Exchange Rate Dynamics and Monetary Spillovers with Imperfect Financial Markets

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Motivation

- Empirical literature finds sizable foreign effects of U.S. monetary shocks

\[ r - (r^* + E_t \{ \Delta Q_t + 1 \}) > 0 \] countercyclical, ↑ when U.S. tightens

- How should foreign central banks respond?
  - In theory: let exchange rate fluctuate (Friedman'53, Galí & Monacelli'05)
  - In practice: fear of floating (Calvo & Reinhart'02)
  - Common argument: dollar-denominated debt
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U.S. policy shocks comove with foreign financial variables (Miranda-Agrippino & Rey’19)

Linked with deviations from uncovered interest parity (Kalemli-Özcan’19)

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    - Common argument: dollar-denominated debt
What We Do

- Two-country monetary model with imperfect financial markets
  - Home is a small emerging market (EM), foreign is the United States
  - Home borrowers issue both domestic currency and dollar-denom. debt

\[ \mu^*_{t} \equiv r_t + 1 - (r^*_t + 1 + E_t \{ \Delta Q_{t+1} \}) \]

- \( \mu^*_{t} \) inversely related to aggregate state of EM borrowers' balance sheets
  - Fluctuates countercyclically, consistent with evidence

Questions:
- What drives the magnitude of spillovers?
- Should EM central banks attempt to defend the exchange rate?
What We Do

- Two-country monetary model with imperfect financial markets
  - Home is a small emerging market (EM), foreign is the United States
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- Model implies endogenous UIP deviation $\mu^*_t \equiv r_{t+1} - (r^*_{t+1} + \mathbb{E}_t \{\Delta Q_{t+1}\})$
  - $\mu^*_t$ inversely related to aggregate state of EM borrowers’ balance sheets
    → fluctuates countercyclically, consistent w/ evidence

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What We Do

- Two-country monetary model with imperfect financial markets
  - Home is a small emerging market (EM), foreign is the United States
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- Model implies endogenous UIP deviation $\mu_t^* \equiv r_{t+1} - (r_{t+1}^* + E_t \{\Delta Q_{t+1}\})$
  - $\mu_t^*$ inversely related to aggregate state of EM borrowers’ balance sheets
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- Questions:
  - What drives the magnitude of spillovers?
  - Should EM central banks attempt to defend the exchange rate?
Findings

- **(Positive)** Effects of U.S. monetary policy on foreign activity mainly driven by financial imperfection
  - Key: feedback between balance sheets and exchange rate
  - Especially large in the presence of both dollar debt and dollar export pricing
    - Magnitude consistent with VAR evidence
Findings

▶ *(Positive)* Effects of U.S. monetary policy on foreign activity mainly driven by financial imperfection

▶ Key: feedback between balance sheets and exchange rate
▶ Especially large in the presence of both dollar debt and dollar export pricing
  ▶ Magnitude consistent with VAR evidence

▶ *(Normative)* Exchange rate stabilization not necessarily desirable

▶ EM monetary tightening also weakens balance sheets, thus raising $\mu_t^*$
  → defending exchange rate is more costly than in frictionless setting
▶ Regimes with ER stabilization create incentives for larger dollar borrowing
Literature

- Evidence on foreign effects of U.S. monetary shocks

- Open-economy models with nominal rigidities

- Closed-economy frameworks with financial frictions

- Balance sheet channel of exchange rate movements

- Recent work on spillovers and fluctuations in EMs
1. **Simple model** to illustrate source of UIP deviation
   - Short-lived borrowers, exogenous net worth

2. **Medium-scale model** for analysis of spillovers
   - Long-lived borrowers $\rightarrow$ net worth evolves endogenously
   - Nominal & real rigidities $\rightarrow$ realistic effects of monetary policy shocks

3. **Evidence** on model-implied UIP equation
A Simple Model with Imperfect Financial Markets
Simple Model

- Two countries
  - **Home**: EM
  - **Foreign**: United States
- Two nondurable goods (home and foreign) and one durable (capital)
- **Agency friction** in EM banks’ process of raising funds to finance capital
- No other real or nominal rigidities
Simple Model: Banks

- Each bank $i$ lives for two periods

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

  $$q_t S_{it} = D_{it} + Q_t D^*_{it} + \xi_{it}$$

  where

  $q_t = \text{price of capital}$

  $Q_t = \text{real exchange rate (price of foreign currency)}$

- In $t + 1$, bank earns

  $$R^{Kt+1}_{t+1} q_t S_{it} - R_t D_{it} - R^*_t Q_{t+1} D^*_{it}$$

  $$\equiv \frac{Z_{t+1} + q_{t+1}}{q_t}$$

  & exits
Simple Model: Agency friction

- **Moral hazard** (Gertler-Kiyotaki’10): after issuing deposits in period $t$, bank chooses whether to
  - operate “honestly:” hold assets until $t + 1$ & meet deposit obligations; or
  - divert funds for personal use

If divert, banker obtains $\theta(D_t + (1 + \gamma)Q_tD^* + \xi_t)$ where $\theta, \gamma > 0$, $\theta(1 + \gamma) < 1$ → creditors force bankruptcy in $t + 1$ and recover remaining funds

- $\gamma > 0$: foreign loans harder to enforce than domestic loans
- Legal & institutional differences between U.S. and EMs, informational disadvantages for foreign creditors (Rajan-Zingales’98, Hermalin-Rose’99)
Simple Model: Agency friction

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$$\theta \left( D_{it} + (1 + \gamma) Q_t D_{it}^* + \xi_{it} \right)$$

where $\theta, \gamma > 0$, $\theta(1 + \gamma) < 1$

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- If divert, banker obtains
  \[
  \theta \left( D_{it} + (1 + \gamma) Q_t D_{it}^* + \xi_{it} \right)
  \]
  where $\theta, \gamma > 0$, $\theta(1 + \gamma) < 1$

  → creditors force bankruptcy in $t + 1$ and recover remaining funds

- $\gamma > 0$: foreign loans **harder to enforce** than domestic loans
  - Legal & institutional differences between U.S. and EMs, informational disadvantages for foreign creditors (Rajan-Zingales’98, Hermalin-Rose’99)
Simple Model: Banker’s problem

Let

\[ \mu_t \equiv \beta \mathbb{E}_t (R_{Kt+1} - R_t) \]
\[ \varrho_t \equiv \beta \mathbb{E}_t (R_{Kt+1} - R^*_t Q_{t+1}/Q_t) \]
\[ x_{it} \equiv \frac{Q_t D^*_t}{q_t S_{it}} \]

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

\[
\left[ x_{it} \varrho_t + (1 - x_{it}) \mu_t \right] q_t S_{it} + \xi_{it} \geq \theta (1 + \gamma x_{it}) q_t S_{it} \quad (IC)
\]
Simple Model: Banker’s problem

Let

\[ \mu_t \equiv \beta \mathbb{E}_t (R_{Kt+1} - R_t) \]
\[ \varrho_t \equiv \beta \mathbb{E}_t (R_{Kt+1} - R^*_t Q_{t+1}/Q_t) \]
\[ \chi_{it} \equiv Q_t D_{it}^* / q_t S_{it} \]

When (IC) binds,

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

- \( \varrho_t \): marginal benefit of issuing foreign deposits
- \( (1 + \gamma) \mu_t \): marginal cost
Simple Model: Banker’s problem

Let

\[ \mu_t \equiv \beta \mathbb{E}_t (R_{Kt+1} - R_t) \]
\[ \varrho_t \equiv \beta \mathbb{E}_t (R_{Kt+1} - R^*_t Q_{t+1}/Q_t) \]
\[ x_{it} \equiv \frac{Q_t D_{it}^*}{q_t S_{it}} \]

When (IC) binds,

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

\[ \mu^*_t \equiv \beta \mathbb{E}_t (R_t - R^*_t Q_{t+1}/Q_t) \]
\[ = \varrho_t - \mu_t \]
\[ = \gamma \mu_t > 0 \]
Simple Model: Households & export demand

\[
\max \{C_{Dt+j}, M_{Ct+j}, D_{t+j}\}_{j=0}^{\infty} \quad \mathbb{E}_t \sum_{j=0}^{\infty} \beta^j [C_{Dt+j} + \chi_m \log(M_{Ct+j})]
\]

subject to

\[
C_{Dt} + Q_t M_{Ct} + D_t \leq W_t \bar{L} + R_t D_{t-1} + \pi_t \quad \forall t
\]

\(C_{Dt}\) is domestic-good consumption, \(M_{Ct}\) is imports, and \(\pi_t\) is transfers from bankers

\[R = \beta^{-1}\]

\[M_{Ct} = \chi_m Q_t^{-1}\]

- Export demand: \(M_{Ct}^* = \chi_x Q_t\)
Simple Model: Equilibrium

- Capital market clearing:

\[ \int S_{it} \, di = \bar{K} \]

- Equity endowment: \( \xi_{it} = \xi_t q_t \bar{K} \); \( \xi_t \) follows exogenous process

- Aggregating budget constraints,

\[ D_t^* = \frac{\chi_m}{Q_t} - \chi_x + R^* D_{t-1}^* \]

\[ = -NX_t \]

- EM households are relatively impatient: \( R^* = 1/\beta^* < R \)
Simple Model: Equilibrium

\[ \mu_t = \theta - \frac{\xi_t}{1 + \gamma x_t} \]  
(Incentive Constraint)

\[ x_t = \frac{Q_tD_t^*}{q_tK} \]  
(Foreign funding ratio)

\[ q_t = \beta \frac{\mathbb{E}_t(Z + q_{t+1})}{1 + \mu_t} \]  
(Price of capital)

\[ Q_t = \frac{\beta}{\beta^*} \mathbb{E}_t(Q_{t+1}) \frac{1}{1 - \gamma \mu_t} \]  
(Real exchange rate)

\[ D_t^* = \frac{\chi m}{Q_t} - \chi x + R^* D_{t-1} \]  
(Balance of Payments)

(with  \( Z \equiv \alpha(\bar{K}/\bar{L})^{\alpha-1} \) )
Simple Model: Equilibrium

Suppose $\beta \uparrow \beta^*, \chi_m = \chi_x$, and unity elast. of $NX_t$ to $Q_t$. Then

$$\tilde{\mu}_t = -\frac{\theta}{\xi} \tilde{\xi}_t + \frac{\theta (\xi - \theta)}{\xi} \tilde{x}_t$$

(Incentive Constraint)

$$\tilde{x}_t = \tilde{Q}_t + \tilde{D}^*_t - \tilde{q}_t$$

(Foreign funding ratio)

$$\tilde{Q}_t = \gamma \tilde{\mu}_t + \mathbb{E}_t \left\{ \tilde{Q}_{t+1} \right\}$$

(Price of capital)

$$\tilde{q}_t = -\tilde{\mu}_t + \beta \mathbb{E}_t \left\{ \tilde{q}_{t+1} \right\}$$

(Real exchange rate)

$$\tilde{D}^*_t = -r^* \tilde{Q}_t + (1 + r^*) \tilde{D}^*_{t-1}$$

(Balance of Payments)

where

$$r^* \equiv \frac{1}{\beta^*} - 1$$

and

$$\tilde{y}_t \equiv \log \left( \frac{y_t}{y} \right)$$

$$\tilde{y}_t \equiv y_t - y$$

for any variable $y_t$.
Figure: Negative $\xi$ shock in the simple model

Note: Effects of a 2 percent drop in bankers’ equity endowment $\xi_t$ in the simple model.

Parameter values: $\beta = 0.9925$, $\beta^* = 0.995$, $\gamma = 0.5$, $\theta = 0.18$, $\xi = 0.20$, $\chi_m = \chi_x = 1$. 

Extension w/ hh participation in forex
A Medium-Scale Model
Bankers

- Survive w/ probability $\sigma_b > 0$

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

$$N_{it+1} = (R_{Kt+1} - R_t)q_tS_{it} + (R_t - R_t^* Q_{t+1}/Q_t) Q_tD_{it}^* + R_t N_{it} \quad (1)$$

where

$$x_{it} = \frac{Q_tD_{it}^*}{q_tS_{it}}$$

$\Lambda_t, \tau =$ household's real stochastic discount factor

$$\Theta(x_{it}) = \theta(1 + \gamma x_{it}^2)$$
Bankers

- Survive w/ probability $\sigma_b > 0$

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

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- Objective:

  $$V_{it} = \max_{S_{it}, D_{it}^*} (1 - \sigma_b) \mathbb{E}_t (Q_{t+1} N_{it+1}) + \sigma_b \mathbb{E}_t (Q_{t+1} V_{it+1})$$

  s.t. (1) and

  $$V_{it} \geq \Theta(x_{it}) q_t S_{it} \quad (IC)$$
Bankers

▶ Survive w/ probability $\sigma_b > 0$

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

$$N_{it+1} = \left(R_{Kt+1} - R_t\right) q_t S_{it} + \left(R_t - R_t^* Q_{t+1} / Q_t\right) Q_t D_{it}^* + R_t N_{it} \quad (1)$$

▶ Objective:

$$V_{it} = \max_{S_{it}, D_{it}^*} \left(1 - \sigma_b\right) \mathbb{E}_t \left(\Lambda_{t,t+1} N_{it+1}\right) + \sigma_b \mathbb{E}_t \left(\Lambda_{t,t+1} V_{it+1}\right)$$

s.t. (1) and

$$V_{it} \geq \Theta(x_{it}) q_t S_{it} \quad (IC)$$

where

$$x_{it} = Q_t D_{it}^* / q_t S_{it}$$

$$\Lambda_{t,\tau} = \text{household’s real stochastic discount factor}$$

$$\Theta(x_t) = \theta \left(1 + \frac{\gamma}{2} x_{it}^2\right)$$
Households

- Objective:

$$\max \{ C_{Dt+j}, M_{Ct+j}, C_{t+j}, D_{t+j}, W_{it+j}, L_{it+j} \}_{j=0}^{\infty} \mathbb{E}_t \left\{ \sum_{j=0}^{\infty} \beta^j \left[ \log (C_{t+j} - hC_{t+j-1}) - \frac{L_{it+j}^{1+\chi}}{1 + \chi} \right] \right\}$$

subject to

$$P_t C_t + P_t D_t + B_t \leq W_{it} L_{it} + P_t R_{t-1} D_{t-1} + R_t^{n} B_{t-1} + W_{it} + \Pi_t \quad \forall t$$
Households

Objective:

\[
\max \mathbb{E}_t \left\{ \sum_{j=0}^{\infty} \beta^j \left[ \log \left( C_{t+j} - hC_{t+j-1} \right) - \frac{L_{it+j}^{1+\chi}}{1 + \chi} \right] \right\}
\]

subject to

\[
P_t C_t + P_tD_t + B_t \leq W_{it}L_{it} + P_t R_{t-1} D_{t-1} + R_{t-1}^n B_{t-1} + W_{it} + \Pi_t \quad \forall t
\]

where

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

\[
P_t = \left( (1 - \omega) P_{Dt}^{-\frac{1}{\rho}} + \omega P_{Mt}^{-\frac{1}{\rho}} \right)^{-\rho}
\]
Households

- Objective:

$$\max_{\{C_{Dt+j}, M_{Ct+j}, C_{t+j}, D_{t+j}, W_{it+j}, L_{it+j}\}} \mathbb{E}_t \left\{ \sum_{j=0}^{\infty} \beta^j \left[ \log (C_{t+j} - hC_{t+j-1}) - \frac{L_{it+j}^{1+\chi}}{1 + \chi} \right] \right\}$$

subject to

$$P_t C_t + P_t D_t + B_t \leq W_{it} L_{it} + P_t R_{t-1} D_{t-1} + R_{t-1}^n B_{t-1} + \mathcal{W}_{it} + \Pi_t \quad \forall t$$

where

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

$$P_t = \left( (1 - \omega) P_{Dt}^{-\frac{1}{\rho}} + \omega P_{Mt}^{-\frac{1}{\rho}} \right)^{-\rho}$$

- Import adjustment cost: $$\varphi_{Ct} = 1 - \frac{\varphi}{2} \left( \frac{M_{Ct}/C_{Dt}}{M_{Ct-1}/C_{Dt-1}} - 1 \right)^2$$
Households

Objective:

\[
\max_{\{C_{Dt+j}, M_{Ct+j}, C_{t+j}, D_{t+j}, W_{it+j}, L_{it+j}\}, j=0} \quad \mathbb{E}_t \left\{ \sum_{j=0}^{\infty} \beta^j \left[ \log (C_{t+j} - hC_{t+j-1}) - \frac{L_{it+j}^{1+\chi}}{1 + \chi} \right] \right\}
\]

subject to

\[
P_t C_t + P_t D_t + B_t \leq W_{it} L_{it} + P_t R_{t-1} D_{t-1} + R_{t-1}^n B_{t-1} + W_{it} + \Pi_t \quad \forall t
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where

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

\[
P_t = \left( (1 - \omega) P_{Dt}^{-\frac{1}{\rho}} + \omega P_{Mt}^{-\frac{1}{\rho}} \right)^{-\rho}
\]

Import adjustment cost: \( \varphi_{Ct} = 1 - \frac{\varphi_M}{2} \left( \frac{M_{Ct}/C_{Dt}}{M_{Ct-1}/C_{Dt-1}} - 1 \right)^2 \)

Producer currency pricing: \( P_{Mt} = e_t P^*_D t, \quad P^*_M = e_t^{-1} P_D t \)
Households

- **Objective:**

\[
\max_{\{C_{Dt+j}, M_{Ct+j}, C_{t+j}, D_{t+j}, W_{it+j}, L_{it+j}\}_{j=0}^{\infty}} \mathbb{E}_t \left\{ \sum_{j=0}^{\infty} \beta^j \left[ \log (C_{t+j} - hC_{t+j-1}) - \frac{L_{it+j}^{1+\chi}}{1 + \chi} \right] \right\}
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subject to

\[
P_tC_t + P_tD_t + B_t \leq W_{it}L_{it} + P_tR_{t-1}D_{t-1} + R_{t-1}^nB_{t-1} + W_{it} + \Pi_t \quad \forall t
\]

where

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

\[
P_t = \left( (1 - \omega) P_{Dt}^{-\frac{1}{\rho}} + \omega P_{Mt}^{-\frac{1}{\rho}} \right)^{-\rho}
\]

- **Import adjustment cost:** \(\varphi_{Ct} = 1 - \frac{\varphi_M}{2} \left( \frac{M_{Ct}/C_{Dt}}{M_{Ct-1}/C_{Dt-1}} - 1 \right)^2\)

- **Producer currency pricing:** \(P_{Mt} = e_t P_{Dt}^*, \quad P_{Mt}^* = e_t^{-1} P_{Dt}\)

- **Wage set optimally w/ prob. 1 - \xi_w, s.t.** \(L_{it} = (W_{it}/W_t)^{-\frac{1+\theta_w}{\theta_w}} L_t\)
Firms & Price Setting

- Final output: \( Y_t = \left( \int_0^1 Y_{it}^{\frac{1}{1+\theta_p}} \, di \right)^{1+\theta_p} \)
Firms & Price Setting

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- Demand for producer \( i \): \( Y_{it} = \left( \frac{P_{Dit}}{P_{Dt}} \right)^{-\frac{1+\theta_p}{\theta_p}} Y_t \)

- \( P_{Dt} = \left( \int_0^1 P_{Dit}^{-\frac{1}{\theta_p}} \, di \right)^{-\theta_p} \)
Firms & Price Setting

- Final output:  \( Y_t = \left( \int_0^1 Y_{it}^{\frac{1}{1+\theta_p}} \, di \right)^{1+\theta_p} \)

- Demand for producer \( i \):  \( Y_{it} = \left( \frac{P_{Dit}}{P_{Dt}} \right)^{-\frac{1+\theta_p}{\theta_p}} Y_t \)
  
  \( P_{Dt} = \left( \int_0^1 P_{Dit}^{-\frac{1}{\theta_p}} \, di \right)^{-\theta_p} \)

- Production function:  \( Y_{it} = K_{it}^\alpha L_{it}^{1-\alpha} \)
  
  \( (\text{real}) \text{ labor and capital rental rates} \ W_t / P_t, Z_t \)
Firms & Price Setting

- Final output: $Y_t = \left( \int_0^1 Y_{it}^{\frac{1}{1+\theta_p}} \, di \right)^{1+\theta_p}$

- Demand for producer $i$: $Y_{it} = \left( \frac{P_{Dt}}{P_{Dit}} \right)^{-\frac{1+\theta_p}{\theta_p}} Y_t$
  
  - $P_{Dt} = \left( \int_0^1 P_{Dit}^{-\frac{1}{\theta_p}} \, di \right)^{-\theta_p}$

- Production function: $Y_{it} = K_{it}^\alpha L_{it}^{1-\alpha}$
  
  - (real) labor and capital rental rates $W_t/P_t, \ Z_t$

- Price set optimally w/ prob. $1 - \xi_p$
Objective:

\[
\max_{\{I_{t+j}\}_{j=0}^\infty} \mathbb{E}_t \left\{ \sum_{j=0}^{\infty} \Lambda_{t,t+j} \left[ q_{t+j} I_{t+j} - \frac{P_{Dt+j}}{P_{t+j}} \phi_{I_{t+j}} \right] \right\}
\]
Objective:

\[ \max \left\{ \{l_{t+j}\}_{j=0}^{\infty} \right\} \mathbb{E}_t \left\{ \sum_{j=0}^{\infty} \Lambda_{t,t+j} \left[ q_{t+j}l_{t+j} - \frac{P_{D,t+j}}{P_{t+j}} \phi_{l,t+j} \right] \right\} \]

where

\[ \phi_{l,t} = \frac{\psi_I}{2} \left( \frac{l_t}{l_{t-1}} - 1 \right)^2 l_t \]

\[ l_t = \left[ (1 - \omega) \frac{\rho}{1+\rho} l_D^{\frac{\rho}{1+\rho}} + \omega \frac{\rho}{1+\rho} (\phi_{l,t} M_l) l_l^{\frac{1+\rho}{1+\rho}} \right]^{1+\rho} \]
Objective:

\[
\max_{\{I_{t+j}\}_{j=0}^{\infty}} \mathbb{E}_t \left\{ \sum_{j=0}^{\infty} \Lambda_{t, t+j} \left[ q_{t+j} I_{t+j} - \frac{P_{Dt+j}}{P_{t+j}} \phi_{I_{t+j}} \right] \right\}
\]

where

\[
\phi_{I_t} = \frac{\psi_{I_t}}{2} \left( \frac{I_t}{I_{t-1}} - 1 \right)^2 I_t
\]

\[
I_t = \left[ \left( 1 - \omega \right)^{\frac{\rho}{1+\rho}} I_{Dt}^{\frac{1}{1+\rho}} + \omega^{\frac{\rho}{1+\rho}} \left( \phi_{I_t} M_{I_t} \right)^{\frac{1}{1+\rho}} \right]^{1+\rho}
\]

Import adjustment cost: \( \varphi_{I_t} = 1 - \frac{\varphi_M}{2} \left( \frac{M_{I_t}/I_{Dt}}{M_{I_{t-1}}/I_{Dt-1}} - 1 \right)^2 \)
The Foreign Economy

- U.S. household’s objective

\[
\max \mathbb{E}_t \sum_{j=0}^{\infty} \beta^* j \left[ \log \left( C_{t+j}^* - h C_{t+j-1}^* \right) - \frac{L_{it+j}^* (1 + \chi)}{1 + \chi} \right]
\]

subject to

\[
P_t^* C_t^* + B_t^* + P_t^* D_t^* \leq W_{it}^* L_{it}^* + R_{t-1}^* B_t^* + P_t^* \frac{R_{t-1}^*}{1 + \tau} D_{t-1}^* + \Pi_t^* + W_{it}^* \quad \forall t
\]
The Foreign Economy

- U.S. household’s objective

\[
\max \left\{ C_{t+j}, M_{t+j}, C_{t+j}, D_{t+j}, B_{t+j}, W_{it+j}, L_{it+j} \right\}_{j=0}^{\infty} \mathbb{E}_t \sum_{j=0}^\infty \beta^j \left[ \log \left( C_{t+j}^* - hC_{t+j-1}^* \right) - \frac{L_{it+j}}{1 + \chi} \right]
\]

subject to

\[
P_t^* C_t^* + B_t^* + P_t^* D_t^* \leq W_{it}^* L_{it}^* + R_{t-1}^* B_t^* + P_t^* \frac{R_{t-1}^*}{1 + \tau} D_{t-1}^* + \Pi_t^* + W_{it}^* \quad \forall t
\]

- Nominal rigidities, investment and trade adj. costs as in the home economy
Market Clearing and Monetary Policy

- Market clearing for home good:

\[ Y_t = C_{Dt} + I_{Dt} + \frac{\xi^*}{\xi} \left( M^*_{Ct} + M^*_{It} \right) + \phi_{It} \]

rel. foreign population size
Market Clearing and Monetary Policy

- Market clearing for home good:

\[ Y_t = C_{Dt} + I_{Dt} + \frac{\xi^*}{\xi} (M^*_C + M^*_I) + \phi_{It} \]

rel. foreign population size

- Evolution of aggregate capital stock

\[ K_{t+1} = (1 - \delta)K_t + I_t \]

\[ = \int S_{it} \, di \]
Market Clearing and Monetary Policy

- Market clearing for home good:

\[ Y_t = C_{Dt} + I_{Dt} + \frac{\xi^*}{\xi} (M^*_{Ct} + M^*_{It}) + \phi_{lt} \]

rel. foreign population size

- Evolution of aggregate capital stock

\[ K_{t+1} = (1 - \delta)K_t + I_t \]

\[ = \int S_{it} \, di \]

- Balance of payments:

\[ Q_t (D^*_t - R^*_t D^*_{t-1}) = C_t + I_t + \frac{P_{Dt}}{P_t} \phi_{lt} - \frac{P_{Dt}}{P_t} Y_t \]
Market Clearing and Monetary Policy

- Market clearing for home good:
  \[ Y_t = C_{Dt} + I_{Dt} + \left( \frac{\xi^*}{\xi} \left( M_{Ct}^* + M_{It}^* \right) \right) + \phi_{It} \]
  rel. foreign population size

- Evolution of aggregate capital stock
  \[ K_{t+1} = (1 - \delta)K_t + I_t \]
  \[ = \int S_{it} \, di \]

- Balance of payments:
  \[ Q_t \left( D_t^* - R_t^* D_{t-1}^* \right) = C_t + I_t + \frac{P_{Dt}}{P_t} \phi_{It} - \frac{P_{Dt}}{P_t} Y_t \]

- Baseline home policy rule:
  \[ R_{t+1}^n = \left( R_t^n \right)^{\gamma_r} \left( \beta^{-1} \pi_t^{\gamma_{\pi}} \right)^{1-\gamma_r} \varepsilon_t^r, \quad \pi_t = P_{Dt}/P_{Dt-1} \]
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Source</th>
</tr>
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<tbody>
<tr>
<td>Home discount factor</td>
<td>$\beta$</td>
<td>0.9925</td>
<td>3% real rate (Carrillo et al.’17)</td>
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<td>U.S. discount factor</td>
<td>$\beta^*$</td>
<td>0.9950</td>
<td>2% real rate (Holston-Laubach-Williams’17)</td>
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<td>Habit parameter</td>
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<td>Justiniano-Primiceri-Tambalotti’10</td>
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<td>Inverse Frisch elasticity of labor supply</td>
<td>$\chi$</td>
<td>3.79</td>
<td>Justiniano-Primiceri-Tambalotti’10</td>
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<tr>
<td>Trade openness, home</td>
<td>$\omega$</td>
<td>0.2</td>
<td>20% GDP export share</td>
</tr>
<tr>
<td>Trade openness, foreign</td>
<td>$\omega^*$</td>
<td>0.2/3</td>
<td></td>
</tr>
<tr>
<td>Relative home size</td>
<td>$\xi/\xi^*$</td>
<td>1/3</td>
<td></td>
</tr>
<tr>
<td>Trade price elasticity</td>
<td>$(1 + \rho)/\rho$</td>
<td>1.5</td>
<td>Hooper et al.’00, McDaniel-Balistreri’03</td>
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<td>Trade adjustment cost parameter</td>
<td>$\varphi_M$</td>
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<tr>
<td>Capital share</td>
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<td>Capital depreciation</td>
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<td>Prob. of keeping price fixed</td>
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<td>Price indexation</td>
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<td>Prob. of keeping wage fixed</td>
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<td>Wage markup</td>
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<td>Investment adjustment cost parameter</td>
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<td>Home Taylor rule coefficients</td>
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<td>$\gamma_{\pi}$</td>
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<td>U.S. Taylor rule coefficients</td>
<td>$\gamma_r^*$</td>
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<td>U.S. monetary shock persistence</td>
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<td>U.S. monetary shock standard deviation</td>
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<td>Bank fraction divertable</td>
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<td>{leverage = 5, $QD^*/D = 0.3$}</td>
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<td>Bank transfer rate</td>
<td>$\xi_b$</td>
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<td>Home bias in bank funding</td>
<td>$\gamma$</td>
<td>2.58</td>
<td>credit spread = 200 bps }</td>
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Accounting for spillovers on domestic activity

- From market clearing,

\[
\hat{y}_t = \alpha_{cy} \hat{c}_t + (1 - \alpha_{cy}) \hat{i}_t + \omega (\hat{m}^*_t - \hat{m}_t)
\]

where \(\alpha_{cy} = 0.77\), and

\[
\hat{m}^*_t = \alpha_{cy} \hat{m}^*_{ct} + (1 - \alpha_{cy}) \hat{m}^*_{it}
\]

\[
\hat{m}_t = \alpha_{cy} \hat{m}_{ct} + (1 - \alpha_{cy}) \hat{m}_{it}
\]
Figure: U.S. Monetary Tightening in a Frictionless Economy
Figure: U.S. Monetary Tightening in a Frictionless Economy

- **Real Exchange Rate**: Showing home depreciation.
- **Exports** and **Imports**: Graphs depicting changes over time.
- **Real Interest Rate**, **Policy Rate**, **Fed funds rate**: Graphs showing percentage changes over time with annotations for different models.

Additional notes: Frictionless model, Exp.-switching (h → 1, φ_I → ∞), Exp.-reducing (φ_M → ∞).
Figure: U.S. Monetary Tightening in a Frictionless Economy

- **Real Exchange Rate**
- **Exports**
- **Imports**
- **Output**
- **Investment**
- **Consumption**
- **U.S. Output**
- **U.S. Investment**
- **U.S. Consumption**
- **Real Interest Rate**
- **Policy Rate**
- **Fed funds rate**

Legend:
- Frictionless model
- Exp.-switching ($h \to 1, \phi_I \to \infty$)
- Exp.-reducing ($\phi_M \to \infty$)
Figure: U.S. Monetary Tightening in a Frictionless Economy

- **Real Exchange Rate**: Home depreciation
- **Exports**: Green line (Frictionless model) compared to red and blue dashed lines (Exp.-switching and Exp.-reducing)
- **Imports**: Green line (Frictionless model) compared to red and blue dashed lines (Exp.-switching and Exp.-reducing)
- **Output**: Green line (Frictionless model) compared to red and blue dashed lines (Exp.-switching and Exp.-reducing)
- **Investment**: Green line (Frictionless model) compared to red and blue dashed lines (Exp.-switching and Exp.-reducing)
- **Consumption**: Green line (Frictionless model) compared to red and blue dashed lines (Exp.-switching and Exp.-reducing)
- **U.S. Output**: Green line (Frictionless model) compared to red and blue dashed lines (Exp.-switching and Exp.-reducing)
- **U.S. Investment**: Green line (Frictionless model) compared to red and blue dashed lines (Exp.-switching and Exp.-reducing)
- **U.S. Consumption**: Green line (Frictionless model) compared to red and blue dashed lines (Exp.-switching and Exp.-reducing)
- **Real Interest Rate**: Green line (Frictionless model) compared to red and blue dashed lines (Exp.-switching and Exp.-reducing)
- **Policy Rate**: Green line (Frictionless model) compared to red and blue dashed lines (Exp.-switching and Exp.-reducing)
- **Fed funds rate**: Green line (Frictionless model) compared to red and blue dashed lines (Exp.-switching and Exp.-reducing)
Imperfect Financial Markets

\[
\hat{n}_t \approx \sigma_b \left\{ \phi \left[ \left( \hat{r}_{kt} - \hat{r}_{t-1} \right) \approx \Delta \hat{q}_t \right] - x \left( \hat{r}^*_{t-1} + \Delta \hat{Q}_t - \hat{r}_{t-1} \right) \right\} + \hat{r}_{t-1} + \hat{n}_{t-1}
\]

\[
\hat{Q}_t \approx \Gamma \left( E_t \left\{ \hat{r}_{kt+1} \right\} - \hat{r}_t \right) + \hat{r}^*_t - \hat{r}_t + E_t \left\{ \hat{Q}_{t+1} \right\}
\]

where \( \phi = \frac{\text{assets}}{\text{net worth}} = 5, \ x = \frac{\text{dollar debt}}{\text{assets}} = 0.18, \ \Gamma = 0.5 \)
Imperfect Financial Markets

\[ \hat{n}_t \approx \sigma_b \left\{ \phi \left( \frac{\hat{r}_{kt} - \hat{r}_{t-1}}{\Delta \hat{q}_{t}} \right) - x \left( \hat{r}_{t-1} + \Delta \hat{Q}_t - \hat{r}_{t-1} \right) \right\} + \hat{r}_{t-1} + \hat{n}_{t-1} \]

\[ \hat{Q}_t \approx \Gamma \left( \mathbb{E}_t \{ \hat{r}_{kt+1} \} - \hat{r}_t \right) + \hat{r}_t^* - \hat{r}_t + \mathbb{E}_t \{ \hat{Q}_{t+1} \} \]

where \( \phi = \frac{\text{assets}}{\text{net worth}} = 5, \quad x = \frac{\text{dollar debt}}{\text{assets}} = 0.18, \quad \Gamma = 0.5 \)

- Given \( Q_t \), feedback between \( q_t \) and \( N_t \) (standard financial accelerator)
- Given \( q_t \), feedback between \( Q_t \) and \( N_t \)
Figure: U.S. Monetary Tightening with Imperfect Financial Markets

Net worth

Credit Spread*

Currency Premium**

Real Exchange Rate

Exports

Imports

Tobin’s q

Investment

Consumption

Output

U.S. Output

Fed funds rate

Baseline model
Frictionless model
No dollar debt (→ \( \Gamma = 0 \))

\[^*\mathbb{E}_t \left( \sum_{i=1}^{20} r_{kt+i} - r_{t+i-1} \right) / 5\]

\[^**\mathbb{E}_t \left( \sum_{i=0}^{19} r_{t+i} - \left( r_{t+i}^* + \Delta \hat{Q}_{t+1+i} \right) \right) / 5\]
Figure: U.S. Monetary Tightening with Imperfect Financial Markets

Net worth
Credit Spread*
Currency Premium**
Real Exchange Rate
Exports
Imports
Tobin's q
Investment
Consumption
Output
U.S. Output
Fed funds rate

Baseline model
Frictionless model
No dollar debt (→ $\Gamma=0$)

* $E_t \left( \sum_{i=1}^{20} r_{kt+i} - r_{t-1} \right) / 5$

** $E_t \left( \sum_{i=0}^{19} r_{t+i} - \left( r_{t+i}^* + \Delta \hat{Q}_{t+1+i} \right) \right) / 5$
Dominant Currency Pricing

- **Dominant Currency Paradigm (DCP)** (Casas, Díez, Gopinath, Gourinchas & Plagborg-Møller 2017): outsized role of the dollar as trade invoicing currency
  - Evidence: Goldberg & Tille (2008), Gopinath et al. (2018)
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- We consider monetary spillovers under **DCP**
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- We consider monetary spillovers under **DCP**
  - U.S. exporters continue to practice PCP $\rightarrow P_{Mt} = e_t P_{Dt}^*$
Dominant Currency Pricing

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  - Evidence: Goldberg & Tille (2008), Gopinath et al. (2018)

- We consider monetary spillovers under **DCP**
  - U.S. exporters continue to practice PCP $\rightarrow P_{Mt} = e_t P_{Dt}^*$
  - Each EM firm $j$ sets dollar price $P_{Mt}^*(j)$, s.t. Calvo friction
Figure: U.S. Monetary Tightening with Imperfect Financial Markets and DCP

\[ E_t \left( \sum_{i=1}^{20} r_{kt+i} - r_{t+i-1} \right) / 5 \]

\[ E_t \left( \sum_{i=0}^{19} r_{t+i} - \left( r^*_t + \Delta \hat{Q}_{t+1+i} \right) \right) / 5 \]
**Figure**: U.S. Monetary Tightening with Imperfect Financial Markets and DCP

\[ *E_t \left( \sum_{i=1}^{20} r_{kt+i} - r_{t+i-1} \right) / 5 \]

\[ **E_t \left( \sum_{i=0}^{19} r_{t+i} - (r_{t+i}^* + \Delta \hat{Q}_{t+1+i}) \right) / 5 \]
**Figure:** U.S. Monetary Tightening with Imperfect Financial Markets and DCP

\[ \mathbb{E}_t \left( \sum_{i=1}^{20} r_{kt+i} - r_{t+i-1} \right) / 5 \]

\[ \mathbb{E}_t \left( \sum_{i=0}^{19} r_{t+i} - \left( r_{t+i}^* + \Delta \hat{Q}_{t+1+i} \right) \right) / 5 \]
Figure: SVAR prediction of effects of 1 percent rise in federal funds rate

Note: Shaded areas represent 95% confidence bands. EM GDP refers to an aggregate of emerging markets’ GDP and AE GDP refers to an aggregate of advanced economies’ GDP (other than the United States). 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 spread, the trade-weighted dollar, AE GDP, and EM GDP. Sample: 1970:I-2008:IV.
Should EM central banks respond to exchange rates?

Generalized policy rule:

\[ R_n = (R_n - 1)\gamma_r (1 - \gamma_e e_t (e_t / e)\gamma_e 1 - \gamma_e) \]

\( \gamma_e \in [0,1] \)

Nests strict inflation targeting (\( \gamma_e = 0 \)) and exchange rate peg (\( \gamma_e = 1 \))

\( \gamma_e \) governs weight on exchange rate stabilization
Should EM central banks respond to exchange rates?

Generalized policy rule:

$$R_n^t = \left( R_{n-1}^t \right)^{\gamma_r} \left( \frac{1}{\beta} \pi_t \frac{1-\gamma_e}{\gamma_e} \left( \frac{e_t}{e} \right) \frac{\gamma_e}{1-\gamma_e} \right)^{1-\gamma_r} \epsilon_t^r, \quad \gamma_e \in [0, 1]$$

- Nests strict inflation targeting ($\gamma_e = 0$) and exchange rate peg ($\gamma_e = 1$)
- $\gamma_e$ governs weight on exchange rate stabilization
**Figure:** Exchange Rate Regimes and Welfare

**Note:** Welfare losses associated with monetary regime $\gamma_e$ relative to $\gamma_e = 0$, expressed as percent of quarterly consumption, in the frictionless model (left panel) and in the baseline model with frictions (right panel). Vertical lines mark the welfare-maximizing $\gamma_e$, denoted $\gamma_e^*$. 
Figure: Exchange Rate Regimes and Welfare

Frictionless model

Baseline model

Note: Welfare losses associated with monetary regime $\gamma_e$ relative to $\gamma_e = 0$, expressed as percent of quarterly consumption, in the frictionless model (left panel) and in the baseline model with frictions (right panel). Vertical lines mark the welfare-maximizing $\gamma_e$, denoted $\gamma_e^*$. 
Figure: Exchange Rate Regimes and Volatility

- \( \sigma(Y_t) \)
- \( \sigma(\pi_t) \)
- \( \sigma(\pi_{wl}) \)
- \( \sigma(\pi_{cd}) \)
- \( \sigma(\Delta e_t) \)
- \( \sigma(Q_t) \)

\( \hat{\gamma}_e \)

Baseline model
Frictionless model
Figure: Effects of Domestic Monetary Tightening

- **Net worth**
- **Credit Spread**
- **Currency Premium**

- **Real Exchange Rate**
  - home depreciation

- **Nominal Exchange Rate**
  - home depreciation

- **Exports**

- **Investment**

- **Output**

- **Home policy rate**
  - Baseline model
  - Frictionless model

Interest differentials & expected depr.
Figure: Effects of U.S. Tightening under Different Exchange-Rate Regimes

Frictionless

Output
Nominal exchange rate
Nominal policy rate

Baseline model

Output
Nominal exchange rate
Nominal policy rate

\( \gamma_e = 0.05 \)
\( \gamma_e = 0.40 \)
An Economy with High Financial Fragility
An Economy with High Financial Fragility

Figure: Domestic Tightening with High Financial Fragility

- Net worth
- Tobin’s q
- Currency premium
- Nominal exchange rate

- Baseline model
- High financial fragility

Evidence: Gould & Kamin (2001)
An Economy with High Financial Fragility

Figure: Domestic Tightening with High Financial Fragility

→ rise in currency premium initially offsets standard UIP effect
→ short-run depreciation following domestic monetary tightening

Evidence: Gould & Kamin (2001)
Figure: Effects of U.S. Tightening under Different Exchange-Rate Regimes

Frictionless

Baseline model

High financial fragility

Output
Nominal exchange rate
Nominal policy rate

output
Nominal exchange rate
Nominal policy rate

ratio
Nominal exchange rate
Nominal policy rate

ratio
Exchange Rate Policy and Banks’ Portfolio Choice

- From banks’ portfolio problem,

\[ x_t = f \left( \frac{\mathbb{E}_t \left\{ \Omega_{Bt,t+1} (R_t - R^*_t \frac{Q_{t+1}}{Q_t}) \right\}}{\mathbb{E}_t \left\{ \Omega_{Bt,t+1} (R_{Kt+1} - R_t) \right\}} \right) \]

\[ f' > 0 \]

\[ x_t = \text{dollar liabilities} / \text{total assets} \]
\[ \Omega_{Bt} = \text{banker’s SDF} \]

- \( \mathbb{E}(x_t) \) related positively with \( \text{Cov}(\Omega_{Bt}, R_{t-1} - R^*_{t-1} \frac{Q_t}{Q_{t-1}}) \) and inversely with \( \text{Cov}(\Omega_{Bt}, R_{Kt} - R_{t-1}) \)
Figure: Exchange Rate Regimes and Liability Dollarization

\[ E(x_t) \]

\[ \times 10^{-4} \text{Cov}(\Omega_{Bt}, R_{t-1} - R_{t-1}^* \bar{Q}_t/\bar{Q}_{t-1}) \]

\[ \text{Cov}(\Omega_{Bt}, R_{Kt} - R_{t-1}) \]
Figure: Financial Variables' Response to U.S. Tightening under Different Exchange Rate Regimes

- **Net worth $N_t$**
- **Bankers' SDF $\Omega_{B_t}$**
- **Real exchange rate $Q_t$**
- **Ex-post return $R_{K_t}$**
- **Domestic real rate $R_t$**
- **U.S. real rate $R_t^*$**

For $\gamma_e = 0.05$ and $\gamma_e = 0.75$.
Exchange Rates and Credit Spreads: Some Evidence
From the optimal portfolio condition,

\[ Q_t = \gamma (\mathbb{E}_t \{ r_{kt+1} \} - r_t) + r^*_t - r_t + \mathbb{E}_t \{ Q_{t+1} \} \]
From the optimal portfolio condition,

\[ Q_t = \gamma \left( \mathbb{E}_t \{ r_{kt+1} \} - r_t \right) + r^*_t - r_t + \mathbb{E}_t \{ Q_{t+1} \} \]

Iterate forward \( T \) periods

\[ Q_t = \gamma \sum_{j=1}^{T} \mathbb{E}_t \{ r_{kt+j} - r_{t+j-1} \} + \sum_{j=1}^{T} \mathbb{E}_t \{ r^*_t - r_t \} + \sum_{j=1}^{T} \mathbb{E}_t \{ Q_{t+T+1} \} \]

\( \equiv s_t \)

\( \equiv r^\text{diff}_t \)
From the optimal portfolio condition,

\[ Q_t = \gamma (\mathbb{E}_t \{ r_{kt+1} \} - r_t) + r^*_t - r_t + \mathbb{E}_t \{ Q_{t+1} \} \]

Iterate forward \( T \) periods

\[ Q_t = \gamma \sum_{j=1}^{T} \mathbb{E}_t \{ r_{kt+j} - r_{t+j-1} \} + \sum_{j=1}^{T} \mathbb{E}_t \{ r^*_{t+j-1} - r_{t+j-1} \} + \mathbb{E}_t \{ Q_{t+T+1} \} \]

\[ \equiv s_t \]

\[ \equiv r_{t}^{\text{diff}} \]

Assume \( Q_t = f_t + \hat{Q}_t \rightarrow \mathbb{E}_t \{ \hat{Q}_{t+T+1} \} \approx 0 \) if \( T \) large

deterministic time trend
From the optimal portfolio condition,

\[ Q_t = \gamma \left( \mathbb{E}_t \{ r_{kt+1} \} - r_t \right) + r_t^* - r_t + \mathbb{E}_t \{ Q_{t+1} \} \]

Iterate forward \( T \) periods

\[ Q_t = \gamma \sum_{j=1}^{T} \mathbb{E}_t \{ r_{kt+j} - r_{t+j-1} \} + \sum_{j=1}^{T} \mathbb{E}_t \{ r_{t+j-1}^* - r_{t+j-1} \} + \mathbb{E}_t \{ Q_{t+T+1} \} \]

\[ \equiv s_t \]

\[ \equiv r_t^{\text{diff}} \]

Assume \( Q_t = f_t + \hat{Q}_t \rightarrow \mathbb{E}_t \{ \hat{Q}_{t+T+1} \} \approx 0 \) if \( T \) large

Then,

\[ Q_t = \gamma s_t + r_t^{\text{diff}} + f_{t+T+1} \]
From the optimal portfolio condition,

\[ Q_t = \gamma \left( \mathbb{E}_t \{ r_{kt+1} \} - r_t \right) + r^*_t - r_t + \mathbb{E}_t \{ Q_{t+1} \} \]

Iterate forward \( T \) periods

\[ Q_t = \gamma \sum_{j=1}^{T} \mathbb{E}_t \{ r_{kt+j} - r_{t+j-1} \} + \sum_{j=1}^{T} \mathbb{E}_t \{ r^*_{t+j-1} - r_{t+j-1} \} + \mathbb{E}_t \{ Q_{t+T+1} \} \equiv s_t \quad \text{and} \quad \equiv r^\text{diff}_t \]

Assume \( Q_t = f_t + \hat{Q}_t \rightarrow \mathbb{E}_t \{ \hat{Q}_{t+T+1} \} \approx 0 \) if \( T \) large
deterministic time trend

Then,

\[ Q_t = \gamma s_t + r^\text{diff}_t + f_{t+T+1} \]

Observables: \( s_t = \frac{T}{12} \left( r^\text{corp}_t - r^\text{gov}_t \right) \), \( r^\text{diff}_t = \frac{T}{12} \left( r^\ast_t - r^\text{gov}_t \right) \)
Table: Empirical exchange rate equation: Level specification

<table>
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<tr>
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<td></td>
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</tr>
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<td>VIX/100</td>
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Note: Dependent variable: Monthly bilateral real exchange rate against the United States. Regressions estimated by OLS. Standard errors shown in parentheses, computed using the Newey-West adjustment. ***, **, and * denote significance at the 1, 5, and 10 percent levels. Sample: 1995:5–2018:9. The baseline regression equation (column (2)) is

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

$Q_t$ is the log real bilateral exchange rate against the dollar. $s_t$ is the AA-3-year corporate bond spread and $r_t^{diff}$ is the 3-year government bond yield differential between the U.S. and Korea, both multiplied times $T/12$ ($T = 36$ months).
**Table: Empirical exchange rate equation: Level specification**

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**Note:** Dependent variable: Monthly bilateral real exchange rate against the United States. Regressions estimated by OLS. Standard errors shown in parentheses, computed using the Newey-West adjustment. ***, **, and * denote significance at the 1, 5, and 10 percent levels. Sample: 2006:7–2018:10 (Brazil), 2000:8–2018:10 (Mexico). The baseline regression equation (column (2)) is

\[
Q_t = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + \beta_s s_t + \beta_r r_{t}^{\text{diff}} + \varepsilon_t
\]

with \(\alpha_2 = 0\) for Mexico. \(Q_t\) is the log real bilateral exchange rate against the dollar. \(s_t\) is the 5-year BBB corporate bond spread and \(r_{t}^{\text{diff}}\) is the 5-year government bond yield differential between the U.S. and the respective country, both multiplied times \(T/12\) (\(T = 60\) months).
Table: Empirical exchange rate equation: First-difference specification

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Note: Dependent variable: log of change in monthly bilateral real exchange rate against the United States. Regressions estimated by OLS. Standard errors shown in parentheses, computed using the Newey-West adjustment. ***, **, and * denote significance at the 1, 5, and 10 percent levels. Sample: 1995:6–2018:9. The baseline regression equation (column (2)) is

\[ Q_t = \alpha_0 + \beta_s \Delta s_t + \beta_r \Delta r_t^{diff} + \epsilon_t \]

\( Q_t \) is the log real bilateral exchange rate against the dollar. \( s_t \) is the AA-3-year corporate bond spread and \( r_t^{diff} \) is the 3-year government bond yield differential between the U.S. and Korea, both multiplied times \( T/12 \) (\( T = 36 \) months).
### Table: Empirical exchange rate equation: First-difference specification

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**Note:** Dependent variable: log of change in monthly bilateral real exchange rate against the United States. Regressions estimated by OLS. Standard errors shown in parentheses, computed using the Newey-West adjustment. ***, **, and * denote significance at the 1, 5, and 10 percent levels. Sample: 1 2006:8–2018:10 (Brazil), 2000:9–2018:10 (Mexico). The baseline regression equation (column (2)) is

$$
\Delta Q_t = \alpha_0 + \alpha_1 t + \beta_s \Delta s_t + \beta_r \Delta r^{\text{diff}}_t + \varepsilon_t
$$

with $\alpha_1 = 0$ for Mexico. $Q_t$ is the log real bilateral exchange rate against the dollar. $s_t$ is the 5-year BBB corporate bond spread and $r^{\text{diff}}_t$ is the 5-year government bond yield differential between the U.S. and the respective country, both multiplied times $T/12$ ($T = 60$ months).
Next Steps

- Global banks
- Foreign reserves & interventions in foreign exchange
- Government debt
Appendix
Figure: Negative $\xi$ shock in the extended model with household participation in forex (s.t. transaction cost $\frac{\kappa}{2} (Q_t D^*_{Ht})$).

Note: Effects of lower bank equity in the extended model, for high (orange dashed line) and low (yellow dotted line) value of the participation cost parameter $\kappa$. The blue solid line shows the effects without household participation. Parameters: $\beta = 0.9925, \beta^* = 0.995, \gamma = 0.5, \theta = 0.18, \xi = 0.20, \chi_m = \chi_x = 1$. 

back
Figure 5. FX market turnover
(in percent of GDP, 2016)

Sources: BIS.

(from Gopinath'19)
**SVAR**


- **Sample**: 1970:I-2008:IV.

- **EM GDP**: Argentina, Botswana, Brazil, Chile, China, Colombia, Ecuador, El Salvador, Hong Kong, India, Indonesia, Israel, Jordan, Korea, Malaysia, Mexico, Peru, Philippines, Singapore, South Africa, Taiwan, Thailand, Turkey, and Venezuela.

- **AE GDP**: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.
Interest differentials and expected depreciation

Figure: Home Monetary Tightening

$r^n_t$

$r^{n*}_t$

$E_t(\Delta e_{t+1})$

$e_t$

$\varepsilon^r_t$

home appreciation

back
Table 5: Empirical exchange rate equation: Level specification: 5-Year Yields

<table>
<thead>
<tr>
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<th>Canada</th>
<th>EA</th>
<th>Japan</th>
<th>UK</th>
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<td>(3) (4)</td>
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<td>1.38***</td>
<td>1.38***</td>
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<td>(0.24)</td>
<td>(0.24)</td>
<td>(0.24)</td>
<td>(0.24)</td>
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<tr>
<td>Corp. spread</td>
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<td>−0.44</td>
<td>−0.59**</td>
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### Table 6: Empirical exchange rate equation: First-difference specification: 5-Year Yields

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<td>0.42*** (0.08)</td>
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Foreign currency debt as a percentage of total debt, non-government sectors

Source: Chui, Kuruc and Turner (2016)