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 less studied, but evidence suggests is large

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    - Well-known expenditure-switching and expenditure-reducing channels
    - Financial channel less studied, but evidence suggests is large

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

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2. Key mechanism: currency risk premium rises as balance sheets deteriorate
3. Analyze consequences for:
   - Spillovers from U.S. monetary policy
   - Desirability of monetary regimes that seek to stabilize the exchange rate

Preview of Main Findings

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1. Financial channel quantitatively dominant for spillovers from U.S. tightening
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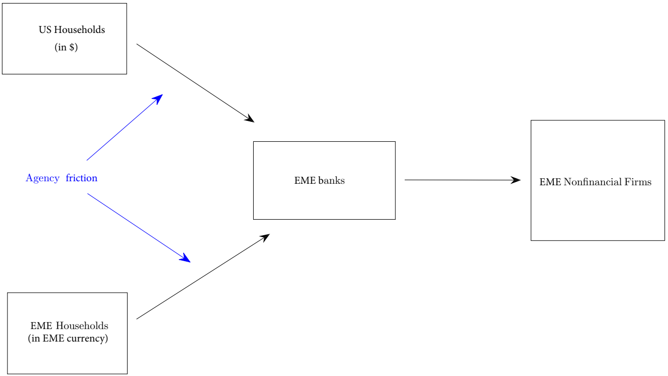
2. Little support for the view that using monetary policy to stabilize the exchange rate is desirable in the presence of foreign-currency debt
   - Tightening domestic monetary policy hurts balance sheets, increasing the currency risk premium $\rightarrow$ weaker appreciation for a given rate hike
   - Greater incentives for liability dollarization under exchange rate targeting regimes

Exchange rates in a simple model with imperfect capital markets

Simple Model

- **Home**: EME
- **Foreign**: U.S.
- Two nondurable goods (home and foreign) and one durable (capital)
- No other real or nominal rigidities



Simple Model: Banks

- Each bank i lives for two periods
- 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

$$q_t = \text{price of capital}$$
$$\mathcal{Q}_t = \text{real exchange rate (price of foreign currency)}$$

- In $t+1$, bank receives net payment

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

& 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

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

- Upon default, creditors liquidate and recover the remaining amount
- $\gamma > 0 \rightarrow$ foreign loans are more easily divertable than domestic loans
  - Caballero and Simsek (2018), Aoki, Benigno and Kiyotaki (2016), Iacoviello and Minetti (2006)
  - Broner, Erce, Martin, Ventura (2013) – empirical evidence

Simple Model: Banker's problem

- Let

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

- Banker solves

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

subject to

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

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- When (IC) binds,

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

  - ϱ_t: marginal benefit of substituting domestic for foreign funding
  - $(1+\gamma)\mu_t$: marginal cost

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$\longrightarrow$ UIP deviation:

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

Simple Model: Households & export demand

- The representative consumer maximizes

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \Big(C_D + \chi_m \log(M_C) \Big)$$

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

$\longrightarrow$

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

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

Simple Model: Equilibrium Conditions

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

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

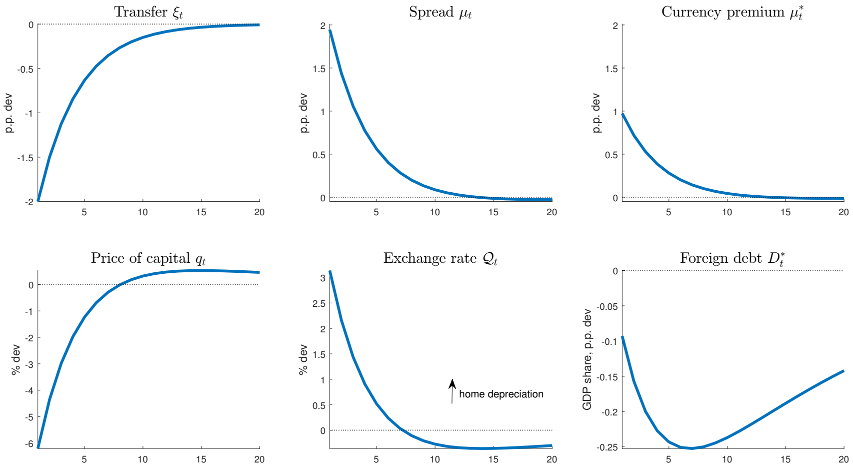
$$q_t = \beta \frac{\mathbb{E}_t(\overline{r}_k + q_{t+1})}{1 + \mu_t} \qquad \text{(Price of capital)}$$

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

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

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

Figure: Negative ξ shock in the simple model



$(\beta = 0.9925, \beta^* = 0.9975, \gamma = 0.5, \theta = 0.2, \xi = 0.25, \chi_m = \chi_x = .25, \rho_\xi = 0.75)$

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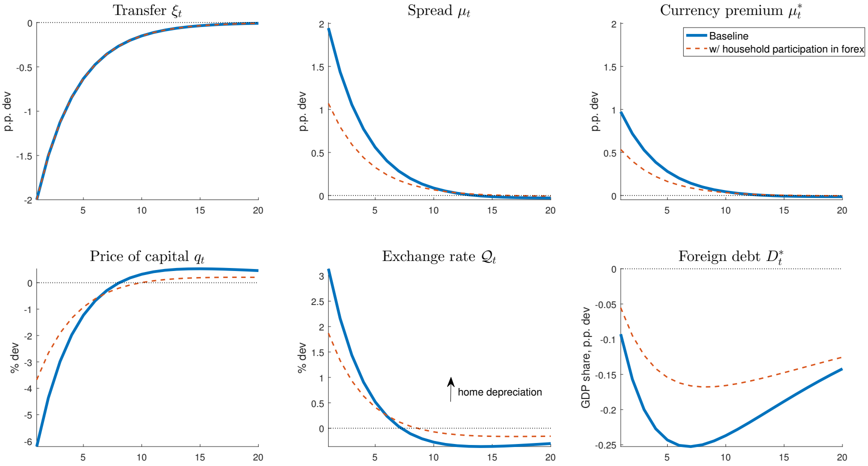

Robust to allowing for household participation in foreign exchange, s.t. cost $\frac{\kappa}{2} D_{Ht}^2$

Monetary Spillovers in a Medium-Scale Model

Banks: net worth evolution and objective

- Banks' survive w/ probability $\sigma_b > 0$

  $\rightarrow$ Endogenous net worth evolution (cond. on surviving):

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

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- Objective:

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

subject to

$$V_{it} \quad \geq \quad \theta \left(1 + \frac{\gamma}{2} x_{it}^2 \right) q_t S_{it} \qquad \text{(IC)}$$

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

Feedback between net worth and exchange rate

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

$$\hat{\mathcal{Q}}_t \approx \Gamma(x, \gamma) \mathbb{E}_t \left\{ \hat{r}_{kt+1} - r_{t+1} \right\} + \left(\hat{r}_{t+1}^* - \hat{r}_{t+1} \right) + \mathbb{E}_t \left\{ \hat{\mathcal{Q}}_{t+1} \right\}$$

($\Gamma_1, \Gamma_2 > 0$)

where $\hat{z}_t \equiv \log(\frac{Z_t}{Z})$ for any variable Z_t

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

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

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

Other model features

- CES preferences of HHs over domestically produced and imported goods
- Costly to change the proportion of domestic and imported goods in the aggregate consumption bundle
- Producer currency pricing: $P_{Mt} = e_t P^*_{Dt}$, where e_t is the nominal exchange rate (in domestic currency per dollar)

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- CES preferences of HHs over domestically produced and imported goods
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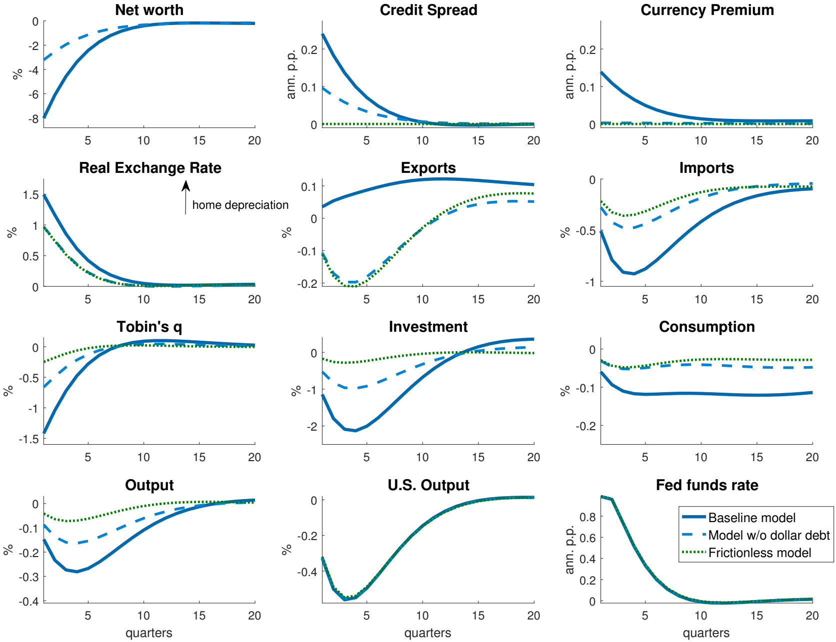
- Producer currency pricing: $P_{Mt} = e_t P^*_{Dt}$, where e_t is the nominal exchange rate (in domestic currency per dollar)
- Nominal price and wage rigidity
  - Price and wage remain fixed with prob. ξ_p and ξ_w resp.
- Capital producers face cost of adjusting level of investment
  - FOC gives investment-q relation
  - Costs of adjusting imported-domestic mix, analogous to consumers
- Monetary policy in each country follows inertial Taylor rule

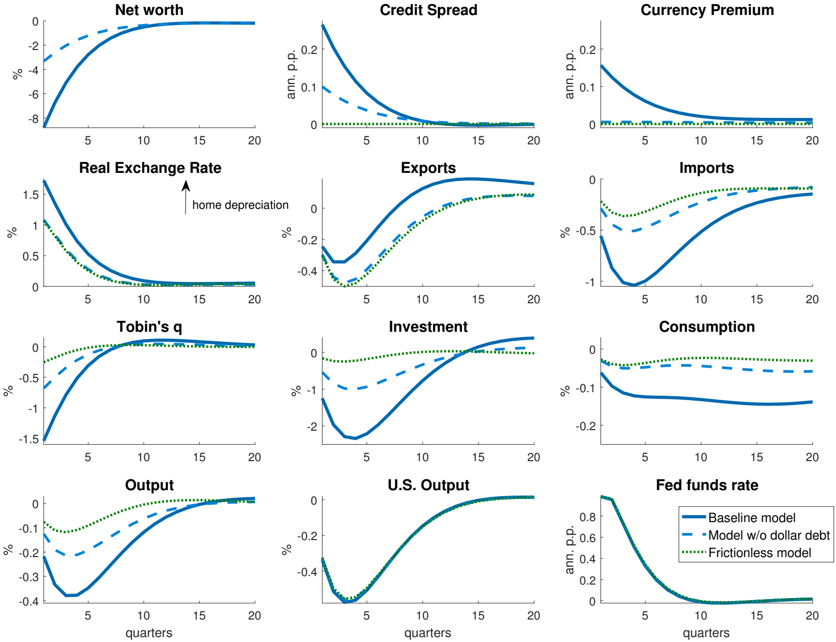
Figure: U.S. monetary tightening, economy with frictions



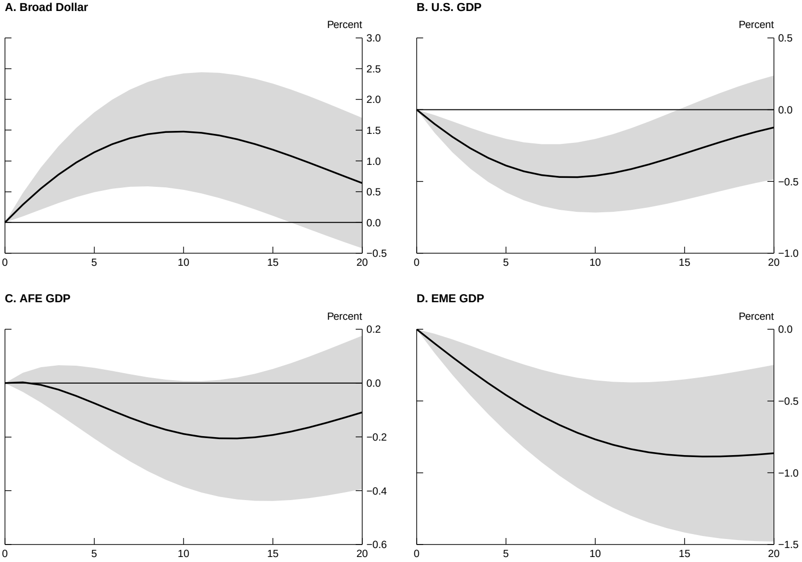
Dominant Currency Pricing

- Dominant Currency Paradigm (Casas, Diez, Gopinath & Gourinchas 2017): firms set export prices in a dominant currency, most often the dollar
  - Evidence: Goldberg & Tille (2008), Gopinath (2015)
- We consider monetary spillovers under DCP
  - Export prices for both home and the U.S. are rigid *in dollars*

Figure: U.S. monetary tightening: DCP



Structural VAR Predictions of the Effects of a 100 Basis Point Rise in Fed Funds Rate



Note: Shaded areas represent 95% confidence bands. Estimates are based on a structural VAR model consisting of U.S. GDP, U.S. core PCE inflation, U.S. federal funds rate, U.S. credit spreads, the trade-weighted dollar, other advanced-economy GDP, and EME GDP.

Should EME central banks respond to exchange rates?

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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 $\gamma_e \rightarrow$ more important exchange rate stabilization motives

Figure: Welfare Loss under Different Monetary Regimes (US monetary shocks)

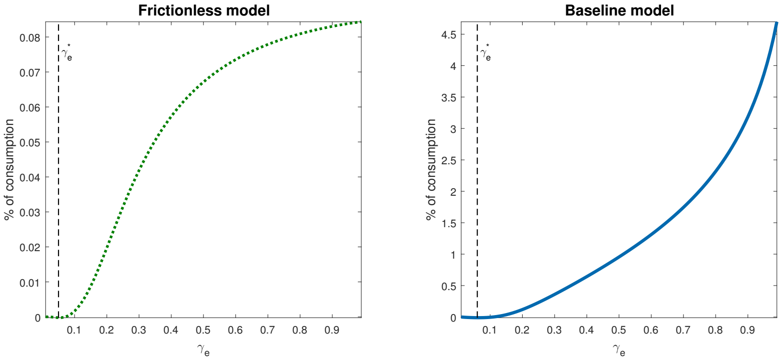


Figure: Volatility under Different Monetary Regimes (US monetary shocks)

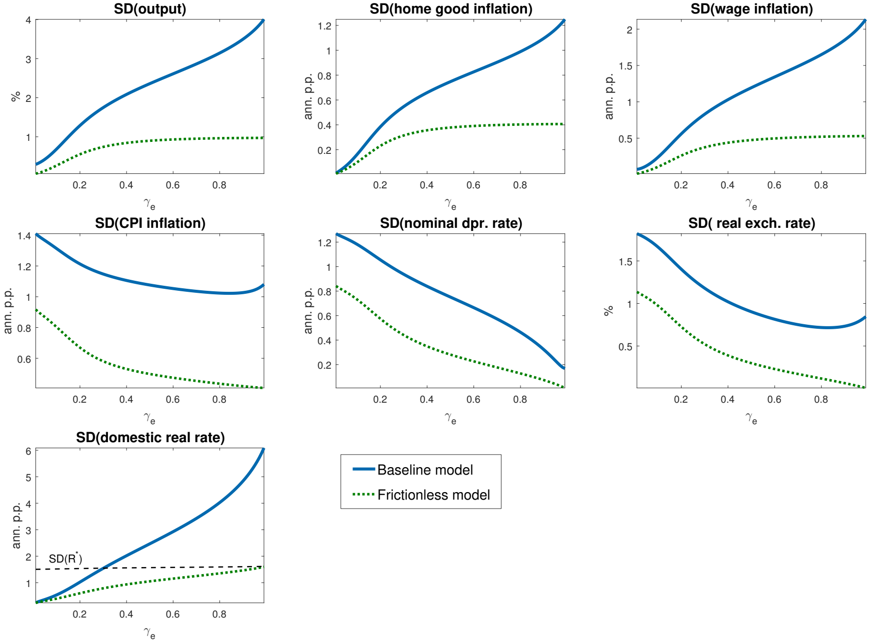


Figure: U.S monetary tightening, different monetary regimes

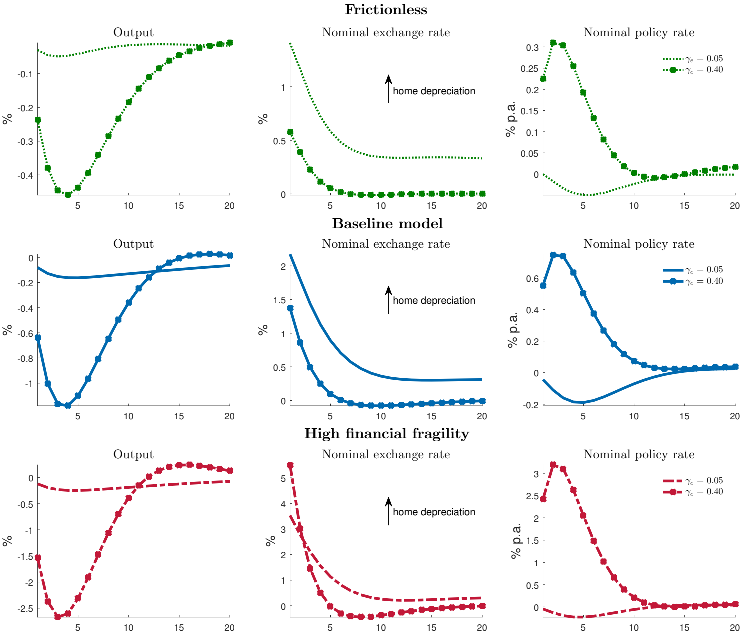
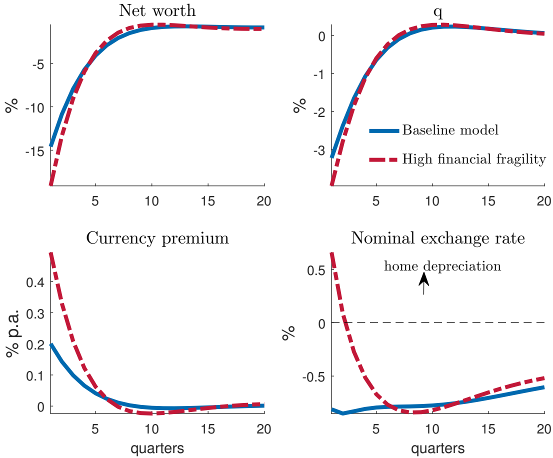


Figure: 100 basis point domestic monetary tightening



⟶ rise in currency premium works to offset standard effect on ER through UIP

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

Evidence: Gould & Kamin (2001)

Exchange rate regimes and liability dollarization

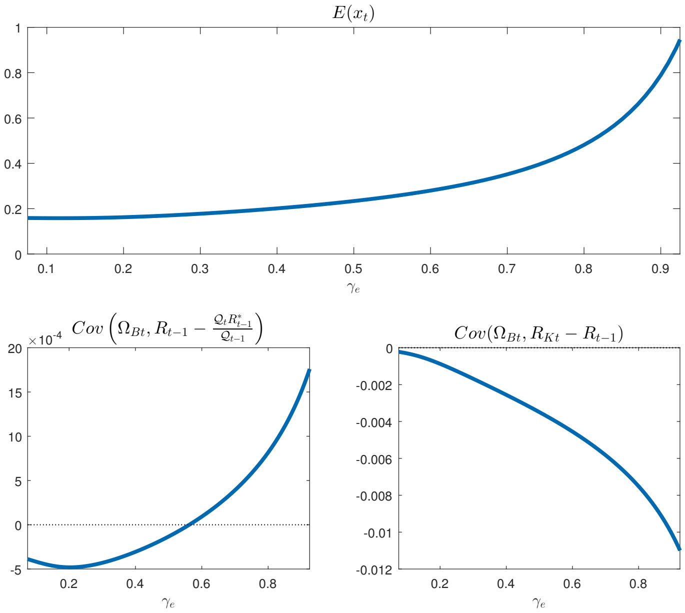
- From banks' portfolio problem,

$$\mathbb{E}(x_t) = f\left(Cov\left(\Omega_{Bt}, R_{t-1} - \frac{R^*_{t-1}\mathcal{Q}_t}{\mathcal{Q}_{t-1}}\right), Cov(\Omega_{Bt}, R_{Kt} - R_{t-1})\right)$$

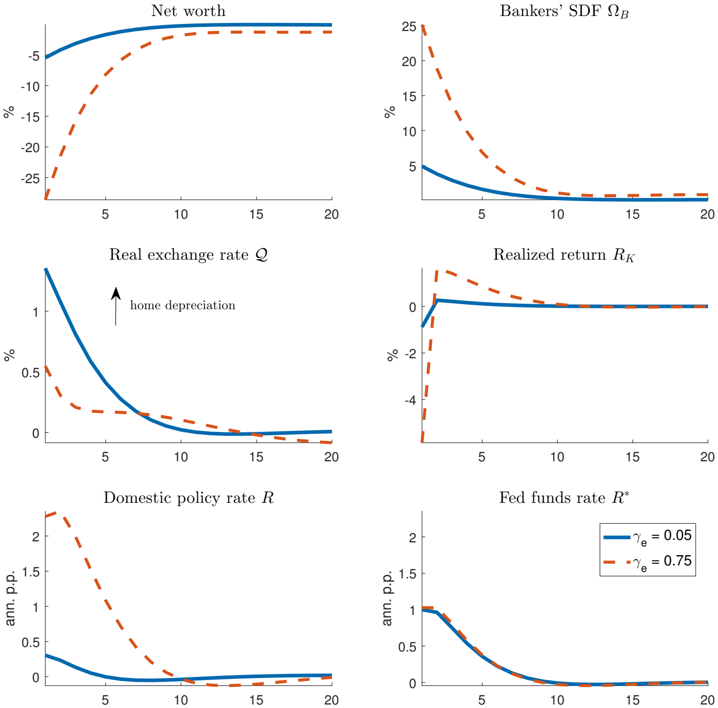
$$f_1 > 0, f_2 < 0$$

$$x_t = \text{dollar liabilities / total assets}$$

$$\Omega_{Bt} = \text{banker's SDF}$$



$E(x_t)$
γ_e
$Cov\left(\Omega_{Bt}, R_{t-1} - \frac{\mathcal{Q}_t R^*_{t-1}}{\mathcal{Q}_{t-1}}\right)$
$\times 10^{-4}$
γ_e
$Cov(\Omega_{Bt}, R_{Kt} - R_{t-1})$
γ_e



Net worth
%
Bankers' SDF Ω_B
%
Real exchange rate $\mathcal{Q}$
home depreciation
%
Realized return R_K
%
Domestic policy rate R
ann. p.p.
Fed funds rate R^*
ann. p.p.
γ_e = 0.05
γ_e = 0.75

Exchange rates and credit spreads: Some evidence

Model-Implied Empirical Regression Equation

- From the optimal portfolio condition,

$$\hat{\mathcal{Q}}_t \approx \gamma \mathbb{E}_t \left\{ r_{kt+1} - r_{t+1} \right\} + r^*_{t+1} - r_{t+1} + \mathbb{E}_t \left\{ \hat{\mathcal{Q}}_{t+1} \right\}$$

- Iterate forward T periods

$$\hat{\mathcal{Q}}_t \approx \gamma \sum_{j=1}^{T} \mathbb{E}_t \left\{ r_{kt+j} - r_{t+j} \right\} + \sum_{j=1}^{T} \mathbb{E}_t \left\{ r^*_{t+j} - r_{t+j} \right\} + \mathbb{E}_t \left\{ \hat{\mathcal{Q}}_{t+T+1} \right\}$$

- *Empirical regression equation:*

$$\mathcal{Q}_t = \alpha_0 + \alpha_1 t + \beta_s s_t + \beta_r r_t^{diff} + \varepsilon_t$$

  - $\mathcal{Q}_t$ = US/Korea real bilateral exchange rate (real \$ per won), in log
  - $s_t = \frac{T}{12} \left(r_t^{corp} - r_t^{gov} \right)$
  - $r_t^{diff} = \frac{T}{12} \left(r_t^{gov*} - r_t^{gov} \right)$

with $T = 36$, and where r^{corp} is the Korean 3-year corp. bond yield and r^{gov}, r^{gov*} are 3-year (real) Korea and US gov. bond yields.

Empirical exchange rate equation, level (Korea)

	(1)	(2)	(3)	(4)
Interest diff.	1.27***	0.97***	1.01***	0.87***
	(0.16)	(0.13)	(0.12)	(0.12)
Corp. spread		2.72***	3.71***	2.17***
		(0.19)	(0.29)	(0.20)
D_{crisis}			−0.22***	
			(0.04)	
VIX/100				0.43***
				(0.07)
R^2	0.19	0.53	0.56	0.58
Observations	281	281	281	281

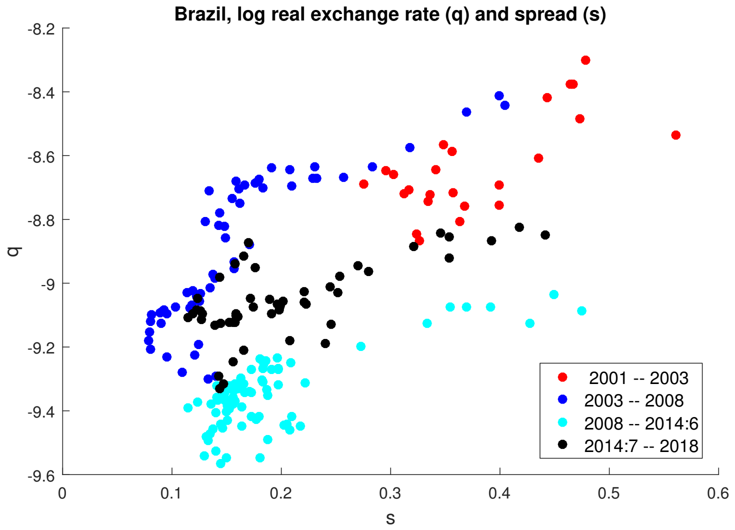
Note.— Dependent variable: US/Korea monthly bilateral real exchange rate. Regression estimated by OLS. Standard errors shown in parentheses. *** denotes significance at the 1 percent level. Sample: 1995:5–2018:9.

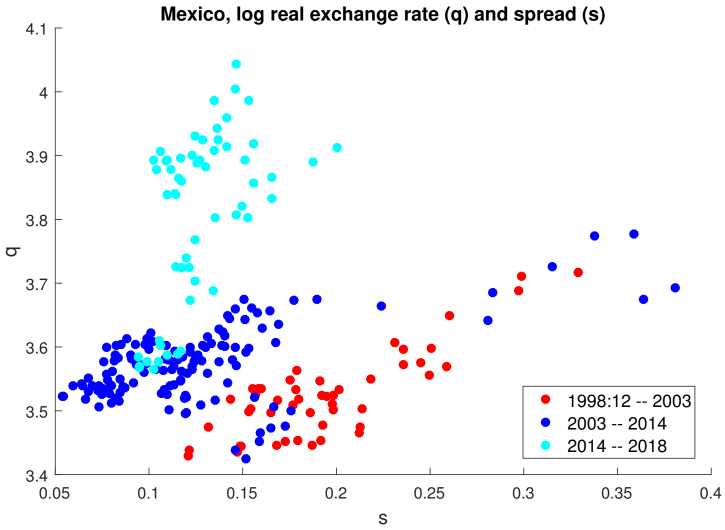
Empirical exchange rate equation, first difference (Korea)

	(1)	(2)	(3)
ΔInterest diff.	0.02	−0.03	0.07
	(0.08)	(0.08)	(0.07)
ΔCorp. spread	1.27***	1.25***	1.26***
	(0.08)	(0.08)	(0.08)
D_{crisis}		0.04***	
		(0.009)	
Δ VIX/100			0.21***
			(0.04)
R^2	0.46	0.49	0.51
Observations	280	280	280

Note.— Dependent variable: US/Korea monthly bilateral real exchange rate. Regression estimated by OLS. Standard errors shown in parentheses. *** denotes significance at the 1 percent level. Sample: 1995:6–2018:9. The regression equation is

$$\Delta \mathcal{Q}_t = \alpha_0 + \beta_s \Delta s_t + \beta_r \Delta r_t^{diff} + \varepsilon_t$$


Brazil, log real exchange rate (q) and spread (s)
-8.2
-8.4
-8.6
-8.8
-9
-9.2
-9.4
-9.6
q
0
0.1
0.2
0.3
0.4
0.5
0.6
s
2001 -- 2003
2003 -- 2008
2008 -- 2014:6
2014:7 -- 2018


Mexico, log real exchange rate (q) and spread (s)
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
q
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
s
1998:12 -- 2003
2003 -- 2014
2014 -- 2018

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

Figure: 100 basis point domestic monetary tightening