker.

Banker's ability to divert funds **depends upon the foreign currency balance sheet position (currency mismatch)** :

$$x_t = \frac{e_t d_t^* - e_t l_t^*}{l_t + e_t l_t^* + b_t} \tag{2}$$

The limits to arbitrage stem from the following restriction:

$$\begin{aligned} l_t + \varpi^* e_t l_t^* + \varpi^b b_t &= \Phi_t n_t \quad \text{if } \lambda_t^b > 0 \\ &< \Phi_t n_t \quad \text{if } \lambda_t^b = 0 \end{aligned} \tag{3}$$

with

$$\Phi_t = \frac{\mathbb{E}_t \Omega_{t+1} R_{t+1}}{\Theta(x_t) - \mathbb{E}_t \Omega_{t+1} \left(R_{t+1}^l - \left\{ \frac{e_{t+1}}{e_t} R_{t+1}^* x_t + R_{t+1}(1 - x_t) \right\} \right)}$$

Banks III: Endogenous deviations to UIP

UIP Deviation 1: Banks

$$\mathbb{E}_t \Omega_{t+1} \left(R_{t+1} - \frac{e_{t+1}}{e_t} R^*_{t+1} \right) = \frac{\lambda^b_t}{1+\lambda^b_t} \left(\frac{l_t + \varpi^* e_t l^*_t + \varpi^b b_t}{l_t + e_t l^*_t + b_t} \right) \frac{\partial \Theta(x_t)}{\partial x} \tag{4}$$

UIP Deviation 2: Household

$$\mathbb{E}_t \Lambda_{t+1} \left(R_{t+1} - \frac{e_{t+1}}{e_t} R^*_{t+1} \right) = \kappa_{D*} \left(\overline{D}^{*,h} - D^{*,h}_t \right) \tag{5}$$

In our baseline framework:

$$\lambda^b_t, \frac{\partial \Theta(x_t)}{\partial x}, \kappa_{D*} > 0 \quad \Rightarrow \quad \text{UIP Dev. 1 and 2}$$

However, even when financial constraint binds ($\lambda^b_t > 0$)

$$\text{Industry currency mismatch, } \frac{\partial \Theta(x^{industry}_t)}{\partial x^{bank}} = 0 \quad \Rightarrow \quad \text{UIP holds 1}$$

$$\text{Household limitless participation, } \kappa_{D*} = 0 \quad \Rightarrow \quad \text{UIP holds 2}$$

1. **Sterilization Procedure** : Let F_t be the amount of official reserves ($\uparrow F \Rightarrow \uparrow M$ then $\uparrow B \Rightarrow \downarrow M$)

$$B_t = e_t F_t \tag{6}$$

2. **Cost of the Intervention**: Official reserves are invested abroad at the external interest rate R_t^*. The central bank makes operational losses given by

$$CB_t = \left(R_t^b - \frac{e_t}{e_{t-1}} R_t^* \right) B_{t-1} \tag{7}$$

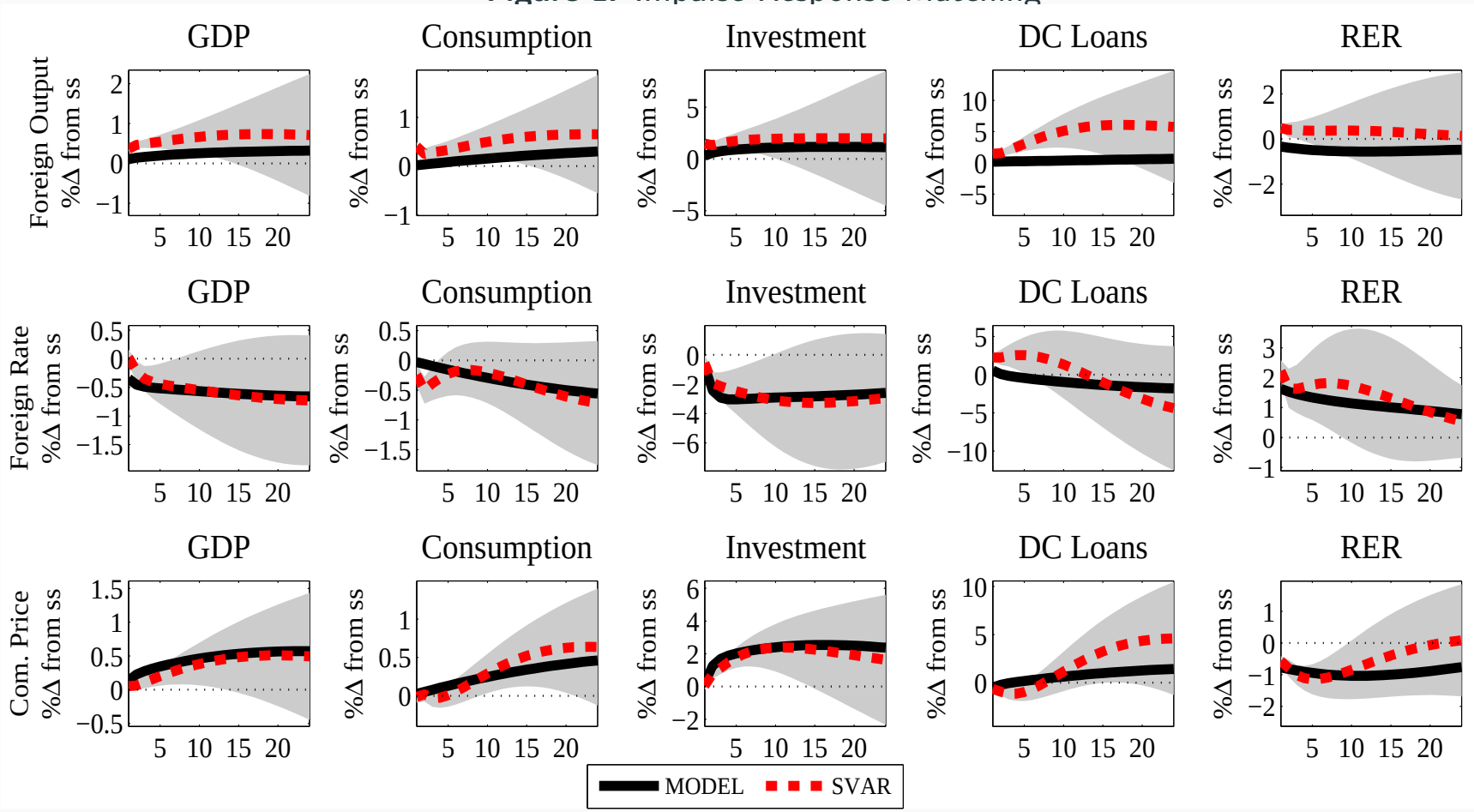
3. **FXI rule**:

$$\ln B_t = -\upsilon_e (\ln e_t - \ln e) \tag{8}$$

Quantitative Results

SVAR and IRF Matching results

Figure 1: Impulse Response Matching



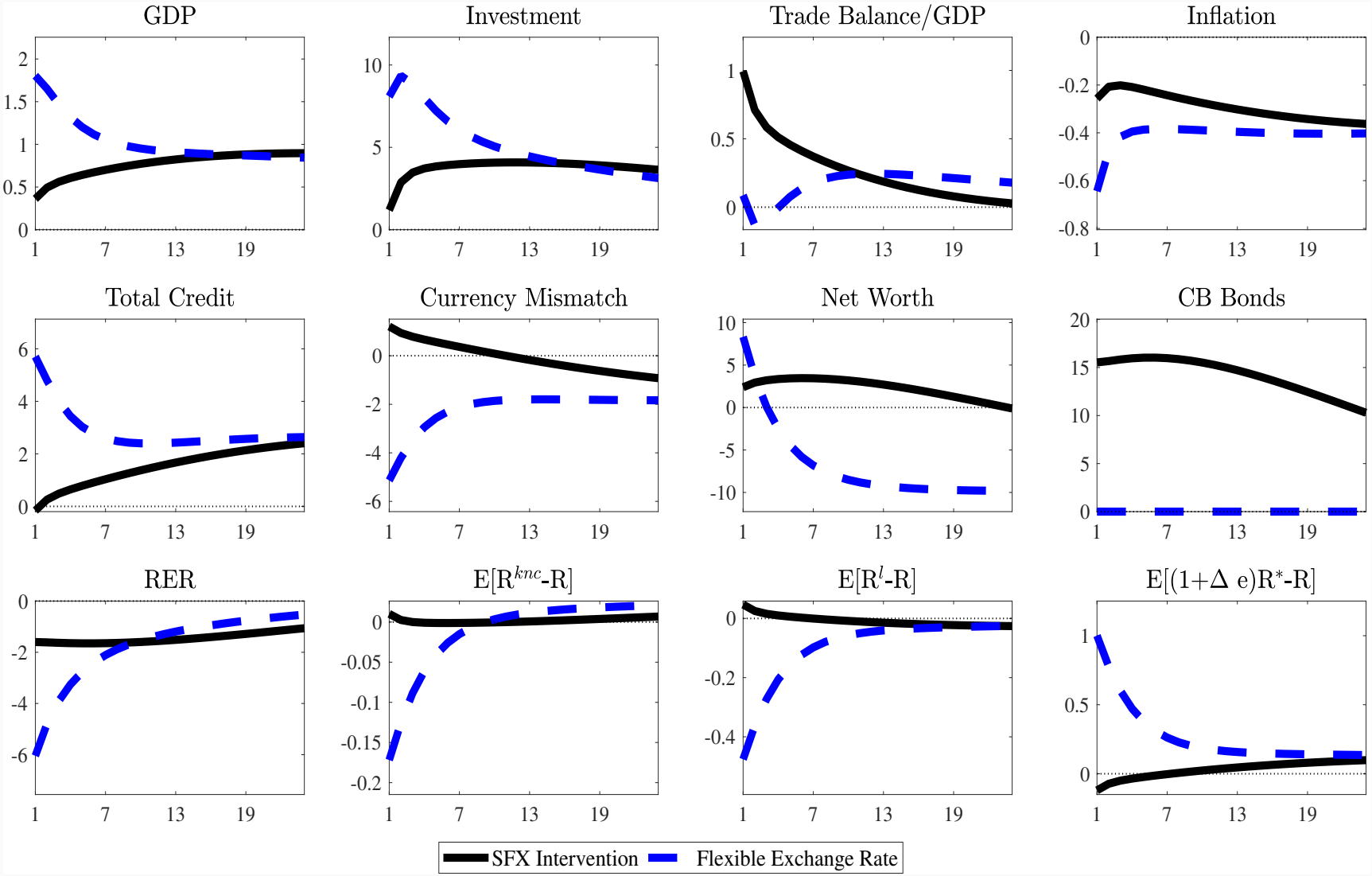
Measuring the effectiveness of FXI

Fratzcher et al (2019) focus on effects over exchange rate:

- *Smoothing criterion*: limits to RER volatility.
- *Event criterion*: RER moves in the intended direction.

- We extend the usage of these criteria for other macro variables.
- *Welfare criterion*: is FXI welfare improving?

FXI reduce the impact of a commodity price shock



Measuring the effectiveness of FXI: Macroeconomic volatility

Conditional on external shocks, FXI significantly reduce aggregate volatility:

Table 1: Macroeconomic Volatilities

	FXI	FER	Δ%
RER	2.35	7.33	-68
Inflation	0.29	0.70	-58
UIP Spread	0.25	1.22	-80
GDP	0.68	2.24	-70
Investment	4.20	11.94	-65
Consumption	0.23	0.25	-8
Total Credit	1.25	6.81	-82
Currency Mismatch	2.10	6.08	-65

Welfare criterion: is FXI welfare improving? Yes

Let ς_{cond} be the fraction of consumption process that a household would be willing to accept to be indifferent between $\mathcal{R}$ (baseline) and $\mathcal{A}$ (alternative):

$$\mathbb{W}\left(\{C^{\mathcal{A}}\},\{H^{\mathcal{A}}\}\right)=\mathbb{W}\left(\{(1+\varsigma^{cond})C^{\mathcal{R}}\},\{H^{\mathcal{R}}\}\right)$$

$$\varsigma^{cond}>0 \quad \Rightarrow \quad \text{welfare gain}$$

$$\varsigma^{cond}<0 \quad \Rightarrow \quad \text{welfare loss}$$

Table 2: Welfare Analysis: $\varsigma_{cond}\%$

$\omega_\pi \backslash \upsilon_e$	0	2.5	5	Baseline, 9.7	20	30	50	100
1.25	−22.8	−19.1	−16.6	−12.0	−3.4	0.8	3.8	5.3
Baseline, 1.50	−6.2	−3.3	−2.0	0.0	3.4	4.8	5.6	5.9
2.00	−0.2	1.9	2.8	3.7	5.3	5.9	6.1	6.0
3.00	1.6	3.4	4.1	4.7	5.7	6.1	6.2	6.0
5.00	2.1	3.8	4.4	4.9	5.9	6.2	6.2	6.0

Generalizations of the baseline framework and FXI's relative effectiveness

Case 1 Higher financial vulnerability: $\downarrow R^* \Rightarrow \uparrow x$, more effective.

Case 2 No financial dollarization: $\delta^f = D^{*,h} = 0$, less effective.

Case 3 No household's transaction costs: $\kappa_{D*} \approx 0$, almost neutral.

Case 4 Industry currency mismatch: $\frac{\partial \Theta(x_t^{industry})}{\partial x^{bank}} = 0$, almost neutral.

Table 3: Macroeconomic Volatilities and Welfare Gain/Loss

	Baseline, $\varsigma = -6.2\%$		**Case 1**, $\varsigma = -19.4\%$		**Case 2**, $\varsigma = -2.4\%$		**Case 3**, $\varsigma = -0.2\%$		**Case 4**, $\varsigma = -0.1\%$	
	FER	$\Delta\%$	FER	$\Delta\%$	FER	$\Delta\%$	FER	$\Delta\%$	FER	$\Delta\%$
RER	7.33	-68	10.35	-72	3.99	-52	1.69	-2	1.42	-3
Inflation	0.70	-58	0.85	-57	0.38	-36	0.20	-10	0.24	7
UIP Spread	1.22	-80	5.59	-93	0.15	6	0.01	9	0.00	-83
GDP	2.24	-70	2.99	-72	1.34	-61	0.60	-17	0.52	-29
Investment	11.94	-65	12.58	-57	8.03	-59	2.97	-13	4.09	-17
Consumption	0.25	-8	0.25	1	0.23	-13	0.12	-7	0.08	-2
Total Credit	6.81	-82	16.16	-92	3.01	-47	0.66	-36	4.42	-15
Currency Mismatch	6.08	-65	12.40	-85	0.90	158	0.24	33	2.59	3

Smoothing RER dynamics using Policy Rate: 1 vs 2 instrument

Extended Taylor Rule

$$i_t - i = \rho_i(i_{t-1} - i) + (1 - \rho_i)\left[\omega_\pi \pi_t + \omega_y \ln\left(\frac{\text{GDP}_t}{\text{GDP}}\right) + \omega_e(\ln e_t - \ln e)\right]$$

Alternative Regimens:

$$\text{FER} : \omega_e = 0 \text{ and } \upsilon_e = 0$$
$$\text{Taylor + RER (1)} : \omega_e = 0.1 \text{ and } \upsilon_e = 0$$
$$\text{Taylor + RER (2)} : \omega_e = 1 \text{ and } \upsilon_e = 0$$
$$\text{FXI} : \omega_e = 0 \text{ and } \upsilon_e = 9.7$$

Table 4: Macroeconomic Volatilities

	FER	Extended Taylor (1)	Extended Taylor (2)	FXI
RER	7.34	4.89	1.24	2.36
Inflation	0.70	0.23	1.61	0.29
UIP Spread	1.22	0.87	0.41	0.25
GDP	2.24	2.00	1.63	0.68
Investment	11.96	15.34	22.19	4.22
Consumption	0.25	0.26	0.27	0.23
Total Credit	6.80	5.64	3.96	1.25
Currency Mismatch	6.08	4.41	2.09	2.11

Concluding Remarks

We integrate FX Intervention, Financial Dollarization, and Banks in a General Equilibrium Framework.

We explore: FXI's effectiveness and transmission mechanisms.

Results

1. FXI successfully reduce the impact of external shocks (Real Exchange Rate Smoothing and Balance Sheet Substitution Channel):

   a. *Significant reduction of unconditional volatility.*

   b. *Significant welfare loss under FER.*

2. FXI might be neutral even when financial constraint binds.

Thank you!

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Non-Commodity Intermediate Good Producer

1. Hires labor, buys capital and imported goods in order to produce.
2. Issue equity, $\mathcal{S}_{j,t}$, to domestic households and borrow from banks in order to acquire capital $q_t^{nc} k_{j,t}^{nc}$.

CES function in order to get disposable funds: $\mathcal{F}_t$

$$\mathcal{F}_t = A^e l_{j,t}^{1-\delta^f} \left(e_t l_{j,t}^*\right)^{\delta^f} \tag{9}$$

Demand schedules for each currency

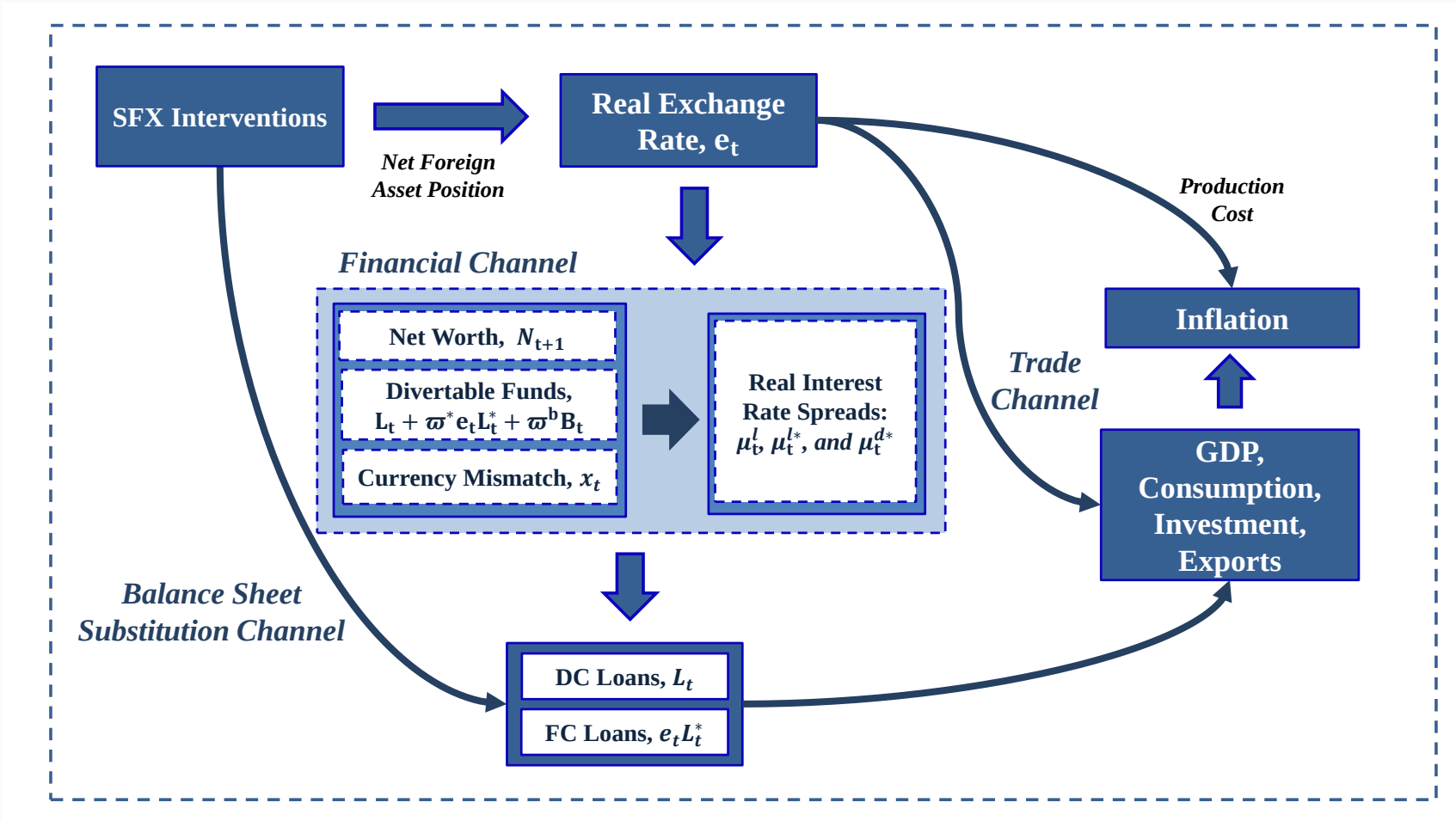
$$q_t^{nc} k_{j,t}^{nc} = \mathcal{F}_{j,t} + \mathcal{S}_{j,t} \tag{10}$$

$$l_{j,t} = (1-\delta^f) \left(\frac{\mathbb{E}_t \Lambda_{t+1} R_{t+1}^k}{\mathbb{E}_t \Lambda_{t+1} R_{t+1}^l} \right) \mathcal{F}_{j,t} \tag{11}$$

$$e_t l_{j,t}^* = \delta^f \left(\frac{\mathbb{E}_t \Lambda_{t+1} R_{t+1}^k}{\mathbb{E}_t \Lambda_{t+1} \frac{e_{t+1}}{e_t} R_{t+1}^{l*}} \right) \mathcal{F}_{j,t} \tag{12}$$

Potential transmission mechanisms for FXI

Figure 2: Exchange rate smoothing and Balance sheet substitution



Parametrization Strategy

Calibration based on previous literature. Some parameters are parametrized at standard values or based on previous works.

Description	Parameter	Value
Elasticity of Intertemporal Substitution	γ	2.00
Inverse Frisch Elasticity	ζ	3.00
Elasticity of Substitution of Goods	η	6.00
Undepreciated NC Capital Rate	λ^{nc}	0.975
Undepreciated C Capital Rate	λ^{c}	0.975
Domestic Ownership on Commodity Firms	χ^{c}	0.00
Tax on Commodity Sector Profit	τ^{c}	0.60
Banker's Start-Up Transfers	ξ	1.00e-10
MP Rate Smoothing	ρ_i	0.70
MP Rate response to Inflation	ω_π	1.50
MP Rate response to Output Gap	ω_y	0.125

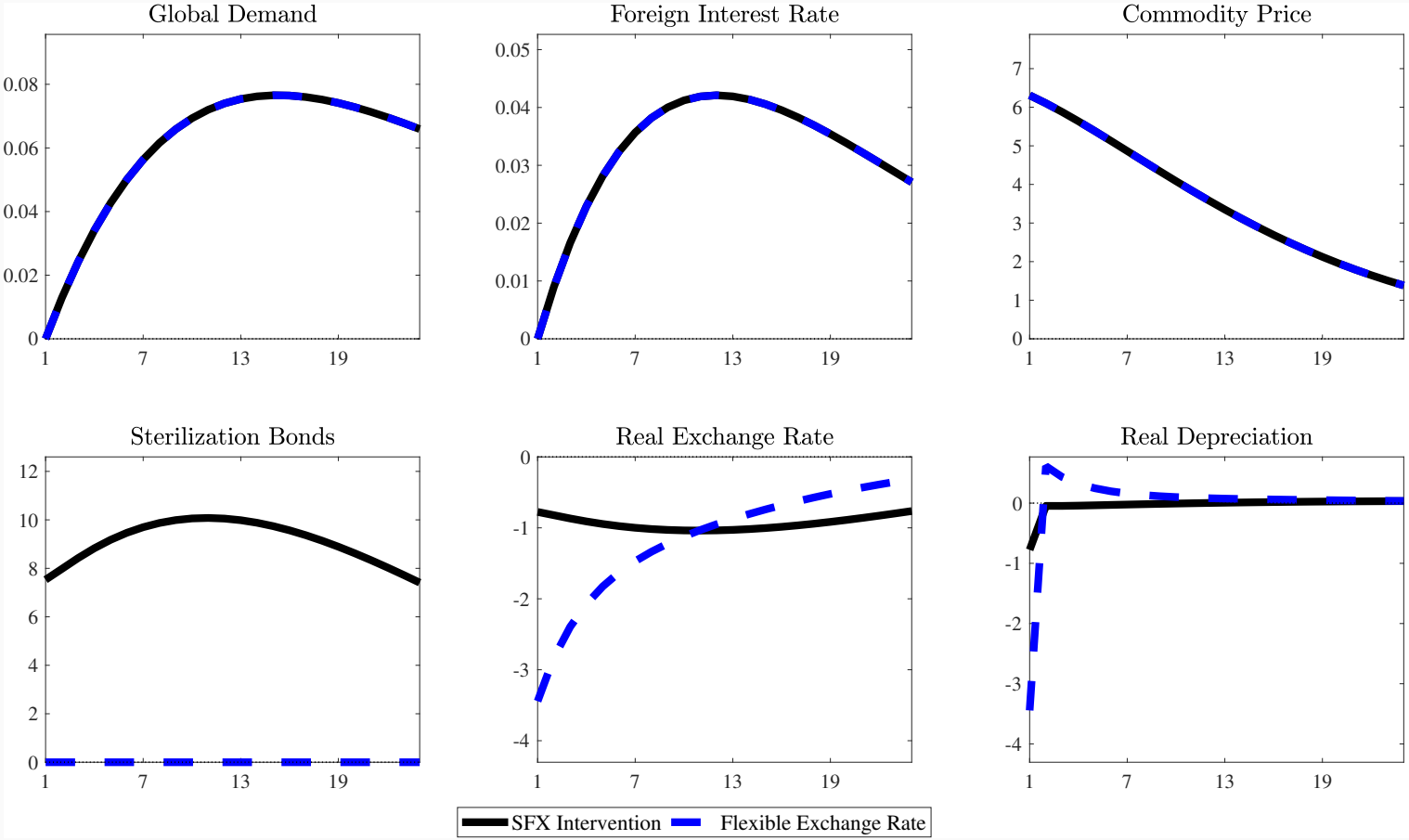
Targeted Calibration. We calibrate a subset of the parameters to be consistent with steady-state targets associated to historical means in the Peruvian financial system.

Steady States

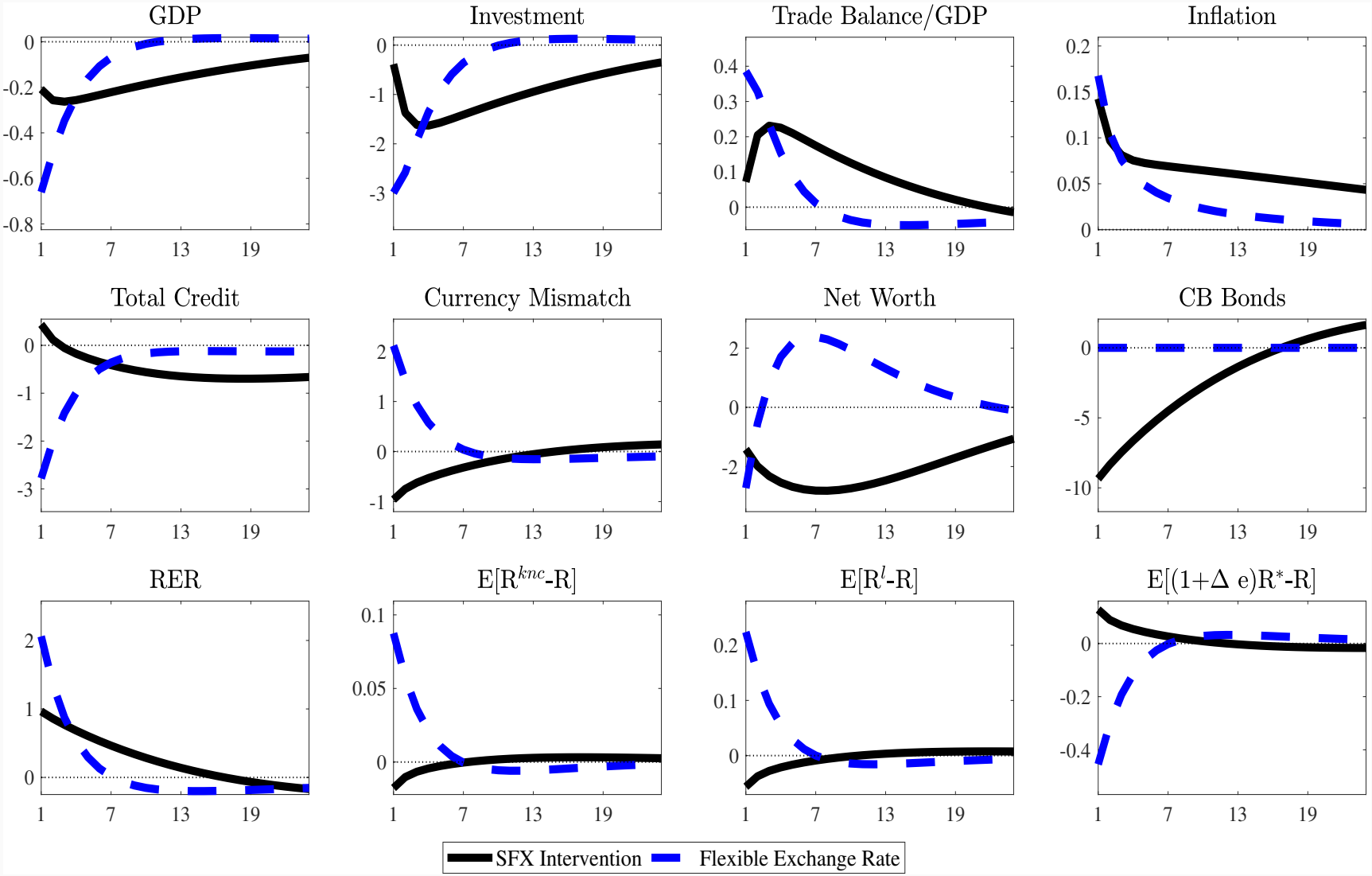
Variable	**Baseline**	**Case 1** $\uparrow x_t$	**Case 2** $\delta^f, D^{*,h} = 0$	**Case 3** $\downarrow \kappa_{D*}$	**Case 4** Agg. x_t	Notation
			Financial System Rates			
Capital return	8.00	7.53	8.12	8.00	8.00	$400(\mathsf{R}^{\mathsf{knc}} - 1)$
DC Loan's return	6.00	5.84	6.00	6.00	6.00	$400(\mathsf{R}^{\mathsf{l}} - 1)$
FC Loan's return	4.00	3.14	-	4.00	4.00	$400(\mathsf{R}^{\mathsf{l}*} - 1)$
FX Bonds return	4.00	3.74	3.93	4.00	4.00	$400(\mathsf{R}^{\mathsf{b}} - 1)$
Foreign Interest Rate	1.00	0.25	1.00	1.00	4.00	$400(\mathsf{R}^{\star} - 1)$
Deposit Interest Rate	4.00	4.00	4.00	4.00	4.00	$400(\mathsf{R} - 1)$
Bank Leverage in B	1.04	0.92	1.21	1.04	1.04	ϕ^b
Bank leverage in L	3.50	3.32	6.86	3.50	3.50	ϕ^l
Bank leverage in L*	2.59	2.46	0.00	2.59	2.59	ϕ^{l*}
Currency Mismatch	17.22	21.40	20.23	17.22	17.22	$100x$
Credit Dollarization	42.50	42.54	0.00	42.50	42.50	$100\frac{e\mathsf{L}^*}{\mathsf{L}+e\mathsf{L}^*}$
Deposit Dollarization	62.23	68.28	23.09	62.23	62.23	$100\frac{e\mathsf{D}^*}{\mathsf{D}+e\mathsf{D}^*}$
RER	1.00	1.02	1.00	1.00	1.00	e
			Sectoral Rates			
Commodity/Total Exports	60.00	60.56	59.96	60.00	60.00	$100\frac{\mathsf{Y}^{x,c}}{\mathsf{Y}^{x}}$
Commodity/Total Investment	16.67	16.51	16.82	16.67	16.67	$100\frac{\mathsf{I}^{c}}{\mathsf{I}}$
			Stock Rates			
Non Commodity Capital/GDP	2.00	2.05	1.99	2.00	2.01	$\frac{\mathsf{K}^{nc}}{4\mathsf{GDP}^{nc}}$
Commodity Capital/GDP	1.59	1.59	1.59	1.59	1.55	$\frac{\mathsf{K}^{c}}{4\mathsf{Y}^{x,c}}$
Stock of Capital/GDP	2.00	2.04	1.97	2.05	2.00	$\frac{\mathsf{K}}{4\mathsf{GDP}}$
Foreign Reserves/GDP	23.00	22.74	22.90	23.63	23.00	$100\frac{\mathsf{B}^{fx}}{4\mathsf{GDP}}$
			Aggregate Demand Rates			
Investment/GDP	20.00	20.43	19.70	20.55	20.00	$100\frac{\mathsf{I}}{\mathsf{GDP}}$
Public Consumption/GDP	15.00	14.83	14.94	15.41	15.00	$100\frac{\mathsf{G}}{\mathsf{GDP}}$
Consumption/GDP	58.00	57.57	58.26	56.85	58.00	$100\frac{\mathsf{C}}{\mathsf{GDP}}$
Current Account/GDP	-0.06	0.01	0.08	-0.06	-0.24	$100\frac{\mathsf{CC}}{\mathsf{GDP}}$
Trade Balance/GDP	7.00	7.16	7.10	7.19	7.00	$100\frac{\mathsf{TB}}{\mathsf{GDP}}$

FX Intervention and RER hump-shaped response

Figure 3: Commodity Price Shock, FX Intervention, and Real Exchange Rate



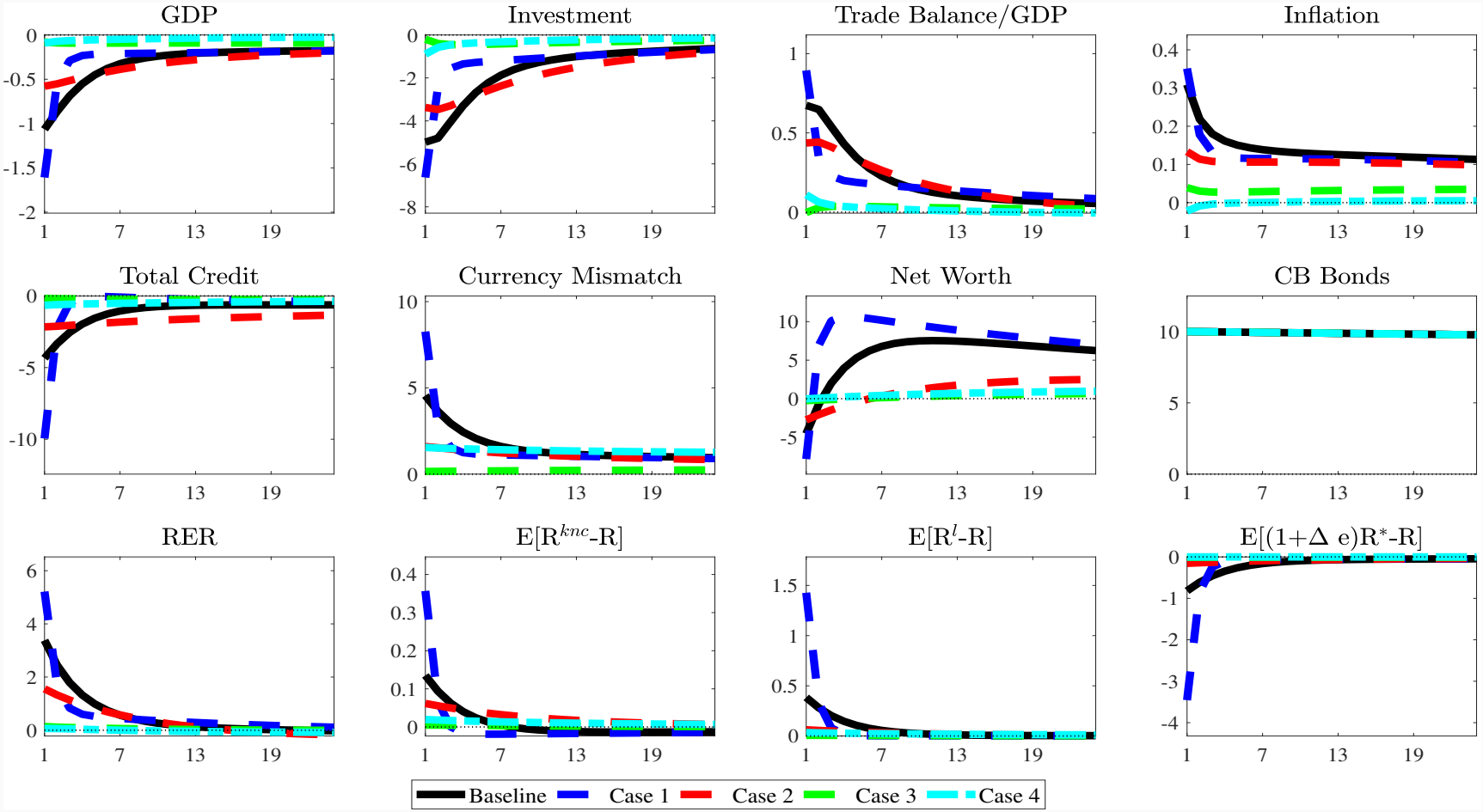
FXI reduce the impact of foreign interest rate shocks



Response to a Persistent Purchase of Foreign Exchange Reserves

Consider the following FXI intervention Rule:

$$\ln B_t - \ln B = \rho_B \left(\ln B_{t-1} - \ln B\right) + u_t^B, \quad \text{with } \rho_B \approx 1$$



Extended Taylor Rule versus FXI Rule (II)

$$\mathbb{W}\left(\{C^{\mathcal{A}}\},\{H^{\mathcal{A}}\}\right)=\mathbb{W}\left(\{(1+\varsigma^{cond})C^{\mathcal{R}}\},\{H^{\mathcal{R}}\}\right)$$

Baseline, $\mathcal{R}: \omega_\pi = 1.5 \quad \omega_e = 0 \quad \upsilon_e = 9.7$

Alternative, $\mathcal{A}: (\omega_\pi, \omega_e) \quad \upsilon_e = 0$

$\omega_\pi \backslash \omega_e$	Baseline, 0.0	0.1	0.5	1.0	2.0	5.0
1.25	−22.8	−9.6	−3.1	−2.9	−3.3	−3.9
Baseline, 1.50	−6.2	−0.8	0.1	−1.4	−2.8	−3.8
2.00	−0.2	2.0	2.2	0.3	−1.8	−3.6
3.00	1.6	2.6	3.2	2.0	−0.3	−2.9
5.00	2.1	2.7	3.4	3.1	1.6	−1.5