Exchange Rate Stabilization and Monetary Transmission

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Motivation: Does FX Stabilization Constrain Monetary Policy?

- Mundellian trilemma — Mundell (63)
  - Cannot have all three: capital flows, **independent MP**, **stable FX**
  - Conventional advice: **float** to preserve monetary autonomy
- **In practice**: EMEs routinely *manage* their currency — Ilzetzki et al. (19)
  - Managed floats, crawling pegs, FX intervention; few true floats
- **This paper**: when & why can FX stabilization help MP effectiveness?

  $\Longrightarrow$ A theory of transmission in shallow financial markets

FX Stabilization Deepens Markets and Strengthens Transmission

- Financial markets in EMEs are shallow
  - Scarce local arbitrage capital, binding risk limits
  - **Inelastic** arbitrage demand $\implies$ weak transmission
- FX stability attracts **outside capital**
  - Foreign investors dislike FX risk ; entry absorbs domestic risk
  - Relaxes limits $\implies$ demand more elastic $\implies$ stronger transmission
- **Normative**: some stabilization is *always* optimal
  - Stable FX $\implies$ monetary autonomy : reverses Mundell
  - But a hard peg backfires (raises $\mathbb{V}[i]$) $\implies$ inverted U-shape

Selected Related Literature

- **Trilemma & FX policy** (Mundell 63; Fleming 62; Basu et al. 23; Caballero & Simsek 25)
  - **Short-rate disconnect in EMEs** (De Leo, Gopinath & Kalemli-Ozcan 25)
  - **FX stabilization draws in foreign capital** (Hassan, Mertens & Zhang 23)

  $\rightarrow$ *FX stabilization strengthens transmission, overturning the trilemma*

- **Frictional asset markets**
  - Segmented : bonds (Vayanos & Vila 21), FX (Gabaix & Maggiori 15; Itskhoki & Mukhin 23)
  - Binding risk/leverage limits (Geanakoplos 10)
  - Inelastic markets (De Long et al. 90; Gabaix & Koijen 23); fire sales (Kiyotaki & Moore 97)

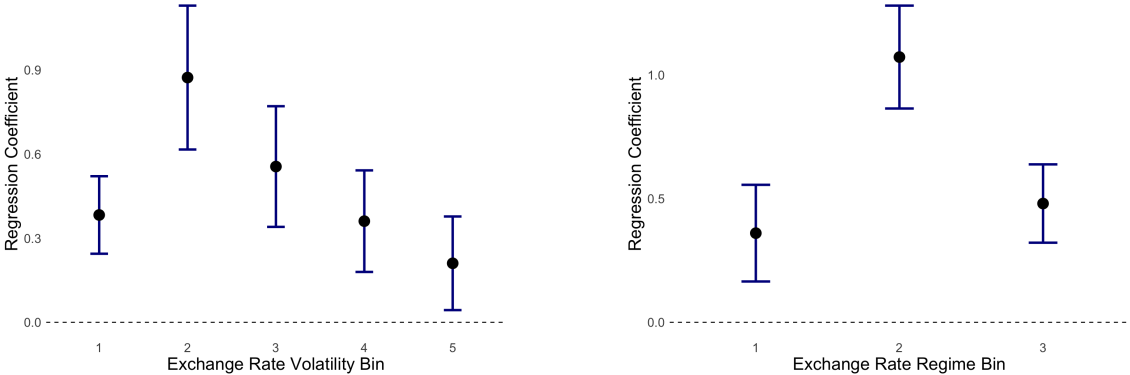
  $\rightarrow$ *Binding constraints* $\Rightarrow$ *inelastic arbitrage* $\Rightarrow$ *weaker transmission*

Additional Literature

Outline

1. Motivating Evidence
2. Model
3. Optimal FX Policy

Transmission to Market Rates Peaks at Intermediate FX Volatility



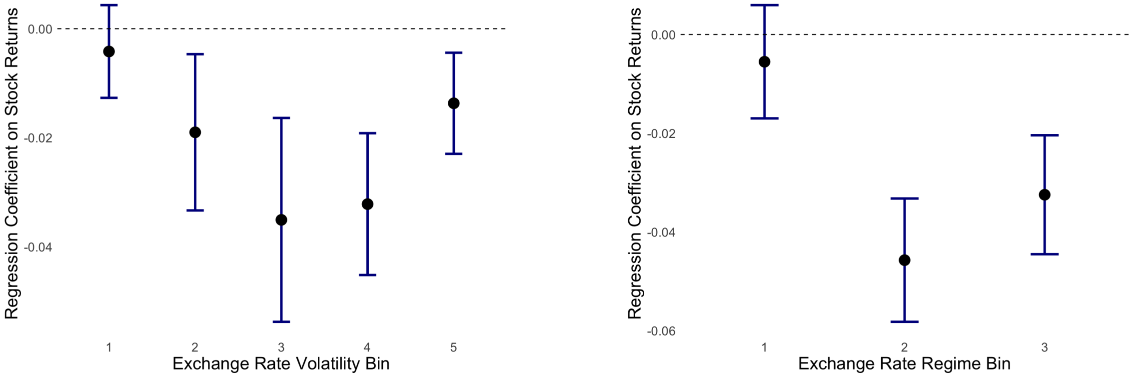
(a) Exchange rate volatility

(b) Exchange rate regime

Regressing Δr^{3m} on Δi

▸ Regression ▸ Robustness ▸ i-volatility ▸ FX Regime Classification ▸ U-shape theory ▸ Macro Outcomes Vol

The Same Pattern Appears in Stock Returns



(a) Exchange rate volatility

(b) Exchange rate regime

Regressing Δy^{stock} on Δi

▸ Robustness ▸ i-volatility ▸ FX Regime Classification ▸ U-shape theory ▸ Macro Outcomes Vol ▸ Brazil

Outline

1. Motivating Evidence
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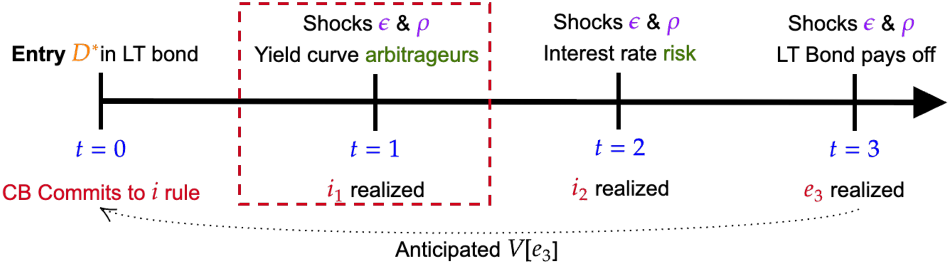
The Central Bank Steers Activity Through the Long-Term Yield

- Focus on date 1 : central bank sets the policy rate i_1
- Wants to control the long-term yield r
  - Proxy for financial conditions that drive activity
  - $P_1 = (1+r)^{-2}$, so in logs $p_1 \approx -2r$
- Long bond in fixed supply $B = e^b$
  - Absorbed by **local arbitrageurs** and international investors



OLG Setup

CB: Policy Rule Responds to Internal and FX Shocks

- Economy hit by two shocks:
  - Aggregate demand shocks ρ_t
  - Country risk-premium shocks ϵ_t
- Exchange rate e_t set by UIP $\quad (e \uparrow \iff$ appreciation):

Endogenous UIP Deviation

$$e_t - \mathbb{E}_t[e_{t+1}] = \underbrace{i_t - i_t^*}_{\text{Interest differential}} - \underbrace{(\psi + \epsilon_t)}_{\text{UIP wedge}}$$

- Central bank commits *ex-ante* to an interest-rate rule:

$$i_t = \bar{i} + \kappa_r \rho_t + \kappa_e \epsilon_t \implies \mathbb{V}[e_t] = \kappa_r^2 \sigma_\rho^2 + (1 - \kappa_e)^2 \sigma_\epsilon^2$$

- **Mundell**: $\kappa_e = 0$

Lower FX Volatility Attracts More Foreign Capital

- Risk-averse (γ) international investors buy local-currency bonds
  - Value returns in dollars $\implies$ dislike FX risk σ_e^2
  - Enter endogenously (heterogeneous outside options)

- Mass of entrants D^* falls with FX volatility:

Response from MP

$$dD^* = -\frac{\gamma}{2}\, d\sigma_e^2$$

- Stabilizing the exchange rate $\Rightarrow$ more foreign capital

Hassan, Mertens & Zhang (23)

Constrained Arbitrageurs Clear the Market and Set the Risk Premium

- Local arbitrageurs absorb the residual log-supply $b - d^*$, wealth n
  1. CRRA, heterogeneous risk tolerance: $\tau \sim \mathcal{U}[0, \theta]$
  2. **Risk limit:** $\mathrm{var}(n_2) \leq (\overline{\sigma}^n)^2$
- Portfolio allocation (risk premium $\mathrm{RP} \equiv 2r - \bar{i} - i_1$):

$$\omega_j \sigma_i = \min\left(\overline{\sigma}^n,\ \tau_j \frac{\mathrm{RP}}{\sigma_i}\right), \qquad \bar{\Omega} \equiv \int \omega_j \, dj$$

- Equilibrium :

$$\underbrace{p_1}_{\approx -2r} = \underbrace{-\bar{i} - i_1 - \mathrm{RP}}_{\text{asset pricing}} = \underbrace{n + \log \bar{\Omega}(\mathrm{RP}) - (b - d^*)}_{\text{market clearing}}$$

Vayanos-Vila Framework FX Risk for Arbitrageurs

Monetary Transmission Is Governed by Market Elasticity

- Key object: arbitrage-demand semi-elasticity $E \equiv d\log\overline{\Omega}(\mathrm{RP})\,/\,d\mathrm{RP}$
- Differentiate the equilibrium $\Rightarrow$ pass-through:

$$\frac{dr}{di_1} = \underbrace{\frac{1}{2}}_{\text{EH}} \cdot \underbrace{\frac{1}{1+E^{-1}}}_{\text{Dampening}}$$

- A rate cut raises the price $\Rightarrow$ arbitrageurs must lever up
- They lever up only if the premium RP rises: E measures by how much
- $2r = \bar{\imath} + i_1 + \mathrm{RP}$: higher RP offsets the easing $\Rightarrow$ dampening

Deep Markets: Elastic Demand, Near-Frictionless Transmission

- **Abundant** arbitrage capital ($n \geq \bar{n}$): no arbitrageur is constrained
- Arbitrage demand is very elastic, $E = 1/\mathrm{RP}$ Gabaix & Koijen (23)
- Pass-through sits at the frictionless EH benchmark:

$$\frac{dr}{di_1} = \frac{1}{2} \cdot \frac{1}{1 + \mathrm{RP}} \approx \frac{1}{2}$$

  - Foreign capital d^* has only a *level* effect Hassan, Mertens & Zhang (23)

▸ Vayanos-Vila

Shallow Markets: Constrained Arbitrageurs, Inelastic Demand

- Scarce capital ($n < \bar{n}$): the risk limit binds for the most risk-tolerant types
  - Cutoff $\bar{\tau}$: types above are pinned at $\bar{\sigma}^n$; only $\tau_j < \bar{\tau}$ adjust at the margin
- Only the unconstrained few adjust to a rate cut $\Rightarrow$ demand inelastic
- Elasticity falls below the deep value $1/\mathrm{RP}$ $\Rightarrow$ pass-through dampened:

$$E = \frac{1}{\mathrm{RP}} \cdot \frac{\bar{\tau}/2\theta}{1 - \bar{\tau}/2\theta} \qquad \Longrightarrow \qquad \frac{dr}{di_1} = \frac{1}{2} \cdot \frac{1}{1 + E^{-1}}$$

- Magnitude (RP $= 4\%$): Asriyan, Jeenas & Martin (25)
  - 90% capped ($\bar{\tau} = \theta/10$) $\Rightarrow$ elasticity E falls $\sim$19-fold
  - $\Rightarrow$ transmission $^{dr}/_{di_1}$: $0.48 \to 0.28$

▸ Inelastic Markets ▸ Broader FC

Foreign Capital Relaxes the Constraint and Restores Transmission

- Foreign capital d^* absorbs part of the supply $\Rightarrow$ fewer arbitrageurs pinned
  - Here d^* works through elasticity, not just the level (unlike deep markets)
- Relaxing the constraint strengthens monetary transmission:

$$d^* \uparrow \Rightarrow \text{RP} \downarrow \Rightarrow \bar{\tau} \uparrow \Rightarrow E \uparrow \Rightarrow \frac{dr}{di_1} \uparrow$$

- d^* is endogenous to FX policy: stabilizing the currency draws it in

Response from MP

"Reversing the Trilemma"

FX stabilization and monetary transmission are complements

Inelastic Markets Broader FC FX Risk for Arbitrageurs

The Mechanism Rests on Two Ingredients

1. International investors dislike FX risk — as they are not fully diversified
   - A strong stylized fact for EMEs ▸ Stylized Fact
   - Importance of investor base Belz & Breckenfelder (26)

2. Arbitrageurs bear too much risk relative to capacity ▸ Any Risky Asset
   - Model is about duration, but empirics use 3-month bonds
   - But model only needs high σ_i from any source of risk: sovereign, liquidity...

$\Longrightarrow$ FX stabilization relaxes arbitrageurs' constraint

- Main model: lower FX risk draws in foreigners, who absorb risk from locals
- Alternative: if locals bear FX risk, stabilization relaxes it *directly* ▸ Direct Channel

(i) FX Risk → Foreign Ownership

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Added control:	Base	+VIX	+Cap. Op.	+Inst.	+Infl.	+US CDS	+All
Panel A: foreign share of local-currency debt							
FX volatility	-2.15***	-1.21***	-2.19***	-2.17***	-1.80***	-1.94***	-1.61***
	(0.36)	(0.36)	(0.36)	(0.36)	(0.36)	(0.32)	(0.33)
R^2 / Obs.			0.66–0.69 / 777			0.81–0.83 / 582	
Panel B: foreign share of foreign-currency debt (placebo)							
FX volatility	-0.00	-0.45	0.07	-0.13	-0.24	0.25	0.00
	(0.86)	(0.88)	(0.86)	(0.85)	(0.89)	(0.73)	(0.76)
R^2 / Obs.			0.86–0.87 / 184			0.91 / 136	

▸ Robustness: Full Controls

(ii) Shallow Markets → Monetary Transmission

Shallow = below-median arbitrageur capacity (institutional-investor assets / GDP)

	Pass-through	
Δi (deep base)	0.47***	(0.05)
$\Delta i \times$ shallow	-0.24***	(0.07)
$\Delta i \times$ FX volatility	0.02	(0.02)
$\boldsymbol{\Delta i \times}$ shallow $\times$ FX vol.	**$-$0.49***	(0.11)
Obs. / R^2	1,091 / 0.23	

FX volatility weakens transmission **only** where arbitrageurs are constrained:
gradient ≈ 0 in deep markets, **$-$0.49** in shallow ones.

▸ Robustness: Shallowness Cutoff

Stabilization Trades FX Risk Against Interest-Rate Risk

- More stabilization (higher κ_e) moves two risks in opposite directions:

$$\frac{d\,\sigma_e^2}{d\kappa_e} = -2(1-\kappa_e)\sigma_\epsilon^2 < 0 \qquad\qquad \frac{d\,\sigma_i^2}{d\kappa_e} = 2\kappa_e\sigma_\epsilon^2 > 0$$

- Lower FX risk $\Rightarrow$ draws in foreigners D^*, relaxes the constraint
- Higher rate risk σ_i $\Rightarrow$ more risk on arbitrageurs, tightens the constraint
- Net effect on transmission balances the two forces:

$$\frac{d}{d\kappa_e}\left(\frac{dr}{di_1}\right) \propto \underbrace{\frac{\gamma\sigma_i^2(1-\kappa_e)}{B-D^*}}_{\text{Foreign absorption}} - \kappa_e \underbrace{\frac{2\theta(2-\text{RP})}{4\theta-\bar{\tau}}}_{\text{Interest-rate volatility}}$$

- Hard peg ($\kappa_e = 1$): volatility dominates $\Rightarrow$ backfires $\Longrightarrow$ interior optimum κ_e^*

▸ Illustration ▸ Return: Empirics

Outline

1. Motivating Evidence
2. Model
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Some Exchange-Rate Stabilization Is Always Optimal

- Maximizing transmission $\longleftrightarrow$ Deviating from targeting r^*
- Central bank sets the policy rule to minimize:

$$\mathcal{L} = \underbrace{\mathbb{E}\left[(r - r^* - \rho_1)^2\right]}_{\text{dislikes output gap}} \quad + \quad \underbrace{\chi \mathbb{V}[i_1]}_{\text{dislikes rate volatility}}$$

- **Mundell** ($\kappa_e = 0$):

$$\mathcal{L} = \sigma_\rho^2 \left[\left(1 - \kappa_r \frac{dr}{di}\right)^2 + \chi \kappa_r^2\right]$$

Weak transmission $\Rightarrow$ need a lot of i-movement to close the output gap

Proposition

From any Mundellian policy ($\kappa_e = 0$), raising κ_e while lowering κ_r to hold σ_i^2 fixed strictly improves welfare. Hence the optimal rule has $\kappa_e^* > 0$.

First-order transmission gain vs. second-order cost of a weaker demand response

FCI in EMEs i-volatility

Conclusion

1. Stable exchange rate $\implies$ stronger transmission in shallow markets
   - Draws in foreign capital that dislikes FX risk
   - Relaxes arbitrageurs' constraints $\Rightarrow$ more elastic markets, stronger transmission

2. Inverted U-shape in the degree of stabilization
   - Trades currency risk against interest-rate risk; a hard peg backfires

3. Some stabilization is always optimal
   - Closes the output gap more tightly without raising rate volatility

Broad message: strength of monetary transmission is endogenous:
managed through the distribution of risk holdings

▸ Extensions

Appendix Slides

Additional Literature

- **Segmented Markets**
  - Intermediary Asset Pricing: Fostel & Geanakoplos (08); He & Krishnamurthy (12); Brunnermeier & Sannikov (14); Gabaix & Maggiori (15); Caballero & Simsek (24)...
  - Monetary Policy: Jeanne & Rose (02); Vayanos & Vila (21); Greenwood et al. (24); Kekre, Lenel & Mainardi (25); De Leo, Gopinath & Kalemli-Ozcan (25) ...

→ *Transmission of monetary policy is endogenous when markets are shallow*

- **Currency Risk**
  - International Investors: Hassan, Mertens & Zhang (23); Rey et al. (24); De Leo et al. (25); Belz & Breckenfelder (26)...
  - Capital Flows: Caballero & Simsek (20); Dahlquist et al. (24); Fu (24)...

→ *Currency risk disciplines foreign participation, shaping market segmentation*

- **FX Stabilization**
  - Trilemma: Mundell (63); Fleming (62); Obstfeld & Rogoff (95); Farhi & Werning (12, 14); Rey (13); Kalemli-Ozcan (19) ...
  - Monetary & FX Policy: Caballero & Krishnamurthy (03); Bianchi & Lorenzoni (21); Itskhoki & Mukhin (23); Basu et al. (25) ...

Main Literature

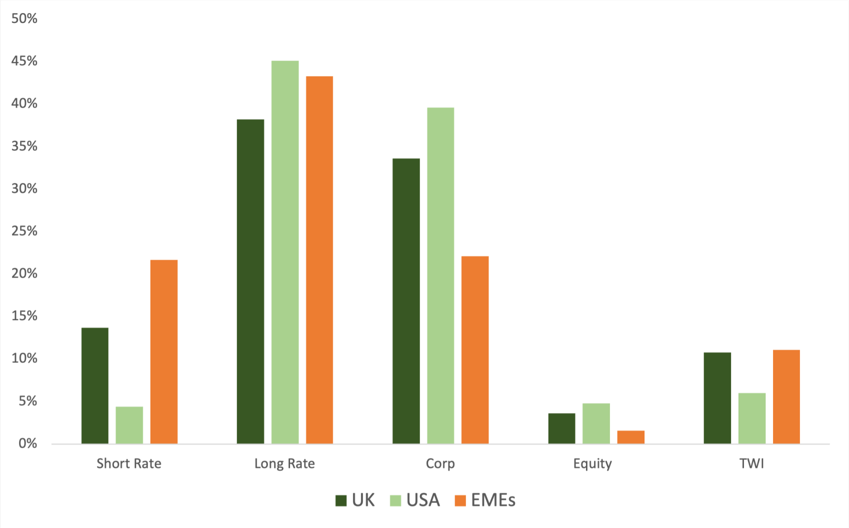
→ *FX stabilization can raise effective monetary autonomy, overturning the trilemma*

Extensions

1. Foreigners: Response from Monetary Policy
2. Connection to Inelastic Markets
3. Foreigners-Implied FX volatility
4. FX Risk on Arbitrageurs' Balance Sheet
5. NK Micro-Foundation for Welfare Objective
6. OLG Setup
7. Correlated Shocks
8. Additional Empirical Exercises
9. Empirical Robustness

▸ Conclusion

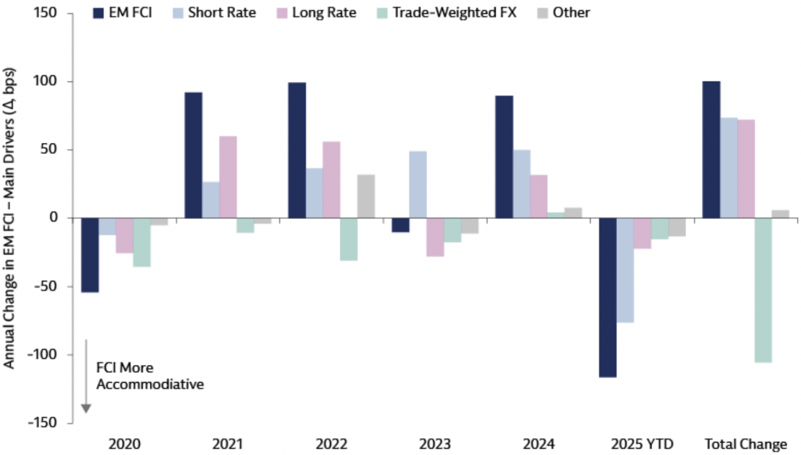
Financial Conditions Index: Weights



Source: Goldman Sachs

Return: Model Return: Loss Function

Financial Conditions Index: Recent Contributions



Source: Goldman Sachs Asset Management, Goldman Sachs Global Investment Research, as of end August 2025. "Other" contains Equities, Credit Spread, and Debt-weighted FX.

Return: Model   Return: Loss Function

Literature Details: Diversification

- Kalemli-Ozcan & Varela (2024): local risk factors (distinct from country-specific loadings on global factors) are crucial to explain UIP deviations in emerging markets.

- Converse & Mallucci (2023): document that how bond mutual funds reallocate in response to risk is inconsistent with the assumption of deep-pocketed investors

- Sialm & Zhu (2024): show that while most funds use currency forwards, they hedge only a small portion of the currency risk.

- Chen & Zhou (2025): use a dataset of U.S. mutual funds' EMEs currency forwards positions to show that the average fund amplifies its exposure to currency risk rather than hedging it.

▸ Return: Discussion

Outline

Data

- 16 major emerging markets Argentina, Brazil, Chile, Colombia, Hungary, Indonesia, India, Mexico, Malaysia, Peru, Philippines, Poland, Romania, Thailand, Türkiye, and South Africa
  - Policy rates from BIS (i)
  - Market rates: 3m yields (local currency) from Bloomberg (r)
  - Stock market returns from Jensen, Kelly & Pedersen (23) (y^{stock})
  - Exchange rate regime from Ilzetzki, Reinhart & Rogoff (19, 21)
  - Exclude "Freely falling" periods
  - Macro outcomes from Global Macro Database (Muller, Xu, Lehbib & Chen (25))
  - Winsorize extreme observations

- Conditioning on exchange rate volatility / management, run

$$\Delta r_{j,t} = a + b\Delta i_{j,t} + \epsilon_{j,t}$$

  - De Leo, Gopinath & Kalemli-Ozcan (25)

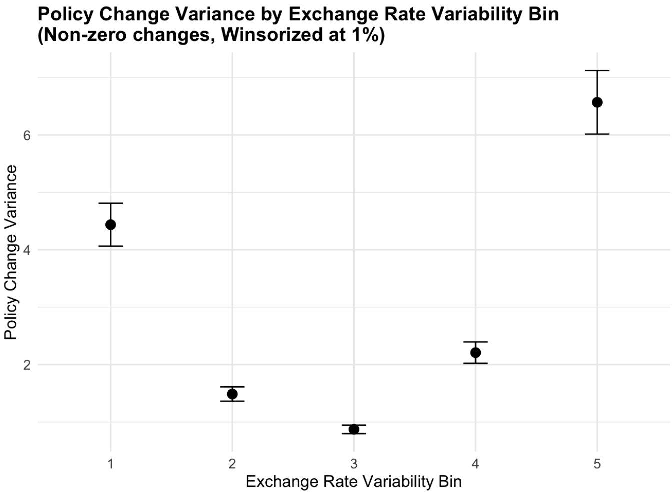
Return

Monetary Transmission: Inverted U-Shape

	Dependent Variable: Δr (3-month market rate)			
	(1)	(2)	(3)	(4)
Δi	0.635***	0.566***	0.636***	0.566***
	(0.052)	(0.060)	(0.052)	(0.060)
FX Volatility	−2.114**	−2.660	−2.117**	−2.652
	(1.044)	(1.889)	(1.045)	(1.890)
FX Volatility^2	−2.359	−1.340	−2.359	−1.374
	(1.483)	(5.485)	(1.483)	(5.488)
Δi × FX Volatility	1.026*	4.112***	1.026*	4.115***
	(0.537)	(1.163)	(0.537)	(1.164)
Δi × FX Volatility^2	**−2.413*** **	**−10.755*** **	**−2.414*** **	**−10.764*** **
	(0.841)	(2.973)	(0.842)	(2.975)
Constant	−0.098	−0.204	−0.097	−0.203
	(0.078)	(0.165)	(0.078)	(0.165)
Observations	838	799	838	799
R^2	0.307	0.312	0.307	0.312
Controls	None	Cap. Ctrls	US MPS	Both

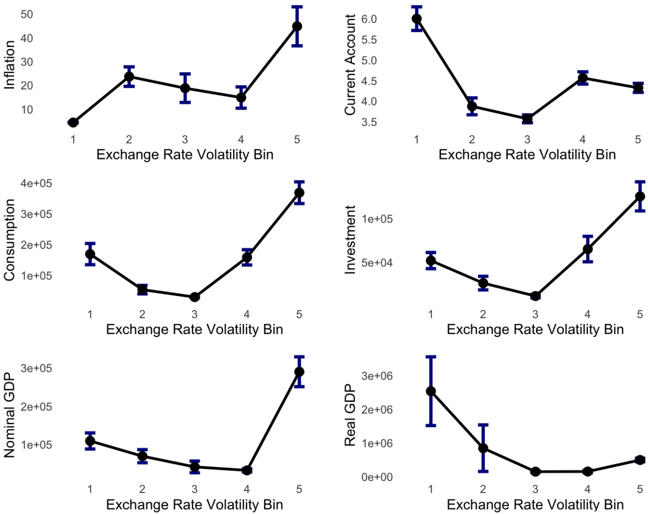
Robust standard errors in parentheses. *** p<0.01, ** p< ▸ Return < ▸ U-Shape Theory ▸ Return: Extensions

Volatility of Monetary Policy Rates



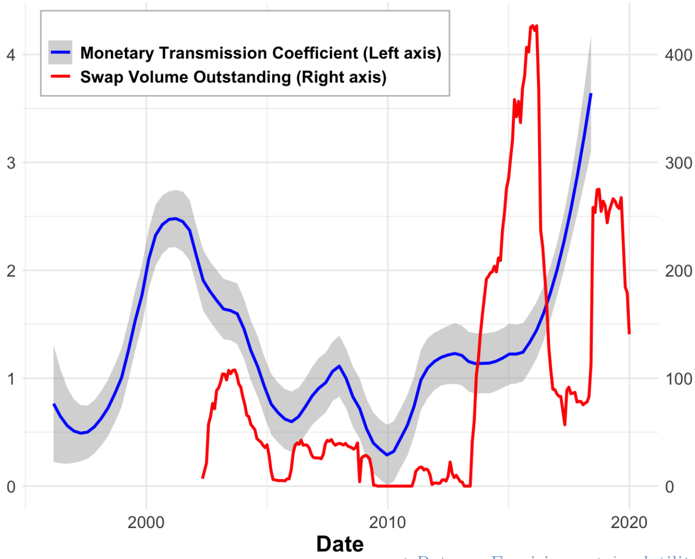
▸ Return: Empirics ▸ Return: Theory ▸ Return: Extensions

Volatility of Macroeconomic Variables



Return: Empirics   Return: Extensions

Case Study: Brazil



Robustness: Market Rates Time-Horizon

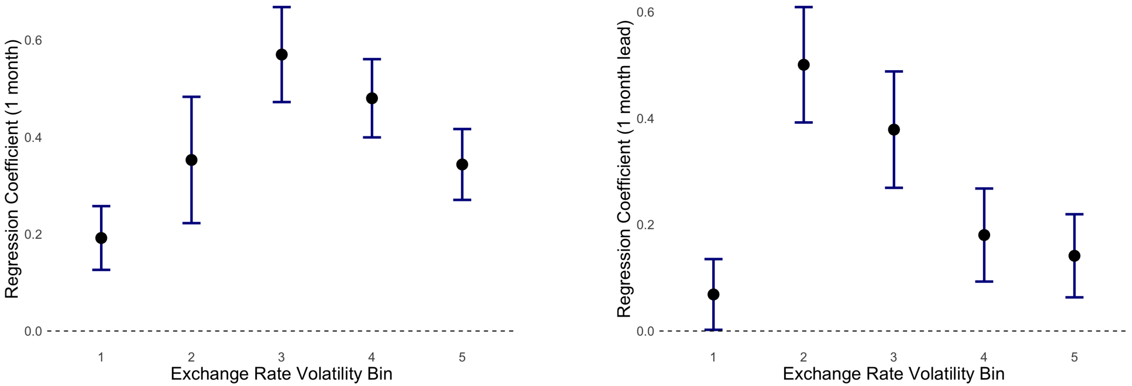


Figure: Estimated transmission of policy rate changes to 3-month market interest rates, conditional on exchange rate volatility. Left: contemporaneous 1-month change in market rates. Right: next 1-month change. The rest of the specification is identical to the baseline one.

Return: Empirics   Return: Extensions

Robustness: FX Allowed Deviation Measure (1)

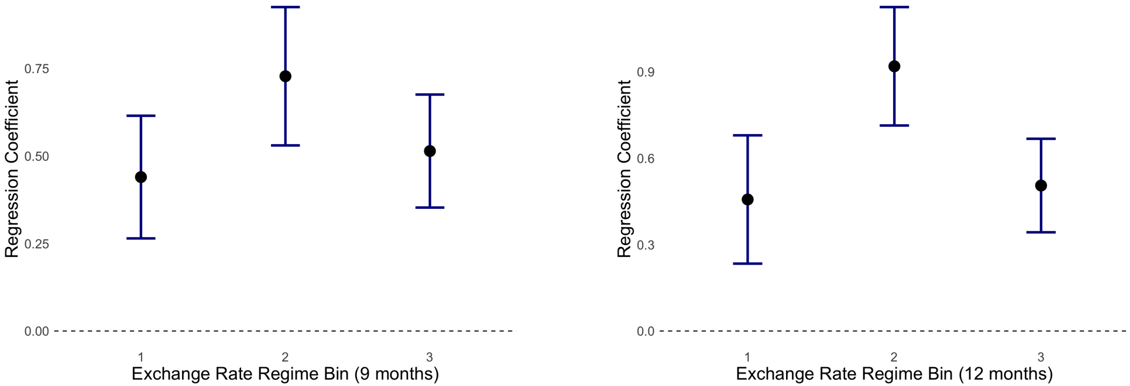


Figure: Estimated transmission of policy rate changes to 3-month market interest rates, conditional on exchange rate regimes. Left: 9-month average of the discrete classification. Right: 12-month average. The rest of the specification is identical to the baseline one.

Return: Empirics Return: Extensions

Robustness: FX Allowed Deviation Measure (2)

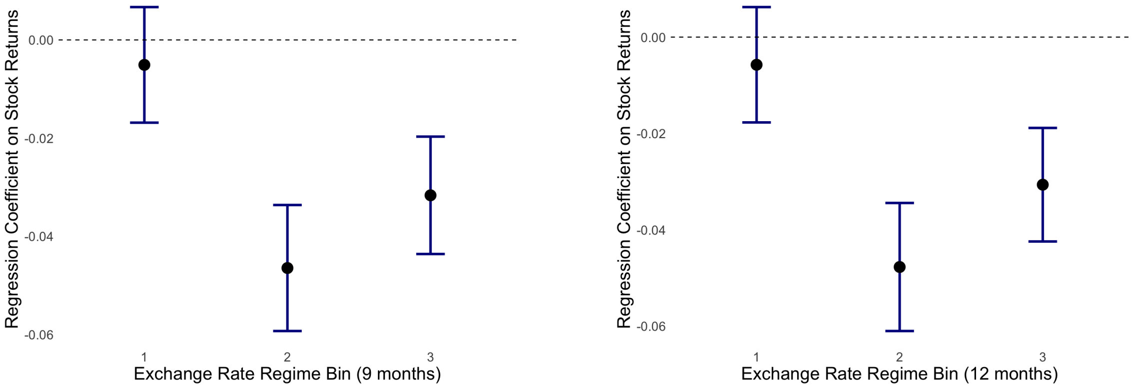


Figure: Estimated transmission of policy rate changes to stock market returns, conditional on exchange rate regimes. Left: 9-month average of the discrete classification. Right: 12-month average. The rest of the specification is identical to the baseline one.

Return: Empirics Return: Extensions

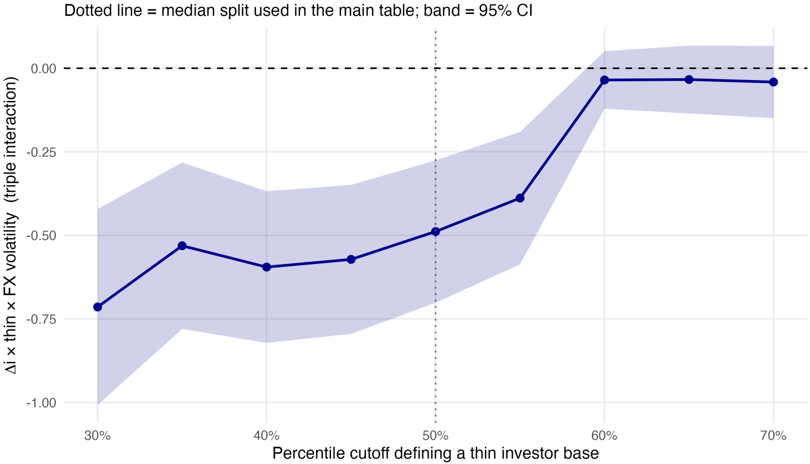
Robustness: FX Risk → Foreign Ownership

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: foreign share of local-currency debt							
FX volatility	-2.15***	-1.21***	-2.19***	-2.17***	-1.80***	-1.94***	-1.61***
	(0.36)	(0.36)	(0.36)	(0.36)	(0.36)	(0.32)	(0.33)
VIX		-2.29***					-3.47***
		(0.28)					(0.51)
Capital openness			-3.68***				-0.02
			(0.88)				(0.95)
Institutions				0.87			3.98***
				(1.00)			(1.03)
Inflation					-1.85***		0.91**
					(0.42)		(0.43)
US CDS						-1.73***	-0.94***
						(0.25)	(0.29)
R^2 / Obs.	0.66–0.69 / 777					0.81–0.83 / 582	
Panel B: foreign share of foreign-currency debt (placebo)							
FX volatility	-0.00	-0.45	0.07	-0.13	-0.24	0.25	0.00
	(0.86)	(0.88)	(0.86)	(0.85)	(0.89)	(0.73)	(0.76)
R^2 / Obs.	0.86–0.87 / 184					0.91 / 136	

Standardized regressors; quarterly EMEs; country FE. Cols. (6)–(7): 2009–19. Onen, Shin & von Peter (23).
FX-vol effect survives every control; null on dollar debt (placebo). $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

▸ Return: Foreign Ownership ▸ Return: Extensions

Robustness: Measuring Shallowness



Triple interaction $\Delta i \times$ shallow $\times$ FX vol. vs. the percentile cutoff defining a shallow investor base: strongly negative when the base is shallow, ≈ 0 once it is deep.

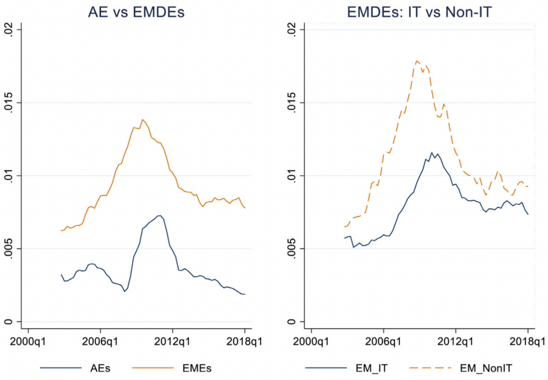
▸ Return: Shallow Markets ▸ Return: Extensions

FX Regime: Classification Details

- Use Ilzetzki et al. (19) fine classification of exchange rate regimes
- Apply Hassan, Mertens & Zhang (23) for FX allowed deviation:
  - Codes 1, 2, and 4 are assigned 0% allowed deviation;
  - Codes 5 and 7 are assigned 1%;
  - Codes 3, 6, 8, and 11 are assigned 2%;
  - Codes 9, 10, and 12 are assigned 5%;
  - Code 13 is assigned 10%;
  - Exclude code 14, freely falling currencies
- Construct three bins conditioning on the value of this FX allowed deviation measure.
  - Robustness: Also look at average value or forward-looking value

Return: Empirics

FXI Across Monetary Regimes



Foreign exchange intervention by country groups and over time.

From Adler, Chang & Wang (2021). Broad measure, 3-year moving average, reported in percentage of GDP.

Return: Optimal FX Policy

FXI Reaction Function

	Response to:								
	Actual Inflation			Next-year Inflation Expect.			12-month Inflation Expect.		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
π-π^T	0.010	0.015	0.015						
	(0.686)	(1.067)	(1.062)						
$E(\pi^{NY}$-$\pi^T)$				0.019	0.004	0.004			
				(0.364)	(0.054)	(0.062)			
$E(\pi^{12m}$-$\pi^T)$							0.035	0.032	0.031
							(0.955)	(0.751)	(0.750)
$\Sigma\Delta$ln(ER)	−0.0740***	−0.0638**	−0.0606**	−0.0868***	−0.0872***	−0.0808***	−0.0906**	−0.0889***	−0.0825***
	(−2.957)	(−2.072)	(−2.127)	(−3.422)	(−4.061)	(−3.592)	(−3.791)	(−4.202)	(−3.717)
Δln(ER)	−0.050***	−0.047***	−0.046***	−0.051***	−0.049**	−0.046**	−0.050***	−0.049**	−0.046**
	(−2.974)	(−2.908)	(−2.895)	(−2.747)	(−2.806)	(−2.663)	(−2.781)	(−2.805)	(−2.671)
L.Δln(ER)	−0.011+	−0.010	−0.009	−0.017***	−0.016***	−0.015***	−0.016***	−0.015***	−0.015***
	(−1.612)	(−1.247)	(−1.257)	(−3.031)	(−2.896)	(−2.823)	(−3.115)	(−3.004)	(−2.937)
L2.Δln(ER)	−0.008	−0.006	−0.006	−0.010*	−0.009+	−0.009	−0.010*	−0.010+	−0.009+
	(−1.387)	(−1.014)	(−1.012)	(−1.673)	(−1.536)	(−1.476)	(−1.710)	(−1.575)	(−1.511)
Reserves/GDP (l1)			−0.010			−0.022**			−0.022**
			(−0.887)			(−2.302)			(−2.315)
Constant	0.003***	0.003***	0.005**	0.003***	0.003***	0.007***	0.003***	0.003***	0.006***
	(5.155)	(16.360)	(2.280)	(4.730)	(10.079)	(4.285)	(4.251)	(12.740)	(4.131)
Country FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Reserves	No	No	Yes	No	No	Yes	No	No	Yes
Observations	1084	1084	1084	997	997	997	997	997	997
Countries	25	25	25	24	24	24	24	24	24

From Adler, Chang & Wang (2021).

Return: Optimal FX Policy

Outline

UIP Deviation

- Carry trade segmented (Jeanne & Rose 02; Itskhoki & Mukhin 25)
- Mean-variance utility and take zero-capital position
- Excess return of borrowing in dollars to invest in the local currency is:

$$(1 + i_t) - (1 + i^*)\frac{e_{t+1}}{e_t}$$

- Yields:

$$\frac{(1 + i_t)}{(1 + i_t^*)} - \mathbb{E}\left[\frac{e_t}{e_{t+1}}\right] = \gamma^* \omega (1 + i_t^*)\sigma_e^2$$

- Endogenous UIP deviation, moves with:
  1. risk aversion γ^* of carry traders;
  2. amount of short term flow they need to absorb ω;
  3. exchange rate risk σ_e^2.
- Any shock to these variables will translate into a risk premium shock ϵ

Return: Central Bank

VV: Arbitrageurs

- Central bank chooses nominal interest rate i_1
- Arbitrageurs maximize log-utility of future wealth
  - Split wealth w between ST bonds (i_1) and LT bonds (duration risk)
  - one-period excess return on long-term bond:

$$\frac{(1+i_2)^{-1}}{P_1} - (1+i_1)$$

  - Maximize:

$$\max_{x_1} \quad \mathbb{E}_1 \left[\ln \left(w(1+i_1) + x_1 \left(\frac{(1+i_2)^{-1}}{P_1} - (1+i_1) \right) \right) \right]$$

- Optimal portfolio choice (second-order approximation):

$$\underbrace{\frac{(1+\bar{i}_2)^{-1}}{P_1} - (1+i_1)}_{\text{Expected return}} \approx \underbrace{\frac{x_1}{w}\sigma_i^2(1+i_1)}_{\text{Risk}}$$

Return: Setup

Return: Deep Markets

VV: Yield Curve Equilibrium

- Market clearing:

$$B - D^* = \frac{w}{\sigma_i^2}\left(\frac{(1+i_1)^{-1}(1+\bar{i}_2)^{-1}}{P_1} - 1\right)$$

- Equilibrium price of LT bonds:

$$P_1 = \frac{(1+i_1)^{-1}(1+\bar{i}_2)^{-1}}{1 + \frac{\sigma_i^2}{w}(B - D^*)}$$

- Rewrite (using $(1+r)^2 \approx 1 + 2r$):

$$(1+i_1)\left(1 + \frac{\sigma_i^2}{w}(B - D^*)\right) \approx 1 + 2r - \bar{i}_2$$

Return

VV: Monetary Transmission

- Differentiating the equilibrium yield w.r.t. the policy rate:

$$\frac{dr}{di_1} = \frac{1}{2} \cdot \frac{1}{1 + \frac{\sigma_i^2}{w}(B - D^*)}$$

- **Exactly the same form** as our deep-market case:

$$\frac{dr}{di_1} = \frac{1}{2} \cdot \frac{1}{1 + \mathrm{RP}}, \qquad \underbrace{\frac{\sigma_i^2}{w}(B - D^*)}_{\text{dampening}} = \mathrm{RP}$$

  – Same quantitative implications: negligible dampening

- Foreign capital D^* enters only as a *level* effect:

$$dD^* = -\frac{\gamma}{2} d\sigma_e^2$$

Shallow Markets Return

Broader Financial Conditions

- Same mechanism for:
  - Other risky assets
  - Also frictionally intermediated
- Take risky asset with payoff μ and variance σ

$$\frac{dp}{di_1} = -\frac{1}{1 + \frac{2\theta - \bar{\tau}}{\bar{\tau}^2}\overline{\sigma}^n \sigma_i}$$

  - Consistent with empirical exercise on stock returns

Show

- Also applies to elasticity of fundamentals:

$$\frac{dp}{d\mu} = \frac{1}{1 + \frac{2\theta - \bar{\tau}}{\bar{\tau}^2}\overline{\sigma}^n \sigma_i}$$

  - Price volatility less driven by fundamentals
  - More by shocks to risk-bearing capacity and noise
  - FX stabilization should make prices more efficient

Return: Shallow Markets

Inelastic Markets: Fundamentals and flows

- Dampening governed by demand semi-elasticity E:

$$\frac{dr}{di_1} = \frac{1}{2} \cdot \frac{1}{1 + E^{-1}}, \qquad E^{-1} = \text{RP}\,\frac{1 - \bar{\tau}/2\theta}{\bar{\tau}/2\theta}$$

  - Shallow markets $\implies$ many arbitrageurs capped $\implies$ small E

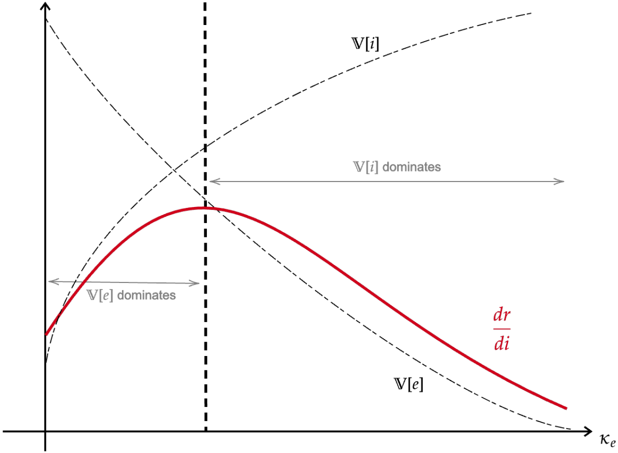
- Same inelasticity governs response to fundamentals *and* flows :

$$\frac{dp}{d\mu} = \frac{1}{1 + E^{-1}} \qquad ; \qquad \frac{dp}{db} = -\frac{E^{-1}}{1 + E^{-1}}$$

- Dual of inelastic markets — Gabaix & Koijen (23)
  - There: inelastic demand amplifies the price impact of flows
  - Here: same inelasticity dampens the transmission of monetary policy
  - Prices driven by risk-bearing capacity, flows, noise, but not fundamentals

Return: Shallow Markets · Broader FC · Return: Extensions

Transmission Is Hump-Shaped in the Degree of Stabilization



▸ Return: Theory ▸ Simulation ▸ Return: Empirics

Arbitrageurs Holding FX Risk

- **FX Funding Needs:** Intermediaries need to accommodate S_c demand for currency forwards
  - Assume uncorrelated risks for simplicity
  - Assume risk limit for tractability:

$$\sigma_D + \sigma_c \leq \bar{\sigma}_n$$

- Unconstrained portfolio choice:

$$\omega_d^* = \tau \frac{2r - i_1 - \bar{i}}{\sigma_i^2} = \tau \frac{\chi_d}{\sigma_i}$$

$$\omega_c^* = \tau \frac{f - \bar{e}}{\sigma_e^2} = \tau \frac{\chi_c}{\sigma_e}$$

- Marginal arbitrageur is thus characterized by:

$$\bar{\tau} \left(\chi_d + \chi_c \right) = \bar{\sigma}_n$$

Return: Setup   Return: Shallow Markets   Return: Discussion   Return: Extensions

Arbitrageurs Holding FX Risk (2)

- Market clearing condition as previously with only one asset:

$$\frac{\chi_d}{\sigma_i}\bar{\tau}\left(1 - \frac{\bar{\tau}}{2\theta}\right) = BP_1$$
$$\frac{\chi_c}{\sigma_e}\bar{\tau}\left(1 - \frac{\bar{\tau}}{2\theta}\right) = S_c$$

- Duration pricing is now mixed with FX pricing:

$$\chi_d = \frac{\bar{\sigma}_n}{\bar{\tau}\left(1 + \frac{\sigma_e S_c}{\sigma_i B P_1}\right)}$$

- Dampened monetary transmission because of FX risk on balance sheet:

$$\frac{dr}{di_1} = \frac{1}{2} \cdot \frac{1}{1 + \frac{\theta(\sigma_i B)^2}{\bar{\tau}^2(\sigma_i B + \sigma_e S_c)}}$$

Return: Setup Return: Shallow Markets Return: Discussion Return: Extensions

Foreigners: Response from Monetary Policy (1)

- Demand from International Investors:

$$D_t^* = \frac{\mathbb{E}_t[e_{t+2}] - e_t P_t}{\gamma \sigma_e^2}$$

- To the first-order:

$$D_t^* = \frac{2r_t + (1 - e_t)}{\gamma \sigma_e^2}$$

- Two opposite effects when $i_t \uparrow$:
  1. Higher r_t attracts investment
  2. Appreciated exchange rate e_t discourages investment
- However since monetary transmission is impaired:

$$\frac{dD_t^*}{di_t} = \frac{2\frac{dr_t}{di_t} - 1}{\gamma \sigma_e^2} < 0$$

Return: International Investors Return: Shallow Markets Return: Extensions

Foreigners: Response from Monetary Policy (2)

$$\frac{dD_t^*}{di_t} = \frac{2\frac{dr_t}{di_t} - 1}{\gamma\sigma_e^2} < 0$$

- New endogenous force helps transmission:
  1. Reduces foreigners' investment after rate hike
  2. Increases term premium by forcing local arbitrageurs to hold more risk

- Reducing FX volatility improves this by making foreigners more aggressive
  - Foreigners' elasticity adds to arbitrageurs'

$$\frac{dr_t}{di_t} = \frac{1}{2}\left(1 + \frac{1}{\frac{\bar{\tau}^2}{(2\theta - \bar{\tau})\bar{\sigma}^n\sigma_i} + \frac{1}{(B - D^*)\gamma\sigma_e^2}}\right)^{-1} = \frac{1}{2}\left(1 + \frac{1}{\frac{d\log\bar{\Omega}}{d\mathrm{RP}} + \frac{dd_t^*}{d\mathrm{RP}}}\right)^{-1}$$

▸ Return: International Investors ▸ Return: Shallow Markets ▸ Return: Extensions

Foreigners-Implied FX volatility

- More D^* investment $\implies$ FX volatility from flows?
- UIP investors equilibrium conditions:

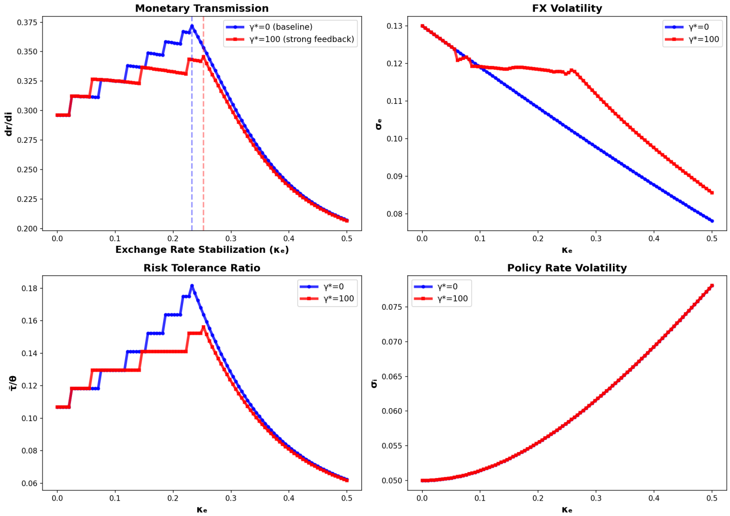
$$e_t = 1 + i_t - i^* - \underbrace{\gamma^* F_t (1 + i_t^*) \sigma_e^2}_{\text{Compensation for accommodating flows}} - \epsilon_t$$

- Where flows are:
  - $F_t = \ldots + D_t^* - D_{t-2}^*$
  - New source of volatility through $\mathbb{V}[D_t^*]$
- System of fixed points with additionally:

$$\sigma_e^2 = \sigma_\rho^2 \kappa_\rho^2 \left(1 - 2\gamma^* \sigma_e^2 \frac{dr}{di}\right)^2 + \sigma_\epsilon^2 \left(1 - \kappa_e \left(1 - 2\gamma^* \sigma_e^2 \frac{dr}{di}\right)\right)^2$$

Return: Extensions

Foreigners-Implied FX volatility: Simulation



▸ Return: Extensions ▸ Return: Diagram U-Shape

Correlated Shocks

- Assume that ϵ and $\rho \sim$ bivariate normal distribution with correlation η

$$\sigma_i^2 = \kappa_r^2 \sigma_\rho^2 + \kappa_e^2 \sigma_\epsilon^2 + 2\eta\kappa_r\sigma_\rho\kappa_e\sigma_\epsilon$$
$$\sigma_e^2 = \kappa_r^2 \sigma_\rho^2 + (1-\kappa_e)^2 \sigma_\epsilon^2 + 2\eta\kappa_r\sigma_\rho(1-\kappa_e)\sigma_\epsilon$$

- Additional terms in the loss function:

$$2\eta\left(\left(\frac{dr}{di}\kappa_r - 1\right)\frac{dr}{di}\kappa_e\sigma_\rho\sigma_\epsilon\right)$$

- Many new terms...
  - But only need the sign at the Mundellian point $\kappa_e = 0$!
  - Only left with:

$$-2\eta\sigma_\rho\sigma_\epsilon\left(\left(1 - \frac{dr}{di}\kappa_r\right)\frac{dr}{di}\right)d\kappa_e$$

- If $\eta < 0$, weakens the results
  - Responding to exchange rate fluctuations goes directly against targeting AD
  - Depends on strength of $d\ln {}^{dr}/_{di}$ vs. η

Return: Extensions

New-Keynesian Micro-Foundations (1)

- Real side:
  - Households supply labor and consume; borrowers demand goods
  - Prices and wages fully rigid $\Rightarrow$ output is demand-determined
- Borrowers (mass M^b):
  - Preferences: $\ln c_1^b + \beta^b c_3^b$
  - Leads to **constant supply** of LT debt:

$$\frac{1}{c_1^b} = \frac{\beta^b}{P_1} \implies b_1 = \beta^b \implies B = M^b \beta^b$$

- With $P_1 = \frac{1}{(1+r)^2}$:

$$c_1^b = b_1 P_1 = \frac{\beta^b}{(1+r)^2}$$

Return: CB Objective Return: OLG Return: Extensions

New-Keynesian Micro-Foundations (2)

- Households (hand-to-mouth; no financial markets):
  - Utility:
$$c_1^h - \nu \frac{(l_1^h)^{1+\varphi}}{1+\varphi}$$
  - Income/consumption:
$$c_1^h = w\, l_1^h$$

- Total demand:
$$c_1 = w l_1^h + M^b \frac{\beta^b}{(1+r)^2}$$

- Production:
  - Foreign-owned firm $\Rightarrow$ profits not rebated
  - Linear technology: $y_1 = l_1^h$
  - Goods market clearing: $y_1 = c_1$

Return: CB Objective   Return: Extensions

NK: Natural Rate r^*

- Market clearing implies:

$$y_1 = w y_1 + M^b \frac{\beta^b}{(1+r)^2} \Rightarrow y_1 = \frac{M^b \beta^b}{(1-w)(1+r)^2}$$

- Linearization for small r:

$$y_1 = \frac{M^b \beta^b}{(1-w)} (1 - 2r)$$

- Natural rates and shocks:

$$r^* + \rho_1 = \frac{1}{2}\left(1 - y^* \frac{(1-w)}{M^b \beta^b}\right) \underbrace{- \frac{(1-w)}{2 M^b \beta^b} \varrho_1}_{+\rho_1}$$

Return: CB Objective   Return: Extensions

NK: Loss Function

- Second-order perturbation around flexible equilibrium:

$$U - \tilde{U} = -\frac{\nu\varphi(\tilde{l}_1^h)^{\varphi-1}}{2}(\tilde{l}_1^h - l_1^h)^2$$

- Hours worked = output:

$$U - \tilde{U} = -\frac{\nu\varphi(\tilde{l}_1^h)^{\varphi-1}}{2}(y^* + \varrho - y_1)^2$$

- Interest rate link:

$$U - \tilde{U} = -\frac{\nu\varphi(\tilde{l}_1^h)^{\varphi-1}}{2}\left(\frac{M^b\beta^b}{(1-w)}\right)^2(r - r^* - \rho_1)^2$$

- Loss function proportional to:

$$\mathcal{L} = \mathbb{E}\left[(r - r^* - \rho_1)^2\right]$$

Return: CB Objective   Return: Extensions

NK: $\mathbb{V}[i]$ (1)

- Add to the real side:
  - Second type of consumption good
  - Produced by second type of HtM households
  - Consumed by ST borrowers
- ST Borrowers (mass N^b):
  - Preferences: $\ln c_1^{b,st} + c_1^{b,st}$
  - Supply of ST debt is irrelevant (controlled by CB)
- Policy rate matters for consumption:

$$c_1^{b,st} = \frac{1}{1+i_1}$$

Return: CB Objective   Return: Extensions

NK: $\mathbb{V}[i]$ (2)

- Assume natural output for second good is:

$$(y_1^{st})^* = \frac{N^b}{1-w}$$

- Same structure for loss function
  - Central bank also puts weight on welfare of second household group

$$U - \tilde{U} = -\frac{\nu\varphi(\tilde{l}_1^h)^{\varphi-1}}{2}(y^* + \varrho - y_1)^2 - \frac{\nu\varphi(\tilde{l}_1^{h,st})^{\varphi-1}}{2}((y_1^{st})^* - y_1^{st})^2$$

- Implies loss function of the form:

$$\mathcal{L} = \mathbb{E}\left[(r - r^* - \rho_1)^2\right] + \chi\mathbb{V}[i_1]$$

- In general, many reasons to dislike policy rate volatility

Robustness: Without χ

- Could potentially set:

$$\kappa_r = \left(\frac{dr}{di}\right)^{-1}$$

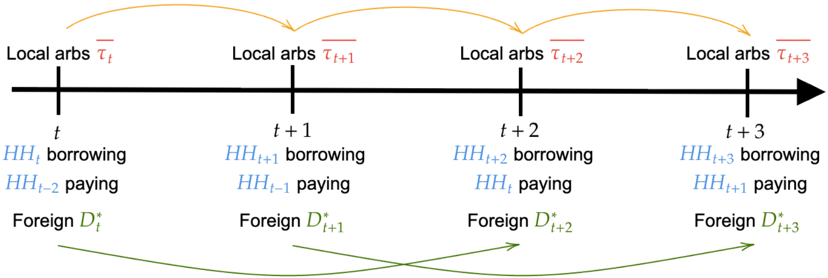
- But unrealistic:
  - Some part of SOE responsive to $i_t \implies$ inefficient fluctuations
  - Costly for financial stability reasons
  - Increases FX volatility
  - Also increases duration risk
- Optimal policy result robust as long as
  - When constrained at $\kappa_e = 0$...
  - optimal κ_r is such that

$$\kappa_r \frac{dr}{di} < 1$$

- In general, many reasons to dislike policy rate volatility

Return: Optimal κ_e

OLG Setup



- Ingredients:
  1. Overlapping 1-period local arbitrageurs
  2. Overlapping 2-period foreigners
  3. Overlapping 2-period households
- Constant supply of long-term debt over time with log-households

Show

Return: Model   Return: Extensions