Balance Sheets, Exchange Rates, and International Monetary Spillovers

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Motivation

1. Spillovers from U.S. monetary tightening to foreign economies
   - Well-known expenditure-switching and expenditure-reducing channels
   - Financial channel is little studied, but can be quite large

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2. How should foreign policymakers respond?
    - Common view → gear policy toward stabilizing the exchange rate, especially in emerging economies (e.g. Calvo and Reinhart (2002))
        - Frequent argument: currency mismatches in balance sheets
    - New Keynesian open-economy models → exchange rate volatility should not concern monetary policy (e.g. Gali and Monacelli (2005))

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   - Larger country is the U.S. and smaller one is the domestic economy
2. Key mechanism: currency risk premium rises as balance sheets deteriorate
3. Analyze consequences for:
   - Spillovers from U.S. monetary policy
   - Desirability of using domestic monetary policy to stabilize the exchange rate

Preview of Main Findings

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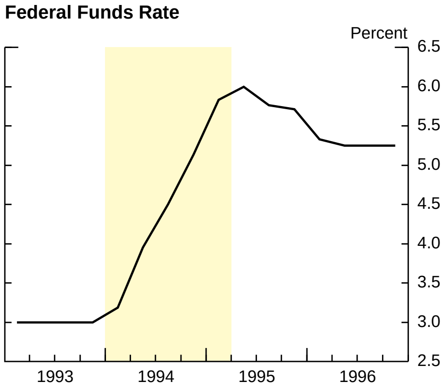
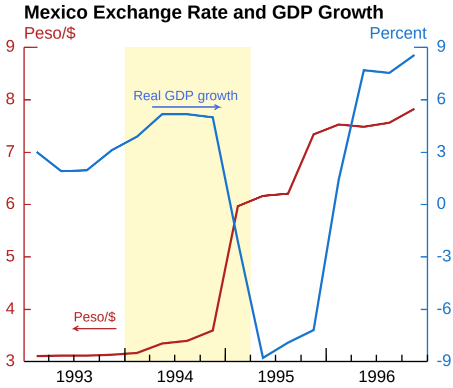
   - Expenditure-switching and expenditure-reducing channels roughly cancel
2. Little support for the view that using monetary policy to stabilize the exchange rate is desirable in the presence of large foreign-currency debt
   - Tightening domestic monetary policy hurts balance sheets, increasing the currency risk premium $\rightarrow$ weaker appreciation for a given rate hike

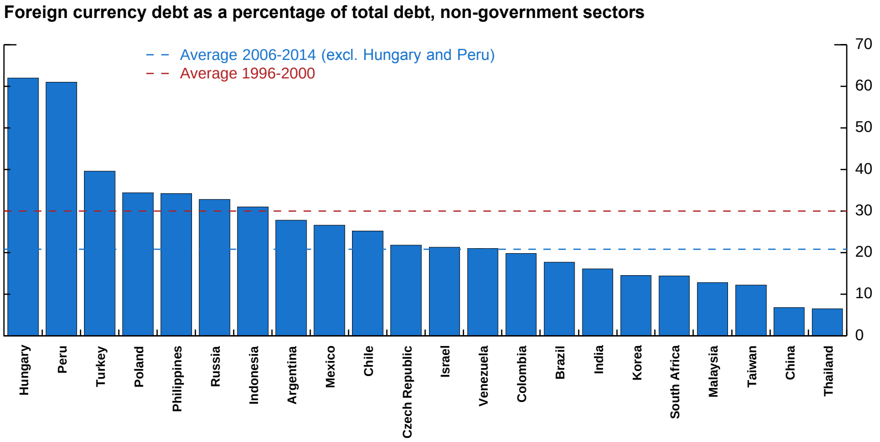
U.S. Policy Tightening and Contractionary Depreciations





- Currency mismatch in (government) balance sheets contributed to the crisis

Are currency mismatches still a concern?



Source: Chui, Kuruc and Turner (2016)

- Yes, still prevalent for private sector although less severe than in the past

Literature

- Open-economy New Keynesian models
  - Gali and Monacelli (2005), Erceg, Gust and Lopez-Salido (2010)
- Closed-economy frameworks with financial frictions
  - BGG (1999), Gertler and Kiyotaki (2010), Gertler and Karadi (2011)
- Balance sheets and exchange rates
  - Macro Evidence: Krugman (1999), Gertler et al. (2007), Cespedes et al. (2004), Aghion et al. (2001, 2004), Bruno and Shin (2015)
  - Micro Evidence: Kalemli-Ozcan et al. (2016), Niepmann and Schmidt-Eisenlohr (2017)
- Recent related work: Gabaix and Maggiori (2015), Aoki, Benigno and Kiyotaki (2016), Bocola and Lorenzoni (2017)

Outline of the Talk

- Simple real macro model to isolate role of balance sheet constraints

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- Embed mechanism in medium-scale two-country New-Keynesian model for monetary policy analysis

Simple model

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- Foreign: U.S.
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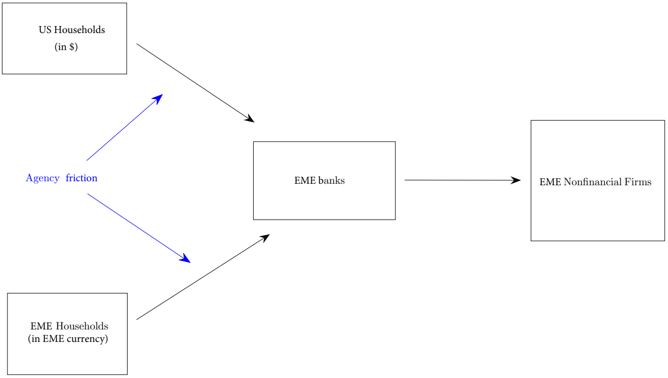

Simple Model: Banks

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- Uses equity endowment ξ_{it} (exogenous) and borrowed funds from domestic households (D_{it}) and foreign households (D^*_{it}, in dollars) to finance capital purchases, S_{it}:

$$q_t S_{it} = D_{it} + \mathcal{Q}_t D^*_{it} + \xi_{it}$$

where

$$q_t = \text{price of capital}$$
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- In $t+1$, bank receives net payment

$$\underbrace{\frac{(r_{Kt+1} + q_{t+1})}{q_t}}_{\equiv R_{kt+1}} q_t S_{it} - R_{t+1} D_{it} - R_{t+1}^* \mathcal{Q}_{t+1} D_{it}^*$$

  & exits

Simple Model: Agency friction

- After borrowing funds, banker may default on creditors and divert amount

$$\theta\Big(D_{it} + (1+\gamma)\mathcal{Q}_t D^*_{it} + \xi_{it}\Big)$$

  for personal gain

  $0 < \theta < 1, \gamma > 0$

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- $\gamma > 0 \rightarrow$ foreign loans are more easily divertable than domestic loans

Simple Model: Banker's problem

- Let

$$\mu_t \equiv \beta \mathbb{E}_t \left(R_{kt+1} - R_{t+1} \right)$$

$$\varrho_t \equiv \beta \mathbb{E}_t \left(R_{kt+1} - \frac{R^*_{t+1} \mathcal{Q}_{t+1}}{\mathcal{Q}_t} \right)$$

$$x_{it} \equiv \frac{\mathcal{Q}_t D^*_{it}}{q_t S_{it}}$$

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- Banker solves

$$\max_{S_{it}, x_{it}} \left[x_{it} \varrho_t + (1 - x_{it}) \mu_t \right] q_t S_{it} + \xi_{it}$$

subject to

$$\left[x_{it} \varrho_t + (1 - x_{it}) \mu_t \right] q_t S_{it} + \xi_{it} \geq \theta \left(1 + \gamma x_{it} \right) q_t S_{it} \quad \text{(IC)}$$

Simple Model: Banker's optimality conditions

- When (IC) binds,

$$(1+\gamma)\mu_t = \varrho_t \quad \text{(optimal loan portfolio)}$$

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$\longrightarrow$ The UIP wedge is

$$\begin{aligned} \mu_t^* &\equiv \beta \mathbb{E}_t \left(R_{t+1} - \frac{R_{t+1}^* \mathcal{Q}_{t+1}}{\mathcal{Q}_t} \right) \\ &= \varrho_t - \mu_t \\ &= \gamma \mu_t \end{aligned}$$

Simple Model: Households & export demand

- The representative consumer maximizes

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_{Dt}, M_{Ct})$$

subject to

$$C_{Dt} + \mathcal{Q}_t M_{Ct} + D_t \leq W_t \overline{L} + R_t D_{t-1} + \pi_t$$

C_{Dt} is domestic-good consumption, M_{Ct} is imports, and π_t is transfers from bankers

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- Assume preferences

$$U(C_D, M_C) = C_D + \chi_m \log(M_C)$$

$\longrightarrow$

$$R = \beta^{-1}$$

$$M_{Ct} = \chi_m \mathcal{Q}_t^{-1}$$

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- Export demand: $M_{Ct}^* = \chi_x \mathcal{Q}_t$

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- Aggregating domestic budget constraints,

$$\mathcal{Q}_t \left(R^* D^*_{t-1} - D^*_t \right) = NX_t$$
$$NX_t = \chi_x \mathcal{Q}_t - \chi_m$$

$(R^* = \beta^{*-1} < R)$

Simple Model: Equilibrium Conditions

$$1 + \gamma x_t = \frac{1}{\theta - \mu_t} \xi_t \qquad \text{(IC)}$$

$$x_t = \frac{\mathcal{Q}_t D_t^*}{q_t \overline{K}} \qquad \text{(Foreign funding ratio)}$$

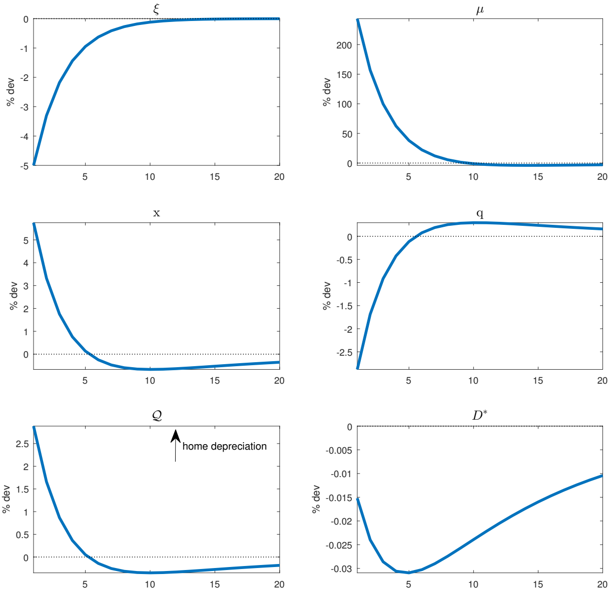
$$q_t = \beta \frac{\mathbb{E}_t(\overline{r}_K + q_{t+1})}{1 + \mu_t} \qquad \text{(Price of capital)}$$

$$\mathcal{Q}_t = \frac{\frac{\beta}{\beta^*} \mathbb{E}_t(\mathcal{Q}_{t+1})}{1 - \gamma \mu_t} \qquad \text{(RER)}$$

$$D_t^* = \frac{\chi_m}{\mathcal{Q}_t} - \chi_x + R^* D_{t-1}^* \qquad \text{(BOP)}$$

(with $\overline{r}_K \equiv \alpha(\overline{K}/\overline{L})^{\alpha-1}$)

Figure: persistent ξ shock in the simple model



$(\beta = 0.9925, \beta^* = 0.9975, \gamma = 1, \theta = 0.2, \xi = 0.25, \chi_m = \chi_x = .25)$

Full model

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- Balance sheet identity

$$\underbrace{q_t S_{it}}_{\substack{\text{claims on} \\ \text{domestic firms}}} \equiv \underbrace{D_{it}}_{\substack{\text{domestic} \\ \text{deposits}}} + \underbrace{\mathcal{Q}_t D^*_{it}}_{\substack{\text{(real) dollar} \\ \text{deposits}}} + \underbrace{N_{it}}_{\substack{\text{net} \\ \text{worth}}}$$

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- Budget constraint

$$q_t S_{it} + R_t D_{it-1} + R^*_t \mathcal{Q}_t D^*_{it-1} \leq R_{kt} q_{t-1} S_{it-1} + D_{it} + \mathcal{Q}_t D^*_{it}$$

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$\longrightarrow$ Evolution of net worth:

$$N_{it} = (R_{kt} - R_t) q_{t-1} S_{it-1} + \left(R_t - R^*_t \frac{\mathcal{Q}_t}{\mathcal{Q}_{t-1}} \right) \mathcal{Q}_{t-1} D^*_{it-1} + R_t N_{it-1}$$

Banks: Objective

Banker's objective:

$$V_{it} = \max_{S_{it}, D_{it}, D^*_{it}} \; (1-\sigma_b)\mathbb{E}_t\Big[\Lambda_{t,t+1}\big(R_{kt+1}q_t S_{it} - R_{t+1}D_{it} - R^*_{t+1}\mathcal{Q}_{t+1}D^*_{it}\big)\Big] + \sigma_b\mathbb{E}_t\Big(\Lambda_{t,t+1}V_{it+1}\Big)$$

subject to

$$\begin{aligned}
q_t S_{it} &= D_{it} + \mathcal{Q}_t D^*_{it} + N_{it} \\
N_{it+1} &= (R_{kt+1} - R_{t+1})q_t S_{it} + \left(R_{t+1} - R^*_{t+1}\frac{\mathcal{Q}_{t+1}}{\mathcal{Q}_t}\right)\mathcal{Q}_t D^*_{it} + R_{t+1}N_{it} \\
V_{it} &\geq \theta\left(1 + \frac{\gamma}{2}x_{it}^2\right)q_t S_{it} \qquad \text{(IC)}
\end{aligned}$$

where $\quad x_{it} = \frac{\mathcal{Q}_t D^*_{it}}{q_t S_{it}}$ and $\Lambda_{t,\tau} \equiv$ household's real stochastic discount factor

Domestic households

- Household i seeks to maximize

$$\mathbb{E}_0 \sum_{j=0}^{\infty} \beta^j \left(\log\left(C_{t+j} - hC_{t+j-1}\right) - \frac{\chi_0}{1+\chi} L_{i,t+j}^{1+\chi} \right)$$

subject to

$$\begin{aligned} P_{Ct} C_t + P_{Ct} D_t &\leq W_{i,t} L_{i,t} + P_{Ct} R_t D_{t-1} + \mathcal{W}_{it} + \Pi_t \\ C_t &= \left[(1-\omega)^{\frac{\rho}{1+\rho}} C_{Dt}^{\frac{1}{1+\rho}} + \omega^{\frac{\rho}{1+\rho}} \left(\varphi_{Ct} M_{Ct}\right)^{\frac{1}{1+\rho}} \right]^{1+\rho} \\ P_{Ct} &= \left[(1-\omega) P_{Dt}^{-\frac{1}{\rho}} + \omega P_{Mt}^{-\frac{1}{\rho}} \right]^{-\rho} \end{aligned}$$

where $\varphi_{Ct} = 1 - \frac{\varphi_M}{2} \left(\frac{M_{Ct}/C_{Dt}}{M_{Ct-1}/C_{Dt-1}} - 1 \right)$

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$$C_t = \left[(1-\omega)^{\frac{\rho}{1+\rho}} C_{Dt}^{\frac{1}{1+\rho}} + \omega^{\frac{\rho}{1+\rho}} \left(\varphi_{Ct} M_{Ct}\right)^{\frac{1}{1+\rho}} \right]^{1+\rho}$$

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where $\varphi_{Ct} = 1 - \frac{\varphi_M}{2} \left(\frac{M_{Ct}/C_{Dt}}{M_{Ct-1}/C_{Dt-1}} - 1 \right)$

- Producer currency pricing: $P_{Mt} = e_t P_{Dt}^{*}$, where e_t is the nominal exchange rate (in domestic currency per dollar)

Foreign (U.S.) households

$$\max \quad \mathbb{E}_0 \sum_{j=0}^{\infty} \beta^{*j} \left(\log\left(C^*_{t+j} - hC^*_{t+j-1}\right) - \frac{{\chi_0}^*}{1+\chi} {L^*_{i,t+j}}^{1+\chi} \right)$$

subject to

$$P^*_{Ct} C^*_t + B^*_t + P^*_{Ct} D^*_t \leq W^*_{i,t} L^*_{i,t} + R^{n*}_t B^*_t + P^*_{Ct} \tilde{R}^*_t D^*_{t-1} + \Pi^*_t + \mathcal{W}^*_{it}$$

where

- D^*_t: short-term deposits in EME banks
- B^*_t: short-term nominal bonds (in zero net supply)
- R^{n*}_t: Fed funds rate
- $\tilde{R}^*_t$: real return received on deposits in EME banks
  - $R^*_t = (1+\tau)\tilde{R}^*_t$, where τ is a tax on home banks' foreign borrowing
  - We use τ to induce different degrees of steady-state foreign indebtedness

Other features

- Nominal price and wage rigidity
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- Capital producers face cost of adjusting level of investment
  - FOC gives investment-q relation
  - Costs of adjusting imported-domestic mix, analogous to consumers
- Monetary policy in each country follows inertial Taylor rule

Linearized evolution of net worth

$$\hat{n}_t \approx \sigma^b \left(R_k \frac{K}{N} \hat{r}_{kt} - R^* \frac{\mathcal{Q}D^*}{N} (\hat{r}_t^* + \Delta \hat{\mathcal{Q}}_t) - R \frac{D}{N} \hat{r}_t + R \hat{n}_{t-1} \right)$$

$$\hat{\mathcal{Q}}_t \approx \frac{R - R^*}{R} \left(\hat{\mu}_t^* - \mathbb{E}_t(\hat{\Lambda}_{t+1}^{\text{banker}}) \right) + \hat{r}_{t+1}^* - \frac{R}{R^*} \hat{r}_{t+1} + \mathbb{E}_t(\hat{\mathcal{Q}}_{t+1})$$

where $\hat{x}_t \equiv \log(\frac{X_t}{X})$ for any variable X_t

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Larger $\frac{\mathcal{Q} D^*}{N}$:

$\rightarrow$ greater elasticity of net worth to $\Delta \hat{\mathcal{Q}}_t$

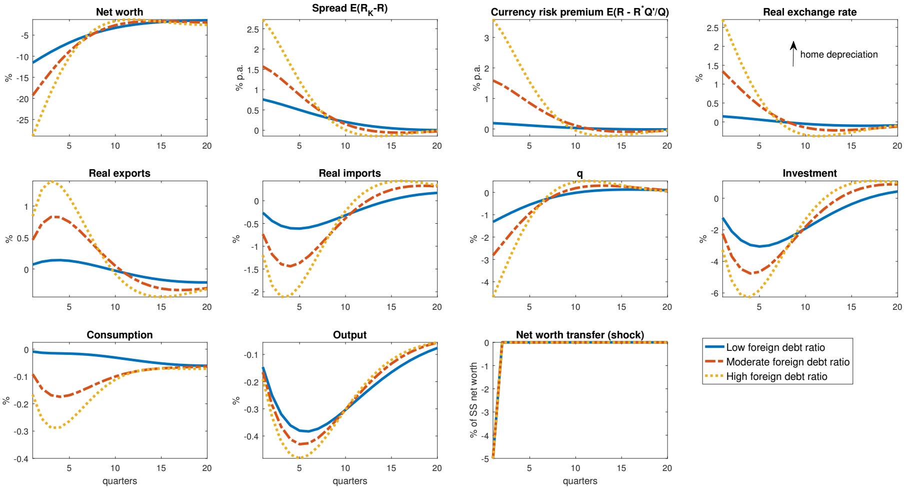
$\rightarrow$ greater feedback between depreciation and weakening balance sheets

Parameters

Home discount factor	β	0.9925	Home real rate 3% p.a.
U.S. discount factor	β^*	0.9975	U.S. real rate 1% p.a.
Habit	h	0.78	
Inverse Frisch elasticity of labor supply	χ	3.79	
Trade price elasticity	$\frac{1+\rho}{\rho}$	1.5	
Trade openness	ω	0.2	Exports-GDP-ratio 28%
Relative home size	ξ_h/ξ_f	0.2	
Trade adjustment cost	φ_M	10	
Capital share	α	0.33	
Capital depreciation	δ	0.025	
Prob. of keeping price fixed	ξ_p	0.84	
Price indexation	ξ_p	0.24	
Price markup	θ_p	0.2	
Prob. of keeping wage fixed	ξ_p	0.70	
Wage indexation	ξ_p	0.15	
Wage markup	θ_p	0.2	
Investment adjustment cost	Ψ_I	2.85	
Home Taylor rule	γ_r	0.82	
	γ_π	1.50	
US Taylor rule	γ_r^*	0.82	
	γ_π^*	2.09	
	γ_x^*	0.07	
	γ_{dx}^*	0.24	
Bank survival rate	σ_b	0.969	8 year expected horizon
Bank fraction divertable	θ	0.57	{ Average Lev. of 5 and credit spread of
Bank transfer rate	ξ_b	0.02	150 bps p.a., 30% max
Home bias in bank funding	γ	6	foreign liab. ratio }

Sources: Justiniano, Primiceri and Tambalotti (2010), Erceg, Guerrieri and Gust (2007)

Figure: One-time drop in aggregate bank net worth



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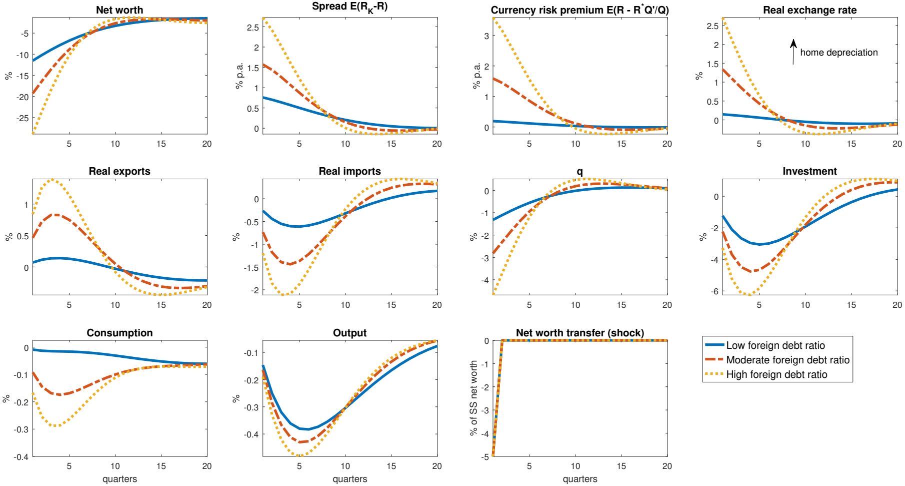
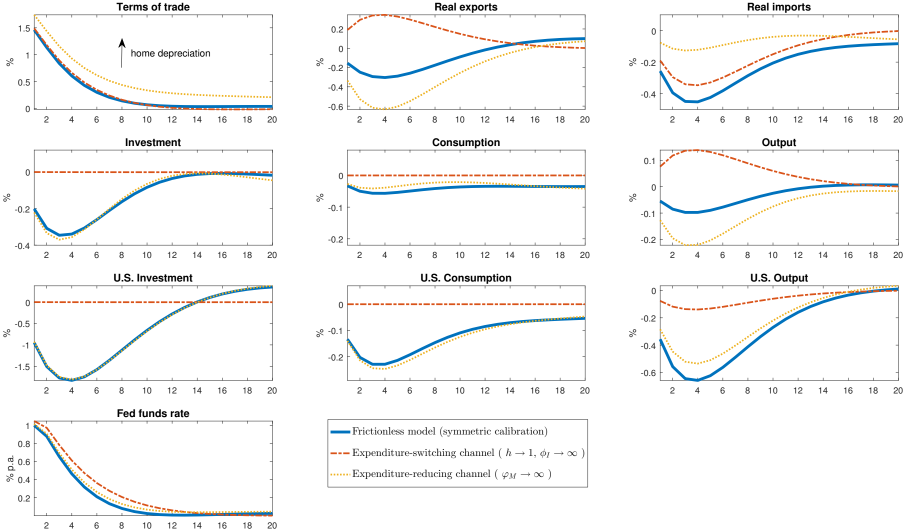


- Presence of foreign-currency debt magnifies depreciation, via greater feedback between $\hat{\mathcal{Q}}_t$ and $\hat{n}_t$

Figure: U.S. monetary tightening, frictionless economy



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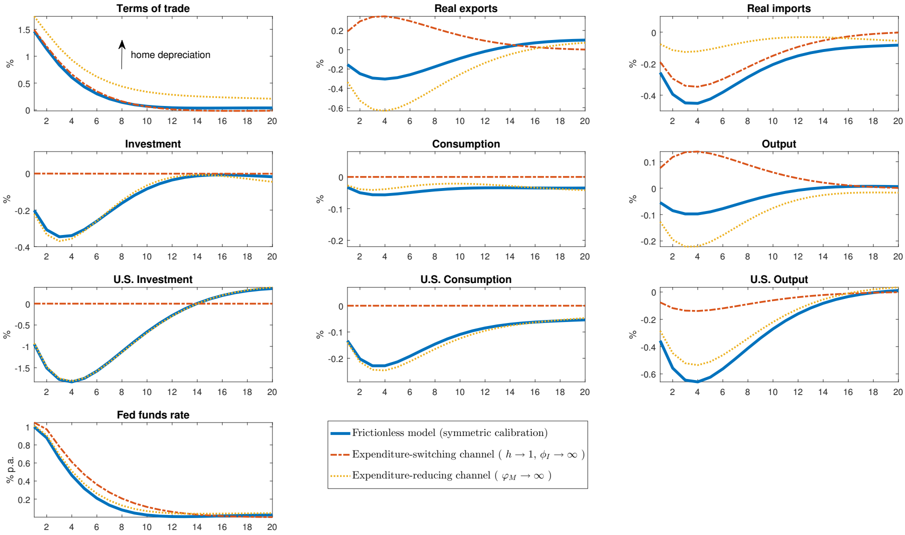

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Figure: U.S. monetary tightening, economy with frictions

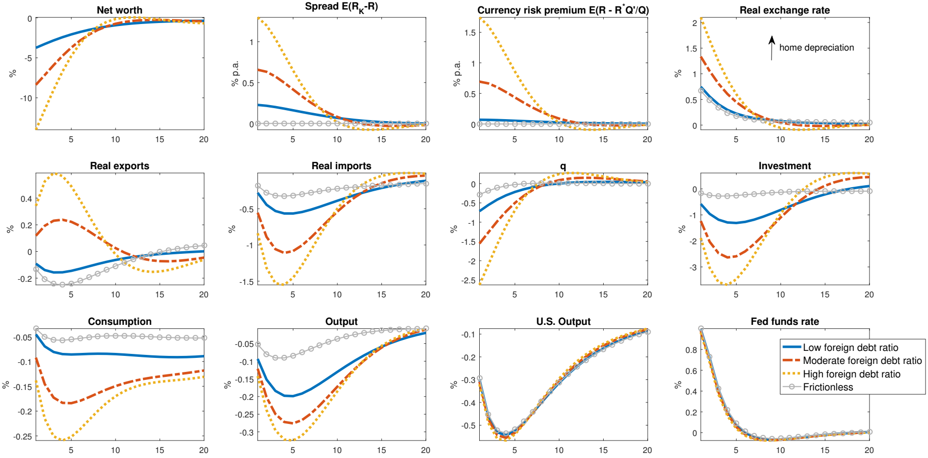
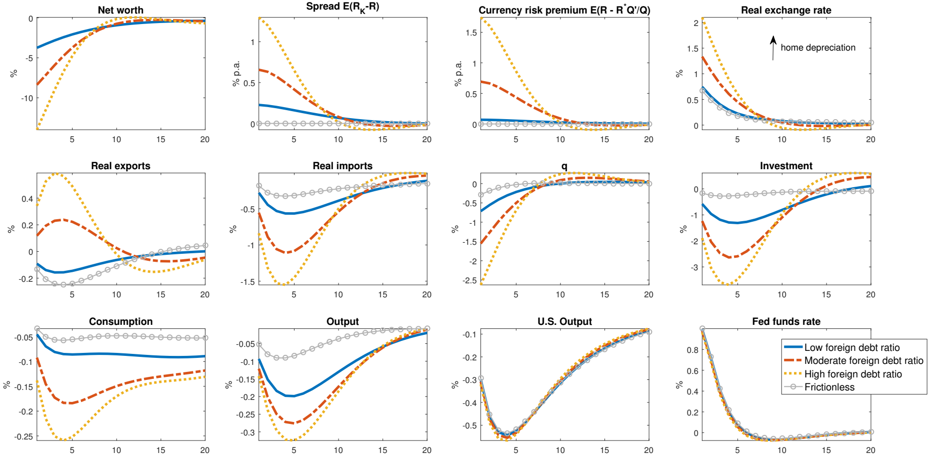


Figure: U.S. monetary tightening, economy with frictions



⟶ Spillovers mainly driven by the financial channel

⟶ Larger with greater foreign-currency debt

Generalized Taylor rule

$$R_t^n = \left(R_{t-1}^n\right)^{\gamma_r}\left(R_t^{nT}\right)^{1-\gamma_r}\varepsilon_t^r$$

$$R_t^{nT} = \frac{1}{\beta}\pi_t^{\frac{1-\gamma_e}{\gamma_e}}\left(\frac{e_t}{e}\right)^{\frac{\gamma_e}{1-\gamma_e}}$$

where $\gamma_e \in [0, 1]$

Generalized Taylor rule

$$R_t^n = \left(R_{t-1}^n\right)^{\gamma_r} \left(R_t^{nT}\right)^{1-\gamma_r} \varepsilon_t^r$$
$$R_t^{nT} = \frac{1}{\beta} {\pi_t}^{\frac{1-\gamma_e}{\gamma_e}} \left(\frac{e_t}{e}\right)^{\frac{\gamma_e}{1-\gamma_e}}$$

where $\gamma_e \in [0, 1]$

- Nests two polar cases of strict inflation targeting and exchange rate peg
- Allows parameterizing hybrid regimes of managed exchange rates
  - Higher $\gamma_e \to$ more important exchange rate stabilization motives

Figure: Standard deviations, different monetary regimes (US monetary shocks only)

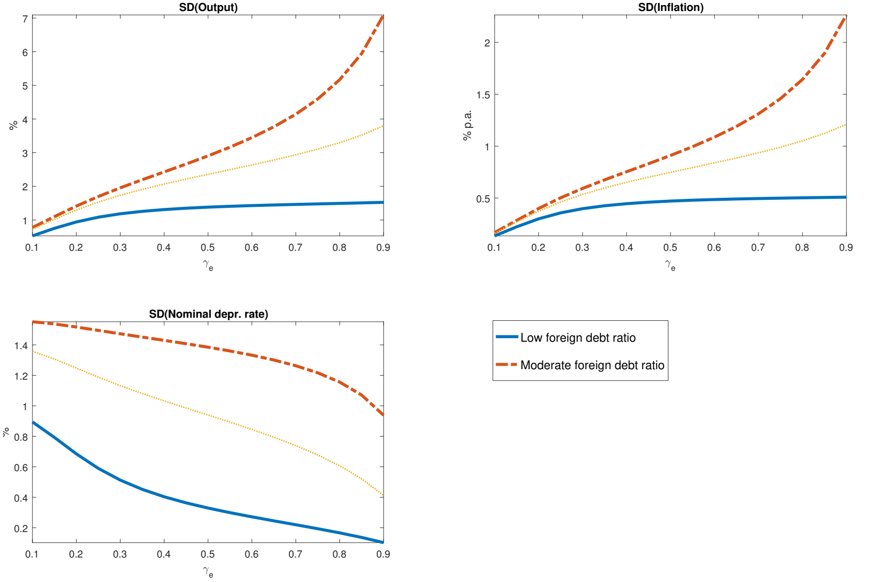


Figure: U.S monetary tightening, different monetary regimes

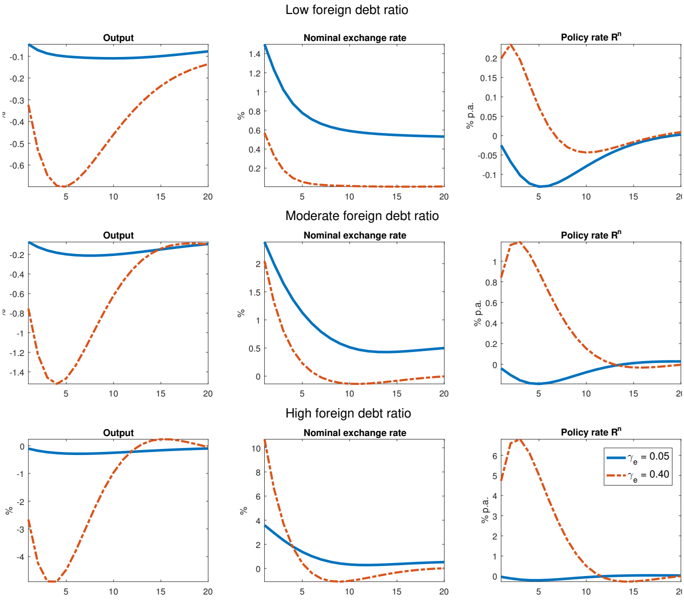


Figure: 100 basis point domestic monetary tightening

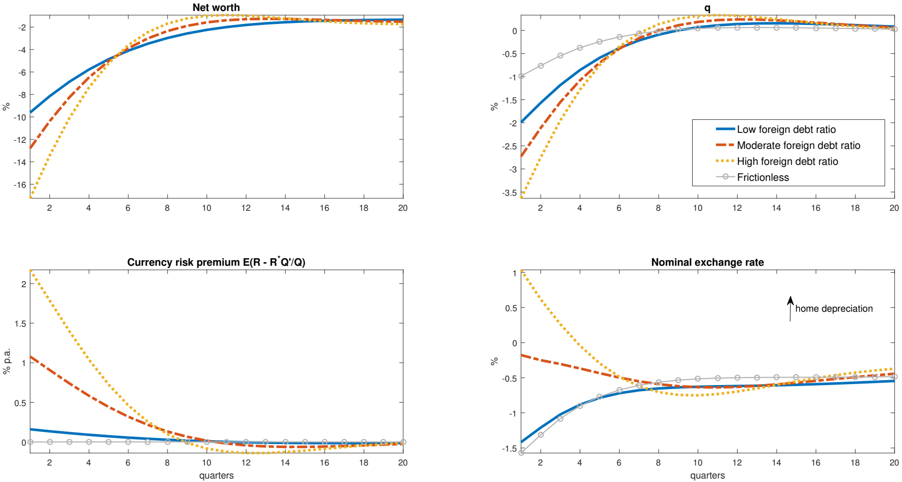
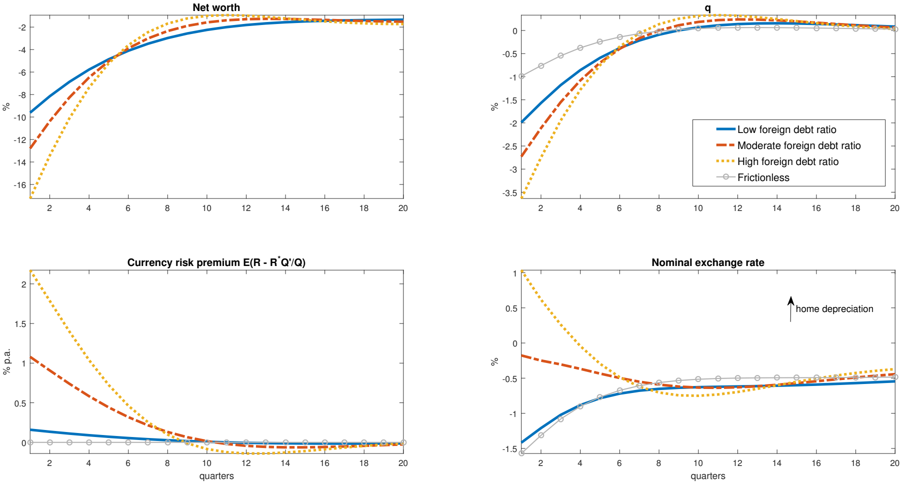


Figure: 100 basis point domestic monetary tightening

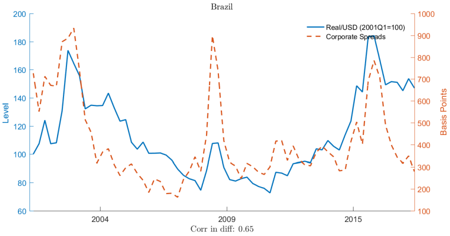


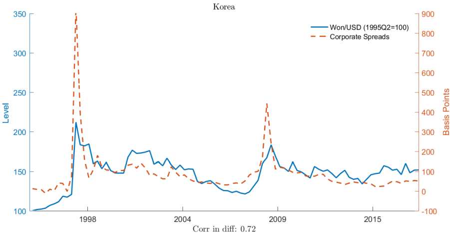
⟶ rise in currency premium works to offset standard effect

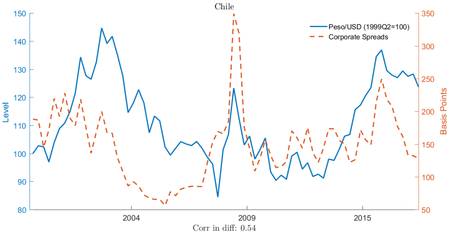
⟶ with high foreign debt, short-run *depreciation* following domestic tightening

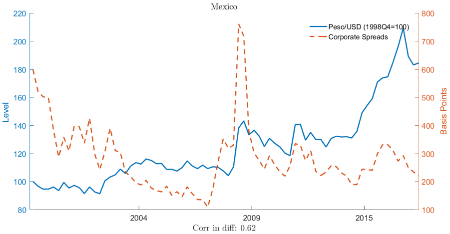
Some evidence on credit spreads and exchange rates

Credit Spreads and Exchange Rates









Credit Spreads and UIP Deviations

Explanatory Variables	Data	Model
Interest diff., $(i_t - i_t^*)$	1.16^{***}	0.13
	(0.23)	
Credit Spreads, CS_t	2.15^{***}	0.54
	(0.80)	
Global Risk, VIX_t	0.31^{***}	–
	(0.01)	
Method	Pooled OLS	
R^2	0.60	
# of Observations	410	

- Countries: Korea, Brazil, Mexico, Chile, Indonesia, Colombia, Thailand and Turkey.
- $\mu_t^* (\equiv e_t - e_{t+1} + i_t - i_t^*) = a_i + \delta_t + b\,(i_t - i_t^*) + c\; CS_t + d\; VIX_t + u_{t+1}$

Conclusions

- Balance-sheet mismatches enhance vulnerability to U.S. tightening
- Depreciation, financial distress, and rising currency risk premium reinforce each other
- Common view is called into question: using monetary policy to stabilize the exchange rate not necessarily more desirable with foreign-currency debt, and can backfire