Small open economy models

Exchange rates and monetary policy transmission

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Empirical regularities: Volatilities

Source: Neumeyer and Perri (JME'2005)

	% Standard Deviation			% Standard Deviation / % Standard Deviation of GDP				
	GDP	R	NX	PC	TC	INV	EMP	HRS
Emerging Economies								
Argentina	4.22	3.87	1.42	1.08	1.17	2.95	0.39	0.57
	(0.36)	(0.52)	(0.11)	(0.05)	(0.03)	(0.13)	(0.07)	(0.08)
Brazil	1.76	2.34	1.40	1.93	1.24	3.05	0.89	1.95
	(0.23)	(0.26)	(0.45)	(0.38)	(0.23)	(0.26)	(0.13)	(0.33)
Korea	3.54	1.42	3.58	1.34	2.05	2.20	0.59	0.71
	(0.50)	(0.23)	(0.55)	(0.07)	(0.18)	(0.16)	(0.07)	(0.05)
Mexico	2.98	2.64	2.27	1.21	1.29	3.83	0.43	0.33
	(0.36)	(0.38)	(0.28)	(0.08)	(0.06)	(0.17)	(0.09)	(0.08)
Philippines	1.44	1.33	3.31	0.93	2.78	4.44	1.34	NA
	(0.17)	(0.13)	(0.45)	(0.11)	(0.44)	(0.43)	(0.33)	
Average	2.79	2.32	2.40	1.30	1.71	3.29	0.73	0.89
Developed Economies								
Australia	1.19	2.00	1.02	0.84	1.20	4.13	1.13	1.40
	(0.09)	(0.17)	(0.08)	(0.07)	(0.08)	(0.22)	(0.10)	(0.14)
Canada	1.39	1.54	0.76	0.74	0.84	2.91	0.75	0.82
	(0.08)	(0.12)	(0.06)	(0.05)	(0.05)	(0.18)	(0.04)	(0.04)
Netherlands	0.93	0.93	0.67	1.17	1.44	2.66	1.27	NA
	(0.06)	(0.12)	(0.07)	(0.08)	(0.12)	(0.22)	(0.14)	
New Zealand	1.99	1.92	1.31	0.82	0.86	3.32	1.15	1.28
	(0.18)	(0.19)	(0.13)	(0.08)	(0.09)	(0.34)	(0.10)	(0.12)
Sweden	1.35	1.92	0.86	1.01	1.67	4.18	1.24	2.94
	(0.14)	(0.26)	(0.09)	(0.10)	(0.22)	(0.34)	(0.13)	(0.17)
Average	1.37	1.66	0.92	0.92	1.08	3.44	1.11	1.61

Empirical regularities: Correlations with Y

Source: Neumeyer and Perri (JME'2005)

	Correlation of GDP with						
	R	NX	PC	TC	INV	EMP	HRS
			Emerging Economies				
Argentina	-0.63	-0.89	0.94	0.97	0.94	0.36	0.52
	(0.08)	(0.02)	(0.11)	(0.01)	(0.01)	(0.11)	(0.11)
Brazil	-0.38	-0.03	0.48	0.58	0.80	0.62	0.75
	(0.22)	(0.18)	(0.16)	(0.19)	(0.08)	(0.15)	(0.09)
Korea	-0.70	-0.86	0.96	0.92	0.94	0.91	0.96
	(0.11)	(0.04)	(0.02)	(0.03)	(0.02)	(0.04)	(0.02)
Mexico	-0.49	-0.87	0.93	0.96	0.96	0.56	0.37
	(0.13)	(0.05)	(0.02)	(0.02)	(0.02)	(0.13)	(0.13)
Philippines	-0.53	-0.40	0.69	0.51	0.76	0.26	NA
	(0.12)	(0.14)	(0.09)	(0.11)	(0.10)	(0.20)	
Average	-0.55	-0.61	0.80	0.79	0.88	0.54	0.65
			Developed Economies				
Australia	0.37	-0.59	0.63	0.79	0.87	0.77	0.76
	(0.11)	(0.08)	(0.07)	(0.05)	(0.03)	(0.06)	(0.06)
Canada	0.25	-0.01	0.83	0.86	0.73	0.93	0.93
	(0.09)	(0.11)	(0.04)	(0.02)	(0.05)	(0.02)	(0.02)
Netherlands	0.34	-0.28	0.64	0.77	0.58	0.81	NA
	(0.12)	(0.10)	(0.07)	(0.04)	(0.07)	(0.03)	
New Zealand	0.07	-0.06	0.72	0.59	0.66	0.73	0.73
	(0.14)	(0.11)	(0.06)	(0.09)	(0.08)	(0.08)	(0.08)
Sweden	-0.05	-0.23	0.55	0.38	0.81	0.81	0.93
	(0.10)	(0.12)	(0.08)	(0.12)	(0.04)	(0.05)	(0.02)
Average	0.20	-0.23	0.67	0.68	0.73	0.81	0.84

Empirical regularities: Correlations with R

Source: Neumeyer and Perri (JME'2005)

	Correlation of R with					
	NX	PC	TC	INV	EMP	HRS
			Emerging Economies			
Argentina	0.71	-0.70	-0.67	-0.59	-0.45	-0.58
	(0.06)	(0.21)	(0.07)	(0.09)	(0.11)	(0.12)
Brazil	-0.02	-0.39	-0.30	-0.12	-0.50	-0.46
	(0.10)	(0.14)	(0.16)	(0.20)	(0.18)	(0.23)
Korea	0.83	-0.78	-0.82	-0.67	-0.67	-0.78
	(0.03)	(0.06)	(0.05)	(0.09)	(0.14)	(0.13)
Mexico	0.68	-0.52	-0.58	-0.59	-0.42	-0.27
	(0.09)	(0.13)	(0.11)	(0.10)	(0.21)	(0.21)
Philippines	0.34	-0.35	-0.42	-0.43	-0.60	NA
	(0.12)	(0.13)	(0.11)	(0.12)	(0.14)	
Average	0.51	-0.55	-0.56	-0.48	-0.53	-0.52
			Developed Economies			
Australia	-0.42	0.58	0.44	0.36	0.49	0.44
	(0.10)	(0.07)	(0.10)	(0.09)	(0.15)	(0.17)
Canada	0.20	0.13	0.18	0.02	0.31	0.11
	(0.11)	(0.12)	(0.10)	(0.12)	(0.17)	(0.17)
Netherlands	-0.31	0.42	0.31	0.35	0.57	NA
	(0.10)	(0.08)	(0.12)	(0.08)	(0.08)	
New Zealand	-0.30	0.20	0.17	0.31	0.15	0.14
	(0.09)	(0.18)	(0.17)	(0.10)	(0.17)	(0.16)
Sweden	-0.25	-0.15	0.16	0.00	-0.02	-0.27
Average	-0.22	0.24	0.25	0.21	0.30	0.11

Empirical regularities: Impulse responses, Y shocks

Source: Uribe and Yue (JIE'2006)

- Productivity shocks: after a positive shock
  - Y, N, C, I – all increase
  - NX and CA – worsen

Empirical regularities: Impulse responses, R shocks

Source: Uribe and Yue (JIE'2006)

- Interest rate shocks: after a positive shock
  - Y, N, C, I – all decrease
  - NX and CA – improve

Empirical regularities: Impulse responses, R shocks

Source: Uribe and Yue (JIE'2006)

- Interest rate shocks: after a positive shock
  - Y, N, C, I – all decrease
  - NX and CA – improve
  - Exchange rate – mixed!

Brief review of exchange rate theories

- From asset market: Uncovered interest parity (UIP)
  - returns on comparable assets should be equalized across different currencies
  - $1 + r_t^{Rp} = (1 + r_t^{\$}) * \frac{Es_{t+1}^{Rp/\$}}{s_t^{Rp/\$}}$
- From goods market: Purchasing power parity (PPP)
  - prices of comparable goods should be equalized when converted into the same currency
  - $P^{Rp} = P^{\$} * s^{Rp/\$}$
  - $\pi^{Rp} = \pi^{\$} + \Delta s^{Rp/\$}$

Introducing money and monetary policy

- Monetary model with sticky prices: Dornbusch (1976) overshooting model
  - monetary tightening leads to higher interest rate due to sticky prices
  - based on interest parity, higher interest rate lead to exchange rate appreciation

Introducing money and monetary policy

- Monetary model with sticky prices: Dornbusch (1976) overshooting model
  - monetary tightening leads to higher interest rate due to sticky prices
  - based on interest parity, higher interest rate lead to exchange rate appreciation
- Simple monetary model with flexible prices: Mussa (1976)
  - temporary monetary tightening leads to a less than proportional appreciation of the exchange rate
  - therefore an increase in nominal interest rate is needed to equilibrate the money market

Introducing money and monetary policy

- Liquidity-type models: Christiano and Eichenbaum (1995)
  - monetary tightening leads to higher interest rate because it affects some agents disproportionately (i.e. firms)
  - based on interest parity, higher interest rate is associated with exchange rate appreciation

Introducing money and monetary policy

- Liquidity-type models: Christiano and Eichenbaum (1995)
  - monetary tightening leads to higher interest rate because it affects some agents disproportionately (i.e. firms)
  - based on interest parity, higher interest rate is associated with exchange rate appreciation
- Fiscal theory of the price level models: Auernheimer (2008)
  - nominal interest rate is a policy instrument, thus an increase in interest rate rises inflation tax revenues (conditional on interest elasticity of money demand being less than 1)
  - with higher revenues government can service higher real stock of debt, which requires a fall in the price level and the exchange rate

Interest rates and the exchange rate: Evidence

What is the effect of a monetary tightening on the nominal exchange rate in the data?

- Eichenbaum-Evans (1996): exchange rate appreciates
- Roubini-Kim (2001): corroborate this for broader set of G-7 countries
- Their main conclusion: the standard prediction is supported by the data

Hnatkovska-Lahiri-Vegh, 2012

- Look at a broader set of 72 countries
  - 25 developed and 47 developing
  - monthly data for 1974-2010
- Re-examine the empirical relationship between monetary policy and exchange rates

Exchange rate regimes

- Use flexible exchange rates regimes taken from Reinhart-Rogoff (2004)
- Use their fine classification for flexible rate regimes and include:
  - moving bands
  - managed floats
  - free floats
  - freely falling
- A country could have multiple flexible rate episodes during the sample period
  - minimum 24 months data for each episode
  - 80 country-episodes pairs in total: 25 developed, 55 developing

Empirical approach

- Monetary policy proxied by interest rates
  - T-Bill rates
  - Discount rate (if T-Bill not available)
- Exchange rates are defined as LCU/USD
- Examine relationship using simple correlations and VARs

Simple correlations

	Developed	Developing
$corr(\ln E_t, i_t - i_t^{us})$		
mean	-0.09	0.24
median	-0.08	0.36
$corr(\Delta_t \ln E, \Delta_t (i - i^{us}))$		
mean	-0.10	0.13
median	-0.11	0.13
$\ln E_t = \beta_0 + \beta_1(i_t - i_t^{us}) + \varepsilon_t$		
mean($\hat{\beta}_1$)	-0.74	2.19
95% c.i.($\hat{\beta}_1$)	[-0.94; -0.54]	[1.99; 2.39]
$\Delta_t \ln E_t = \alpha_0 + \alpha_1 \Delta_t(i_t - i_t^{us}) + u_t$		
mean($\hat{\alpha}_1$)	-0.44	0.24
95% c.i.($\hat{\alpha}_1$)	[-0.57; -0.31]	[0.09; 0.38]

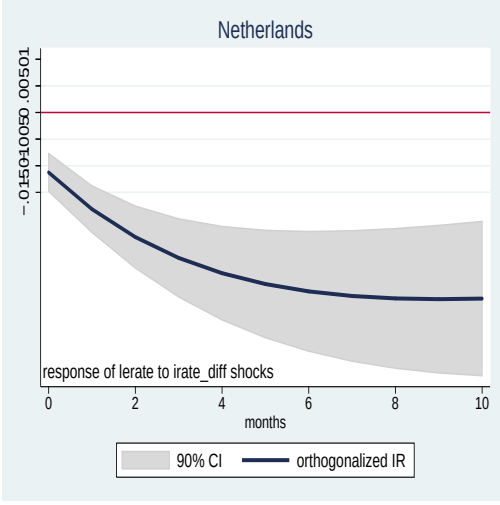
VARs: Exogenous interest rate rule

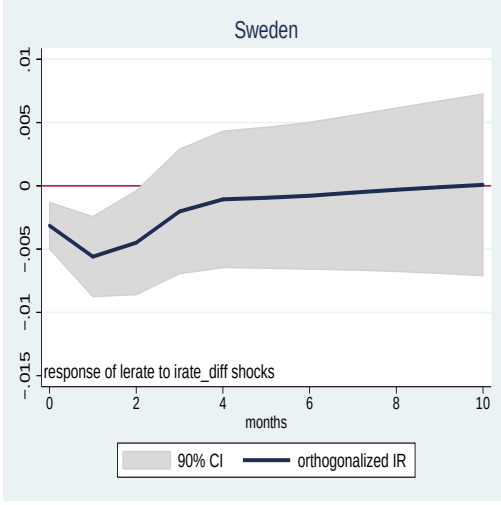
Bivariate VAR specification:

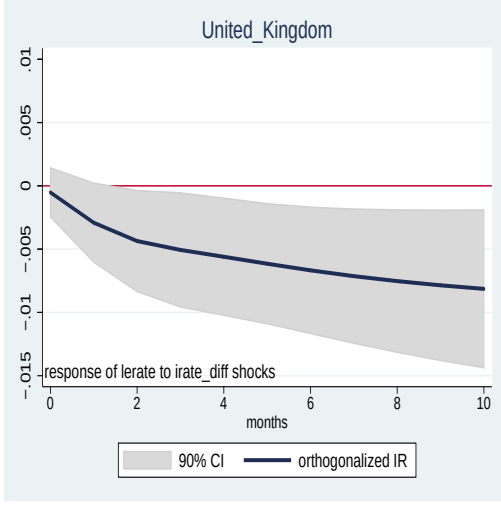
- ordering: $i - i^{US}, \ln E$

	(a). Levels		
	impact	1 month	3 months
Industrial countries: appreciation	84%	88%	84%
Developing countries: depreciation	75%	75%	75%
	(b). First-differences		
	impact	1 month	3 months
Industrial countries: appreciation	84%	88%	52%
Developing countries: depreciation	70%	62%	60%

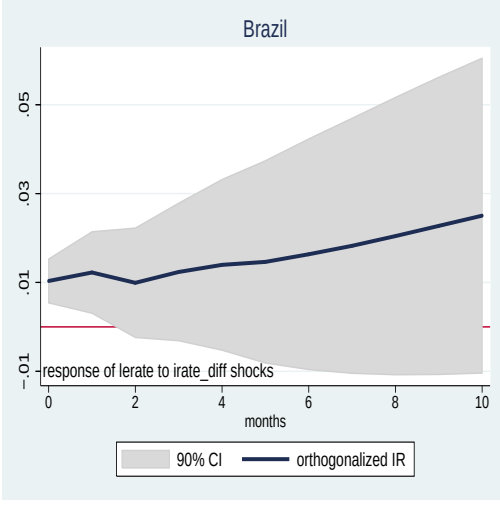
Bivariate VARs: Some developed countries

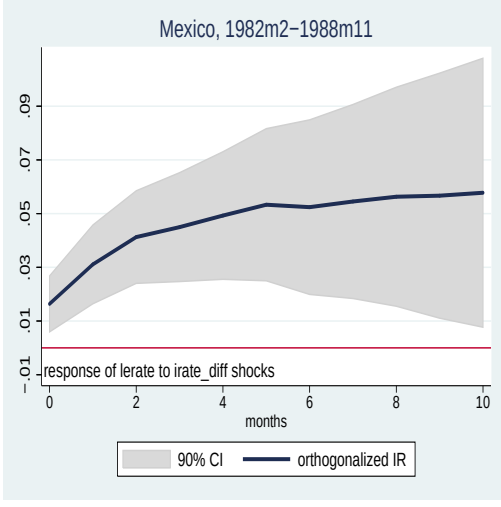


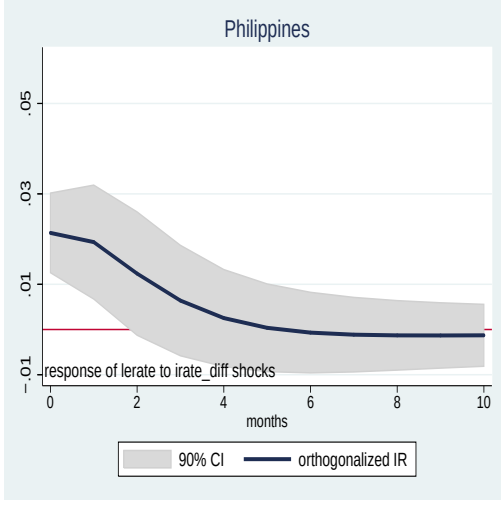




Bivariate VARs: Some developing countries







VARs: Endogenous interest rate rules

- Specification 2. With price level: $\ln P, i - i^{US}, \ln E$
- Specification 3. With CPI inflation: $\pi, i - i^{US}, \ln E$
- Specification 4. With expected inflation: $\pi_{t+1} - \pi_{t+1}^{US}, i_t - i_t^{US}, \ln E_t$
- Specification 5. With risk premium shocks: $rp, i - i^{US}, \ln E$
- Specification 6. With output: $\ln y, i - i^{US}, \ln E$
- Specification 7. All shocks: $rp, \ln y, \ln P, i - i^{US}, \ln E$
- Specification 8. Structural VAR:
  - interest rates have no long-run effects on the *real* exchange rate

VAR results

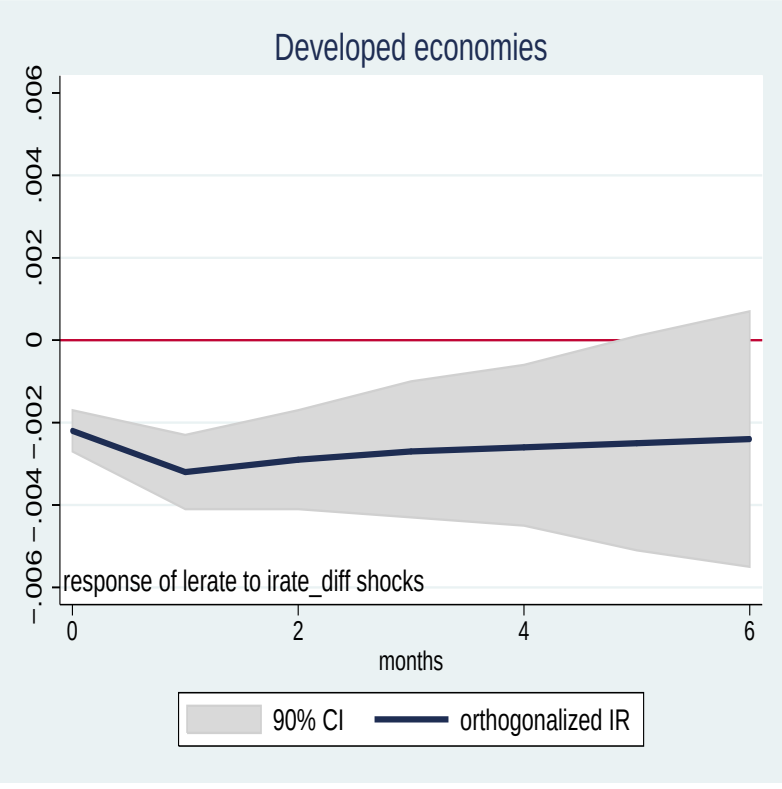
Impulse response of exchange rate to interest rate shock

	(a). Levels		
	impact	1 month	3 months
(2): $\ln P, i - i^{US}, \ln E$			
Industrial: app	82%	82%	82%
Developing: dep	76%	67%	74%
(3): $\pi - \pi^{US}, i - i^{US}, \ln E$			
Industrial: app	82%	82%	82%
Developing: dep	67%	69%	69%
(4): $\pi_{t+1} - \pi^{US}_{t+1}, i_t - i^{US}_t, \ln E_t$			
Industrial: app	82%	82%	82%
Developing: dep	71%	69%	71%
(5): $rp, i - i^{US}, \ln E$			
Industrial: app	72%	84%	84%
Developing: dep	72%	72%	69%
(6): $\ln y, i - i^{US}, \ln E$			
Industrial: app	84%	89%	84%
Developing: dep	64%	73%	64%
(7): $rp, \ln y, \ln P, i - i^{US}, \ln E$			
Industrial: app	83%	92%	92%
Developing: dep	70%	60%	70%

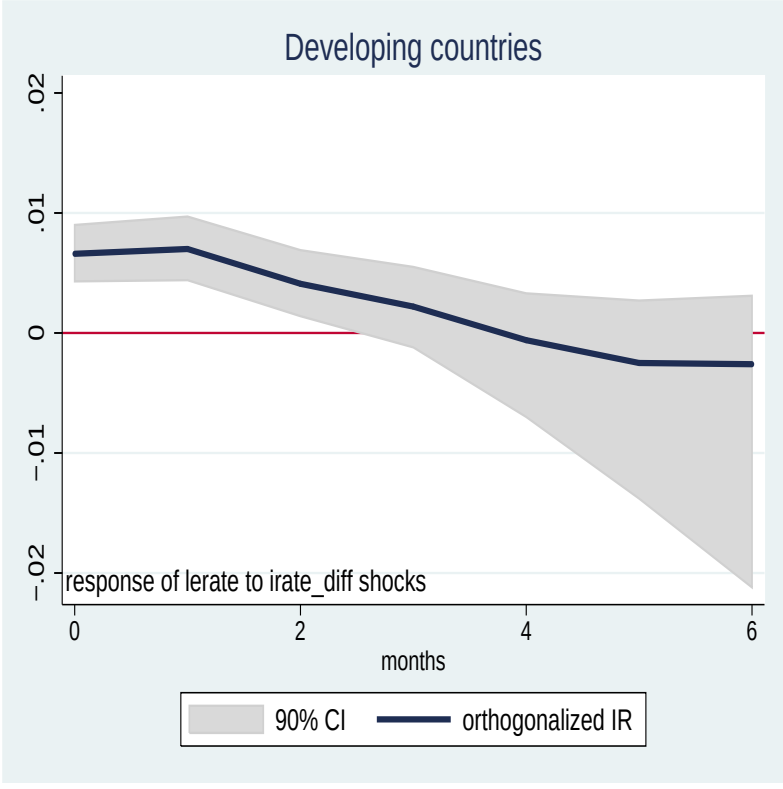
Panel VAR

- An alternative strategy is to run panel VARs
  - separate panels for developing and developed countries
- Remove country-specific fixed effects in two ways
  - de-meaning and de-trending
  - first-differencing
- Use Arellano-Bond GMM approach using lagged regressors as instruments

Panel VARs: Impulse response (levels)



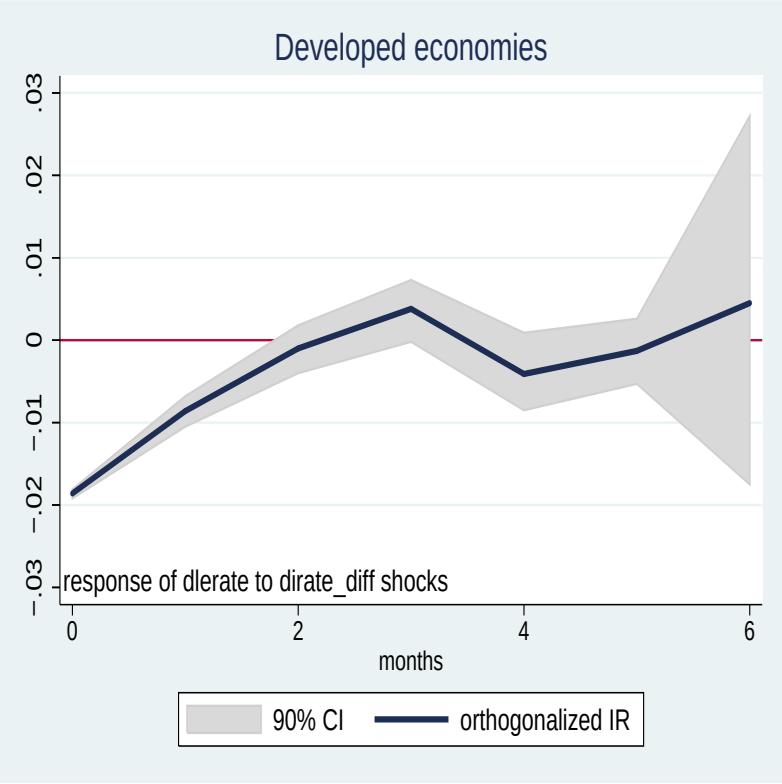
(g) industrial countries



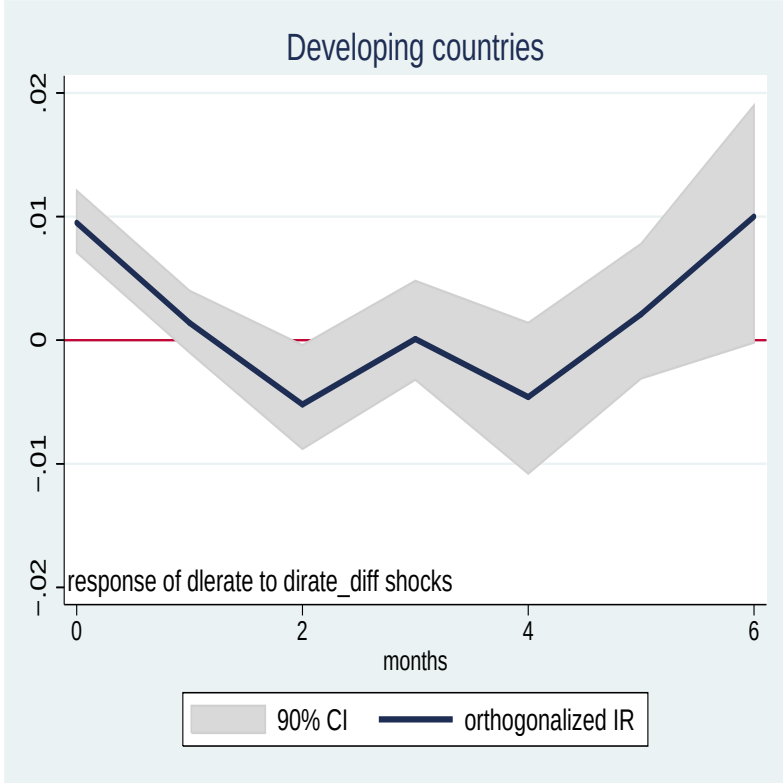
(h) developing markets

Figure: Exchange rate response to interest rate shock

Panel VARs: Impulse response (first-difference)



(a) industrial countries

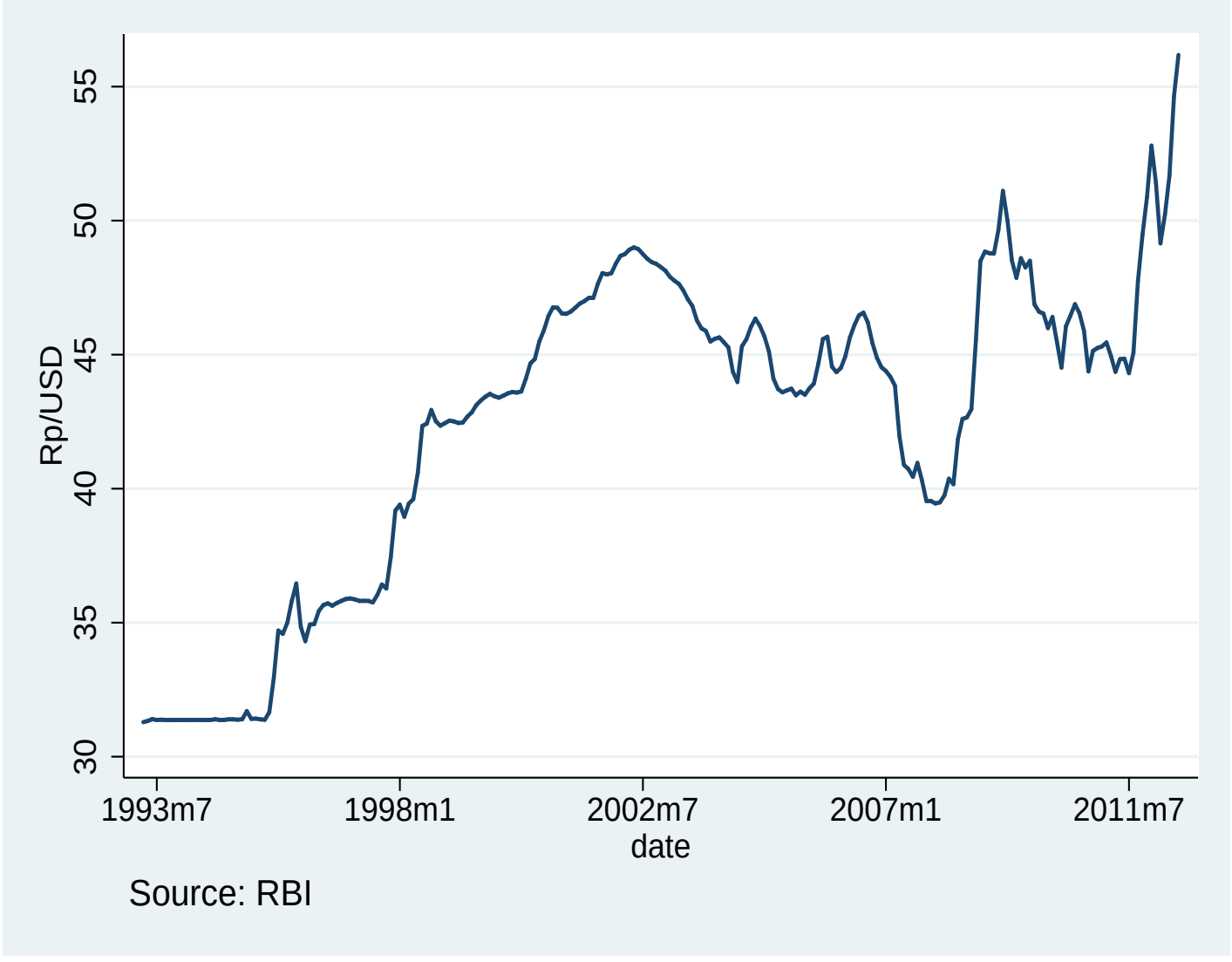


(b) developing markets

Figure: Exchange rate response to interest rate shock

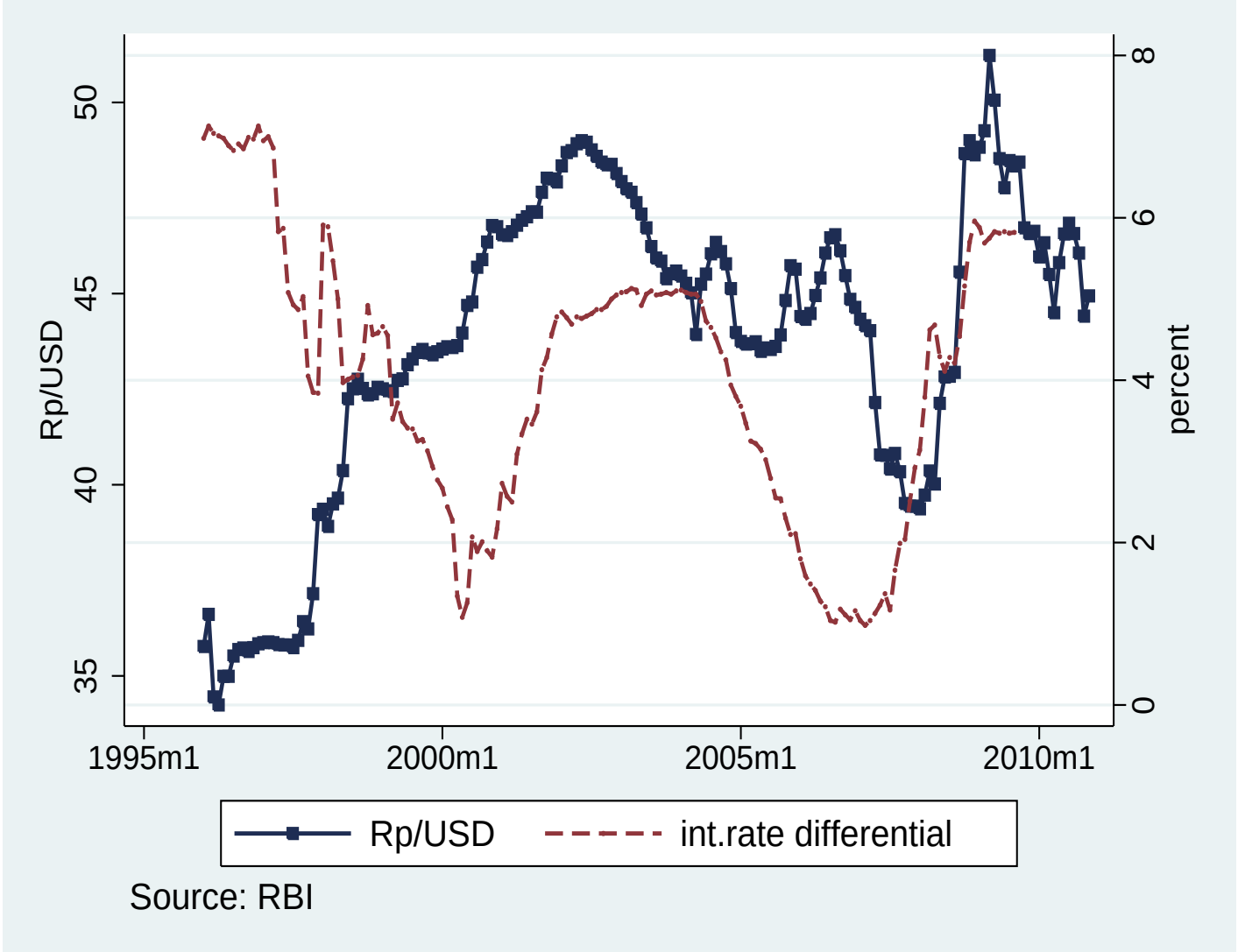
Case study: India

Figure: Rupee exchange rate, Rp/USD



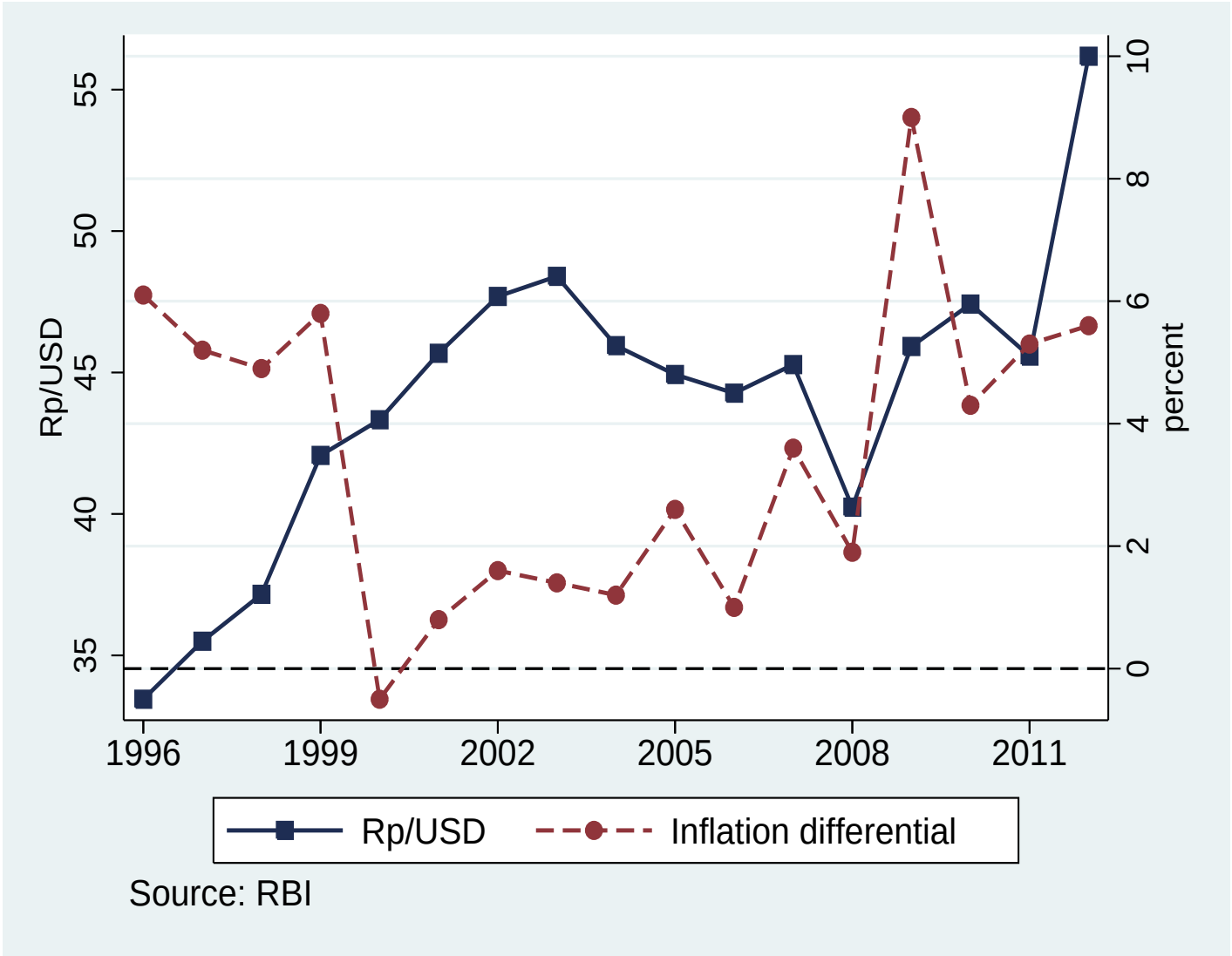
Case study: India

Figure: Rupee exchange rate vs interest rate differential, relative to USD



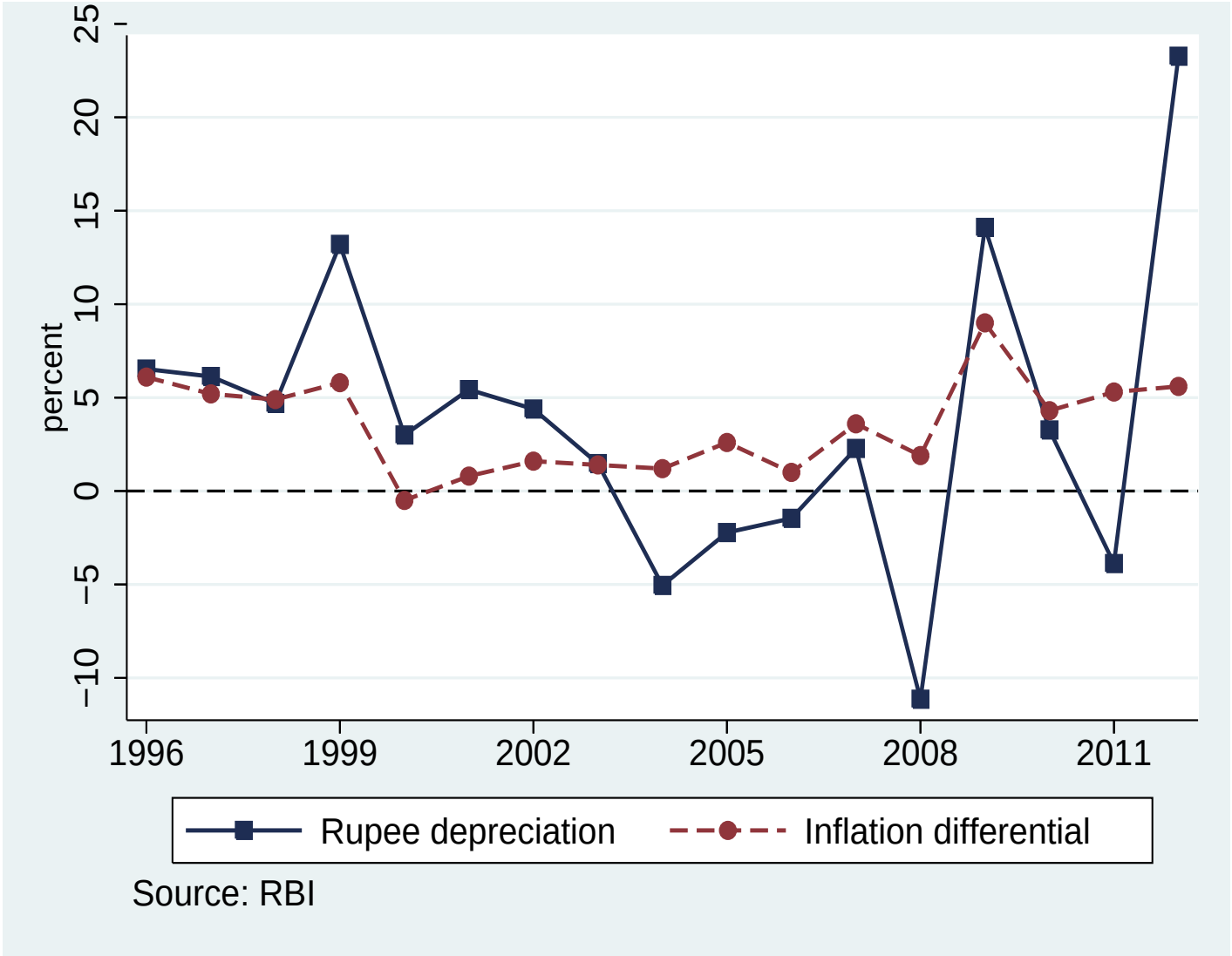
Case study: India

Figure: Rupee exchange rate vs inflation differential, relative to USD



Case study: India

Figure: Rupee depreciation vs inflation differential, relative to USD



Case study: India

Figure: Choosing the sample period

Natural Classification Bucket	Number assigned to category in fine grid	Number assigned to category in coarse grid
No separate legal tender	1	1
Pre announced peg or currency board arrangement	2	1
Pre announced horizontal band that is narrower than or equal to +/- 2%	3	1
De facto peg	4	1
Pre announced crawling peg	5	2
Pre announced crawling band that is narrower than or equal to +/- 2%	6	2
De facto crawling peg	7	2
De facto crawling band that is narrower than or equal to +/- 2%	8	2
Pre announced crawling band that is wide than or equal to +/- 2%	9	2
De facto crawling band that is narrower than or equal to +/- 5%	10	3
Moving band that is narrower than or equal to +/- 2% (i.e., allows for both appreciation and depreciation over time)	11	3
Managed floating	12	3
Freely floating	13	4
Freely falling	14	5

Case study: India

VAR evidence (refer to STATA code):

- Following positive Y shocks:
  - Y in/decrease
  - ER app/depreciates
- Following positive R shocks:
  - Y in/decrease
  - ER app/depreciates

Model objectives

- Rationalize different business cycle properties of developed and developing countries
- ... and explain the differential response of the exchange rate in the two groups of countries
- Start with a neoclassical version of a small open economy model
- Think how developed and developing countries are different:
  - Shocks are different
  - Transmission of shocks is different
  - Ability to precommit to a policy rule is different: "fear of floating"

Transmission of shocks

- Modify the standard model to introduce three effects of monetary policy
  - Liquidity demand effect
  - Fiscal effect
  - Output effect

Impact of margins

- Effects reflect institutional features and differences in stage of the developmental process
  - size of money base and access to interest bearing assets
  - state of public finances and reliance on inflation tax
  - deepness of financial markets and reliance on bank finance
- Effects impact the transmission of monetary policy to the exchange rate
- Effects have opposing impacts on the exchange rate
- Can differences in strengths of these effects explain the different responses in developed and developing countries?

The Model

- Small open economy
- Four types of agents
  - Worker-household
  - Banks
  - Firms
  - Government

Environment

- Workers allocate time between work and leisure
- Firms produce output using labor
  - face wage-in-advance constraint
- Banks take deposits and make loans
  - lend to both firms and government
- Government faces an exogenously given level of fiscal spending

Households

- Lifetime utility:

$$V = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U\left(c_t, x_t\right)$$

- Households face transactions costs: $s_t = v\left(\frac{H_t}{P_t}\right) + \psi\left(\frac{D_t}{P_t}\right)$
- Budget constraint:

$$\begin{aligned} & P_t\left(b_{t+1} + c_t + I_t + s_t + \kappa_t\right) + H_t + D_t \\ = \quad & P_t\left(Rb_t + w_t x_t + \rho_t k_{t-1} + \Omega_t^f + \Omega_t^b + \tau_t\right) + H_{t-1} + \left(1 + i_t^d\right) D_{t-1} \end{aligned}$$

Firms

- Firms produce using the technology:

$$y_t = A_t k_{t-1}^{\alpha} l_t^{1-\alpha}$$

- Loan demand: fraction ϕ of the wage bill needs to be paid upfront

$$N_t = \phi P_t w_t l_t, \quad \phi > 0$$

- The firm's nominal flow constraint is

$$P_t b_{t+1}^f + \left(1 + i_t^l\right) N_{t-1} + P_t \Omega_t^f = P_t \left(R b_t^f + y_t - w_t l_t - \rho_t k_{t-1} \right) + N_t$$

Banks

- Banks make loans N and Z and accept deposits D
- Issue foreign debt d^b and hold required reserves θD
- Bank's nominal flow constraint

$$\begin{aligned} & N_t + Z_t - D_t + \theta \left(D_t - D_{t-1} \right) + P_t \left(q_t - d^b_{t+1} \right) + P_t \Omega^b_t \\ = \quad & \left(1 + i^l_t - \phi^n \right) N_{t-1} + \left(1 + i^g_t \right) Z_{t-1} - \left(1 + i^d_t \right) D_{t-1} - P_t R d^b_t \end{aligned}$$

- q: bank cost of managing their portfolio of foreign assets (breaks interest parity)
- ϕ^n : cost of managing loans (calibration parameter)

Government

- Consolidated government's nominal flow constraint is

$$P_t \bar{\tau} + (1 + i_t^g) Z_{t-1} = M_t - M_{t-1} + Z_t$$

- Rate of growth of the nominal money supply is:

$$\frac{M_{t+1}}{M_t} = 1 + \mu_{t+1}, \qquad M_0 \text{ given.}$$

Policy choices

- The government has three policy instruments:
  - rate of money growth μ
  - interest rate policy which involves setting i^g
  - lump sum transfers to the private sector τ
- Since τ is exogenous, only one of μ and i^g can be chosen freely

Key margins

- Deposit demand introduces the liquidity demand effect of monetary policy
- Wage-in-advance introduces output effect of monetary policy
- Exogenous τ is the source of fiscal effect of interest rate policy

Calibration strategy

- Keep most of the parameters common to both sets of countries
- Calibrate a few key parameters separately for developed and developing countries
- Parameterization for the developed countries:
  - Australia, Canada, Netherlands, New Zealand, Sweden and UK
- Parameterization for developing countries:
  - Argentina, Brazil, Korea, Mexico, Philippines, and Thailand
- Period used: 1974-2010
- Nominal variable: 1998-2010 (avoids Asian crisis volatility)

Functional forms

- Preferences

$$U(c,x) = \frac{1}{1-\sigma}\left(c - \zeta x^{\nu}\right)^{1-\sigma}, \quad \zeta > 0, \quad \nu > 1$$

- Transactions cost

$$s_{\varkappa}\left(\varkappa^2 - \lambda_{\varkappa}\varkappa + \left(\tfrac{\lambda_{\varkappa}}{2}\right)^2\right), \qquad \chi = h, d$$

- Capital adjustment cost

$$\kappa(I_t, k_{t-1}) = \frac{\xi}{2} k_{t-1}\left(\frac{I_t - \delta k_{t-1}}{k_{t-1}}\right)^2, \qquad \xi > 0$$

- Banking cost

$$q_t = \frac{\gamma}{2}\left(d^b_{t+1} - \bar{d}^b\right)^2, \qquad \gamma > 0$$

Calibration: Common parameters

PREFERENCES		
discount factor	β	0.97
risk-aversion	σ	5
labor curvature	υ	1.6
labor weight	ζ	2.48
TECHNOLOGY		
capital income share	α	0.38
depreciation rate	δ	0.044
share of wage-in-advance	ϕ	0.15
capital adjustment costs	ξ	4.5
MONEY		
banks cost technology	γ	100

Calibration: Group-specific parameters

Targets:

- M1/GDP: 20% in developed countries and 10% in developing economies
- D/H: 4 in developed countries and 1 in developing countries
- interest elasticities of deposits and cash set to be equal within each group
- and across groups, and equal to -0.04

MONEY		DEVELOPED	DEVELOPING
reserve requirement	θ	0.03	0.10
transaction cost technology	$\lambda_\varkappa$	λ_h =0.244, λ_d =1.303	λ_h =0.125, λ_d =0.138
	s_x	s_h =24.55, s_d =0.097	s_h =100, s_d =4.8
share of wage-in-advance	ϕ	0.15	0.15
lump-sum transfers	τ	1.3% of GDP	2.1% of GDP

Shocks

- Productivity: $A_{t+1} = 0.95A_t + \varepsilon^A_{t+1}$
- Interest rate rules:
  - Exogenous

$$i^g_{t+1} = \rho_g i^g_t + \varepsilon^g_{t+1}$$

  - Generalized Taylor

$$i^g_{t+1} = \rho_g i^g_t + \alpha_1 \left(\pi_t - \pi^*\right) + \alpha_2 y^{gap}_t + \varepsilon^g_{t+1}$$

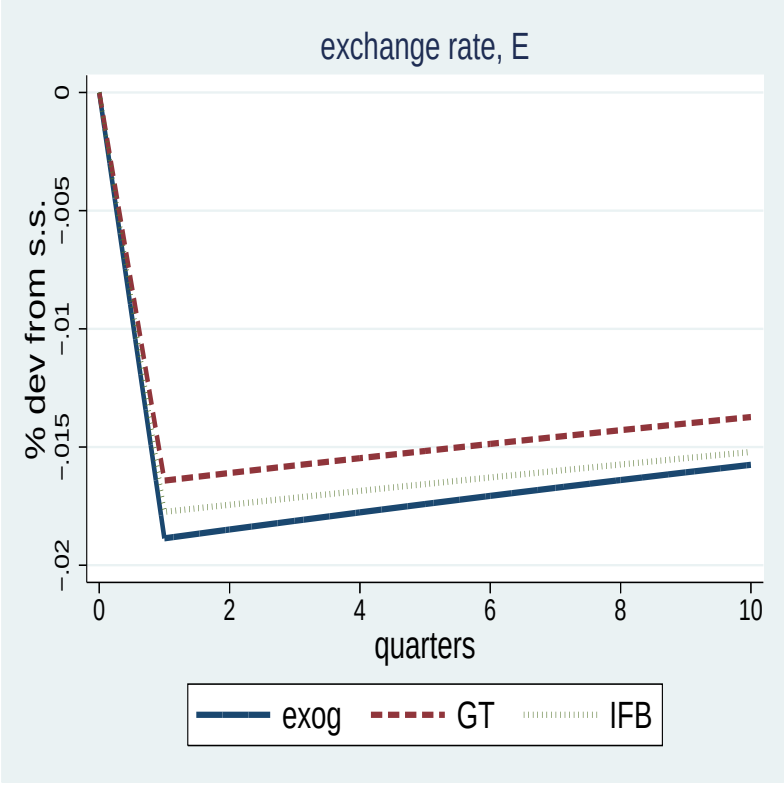
  - Inflation-Forecast-Based (IFB)

$$i^g_{t+1} = \rho_g i^g_t + \alpha_1 \mathbb{E}_t \left(\pi_{t+1} - \pi^*\right) + \alpha_2 y^{gap}_t + \varepsilon^g_{t+1}$$

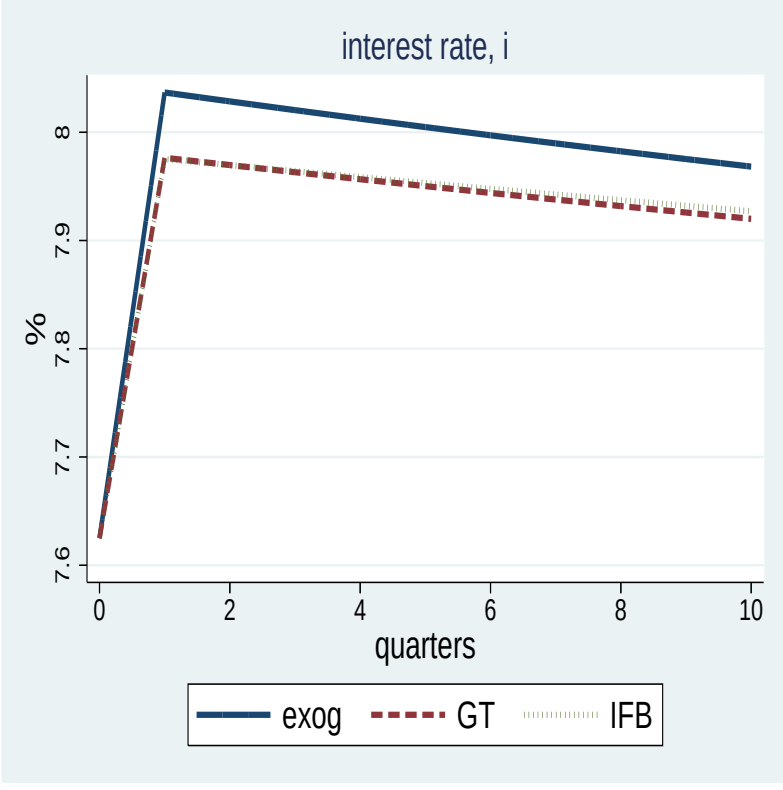
Estimated interest rate rules

	Developed countries			Developing countries		
	Exogenous	Taylor	IFB	Exogenous	Taylor	IFB
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
i_t^g	0.982***	0.918***	0.897***	0.959***	0.684***	0.876***
	(0.007)	(0.018)	(0.024)	(0.023)	(0.086)	(0.059)
y_t^{gap}		0.054***	0.069***		0.116***	0.063***
		(0.012)	(0.013)		(0.031)	(0.019)
$\pi_t - \pi^*$		0.076***			0.382***	
		(0.026)			(0.138)	
$\mathbb{E}_t\left(\pi_{t+1} - \pi^*\right)$			0.107***			0.128***
			(0.030)			(0.075)
$\sigma(i^g)$	1.416			5.209		
$\sigma(\varepsilon_{t+1}^g)$	0.479	0.407	0.405	2.150	1.470	0.754

Developed country impulse responses

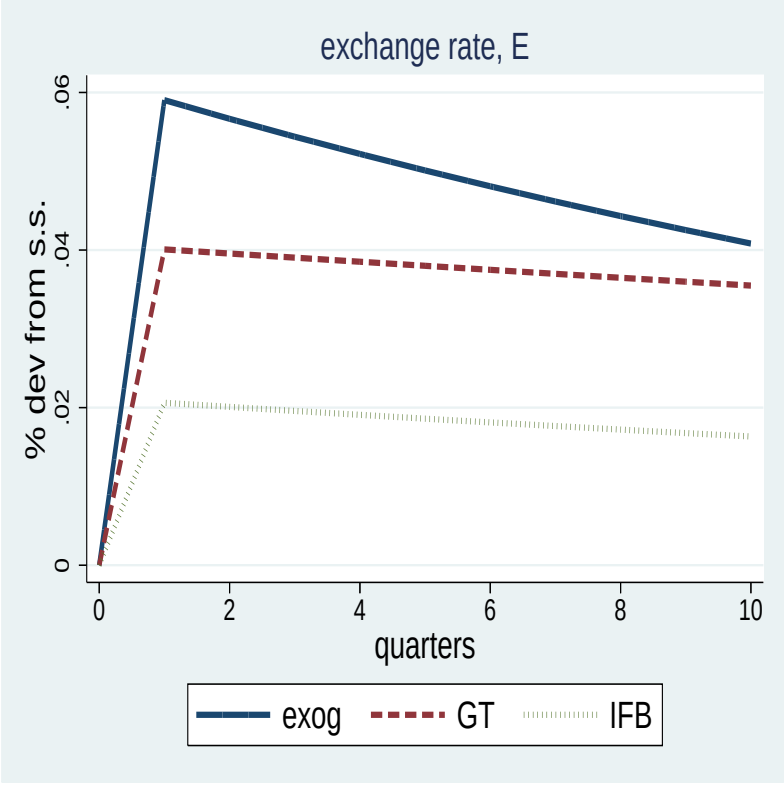


(a) E: developed countries

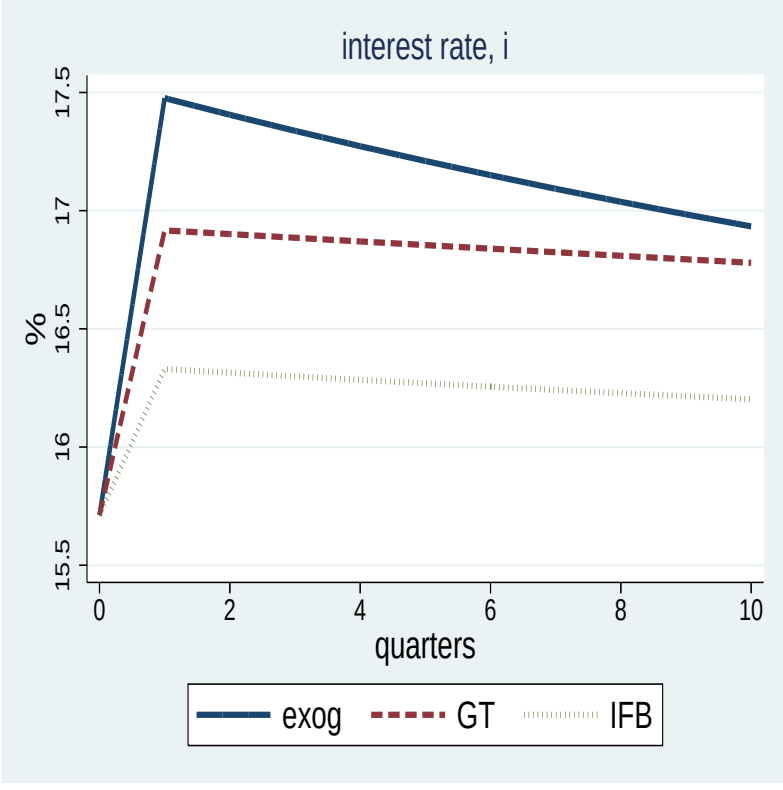


(b) i: developed countries

Developing country impulse responses



(c) E: developing countries



(d) i: developing countries

Key equilibrium relations

- Interest parities:

$$\begin{aligned} i_t^l &= i_t^g + \phi^n, \\ i_t^d &= (1-\theta)\, i_t^g \end{aligned}$$

- Combined government flow constraint:

$$\bar{\tau} = \left(h_t - \frac{h_{t-1}}{1+\pi_t} \right) + \theta \left(d_t - \frac{d_{t-1}}{1+\pi_t} \right) + z_t - \left(\frac{1+i_t^g}{1+\pi_t} \right) z_{t-1}$$

- Demand for cash and deposits:

$$h_t = \tilde{h} \left(\frac{i_{t+1}}{1+i_{t+1}} \right) \; and \; d_t = \tilde{d} \left(\frac{i_{t+1} - (1-\theta)\, i_{t+1}^g}{1+i_{t+1}} \right)$$

Exchange rate determination

- Exchange rate: $E_t = \frac{M_t}{L\left(i_{t+1}, i^g_{t+1}\right)}$, M_0 given
- Real money demand: $L\left(i_{t+1}, i^g_{t+1}\right) = h(i_{t+1}) + \theta d\left(i_{t+1}, i^g_{t+1}\right)$
- Changes in i^g have two types of effects:
  - *direct effect:* on deposits through interest parities
  - *indirect effect:* on i through government budget constraint
- i and i^g jointly determine L which determines E

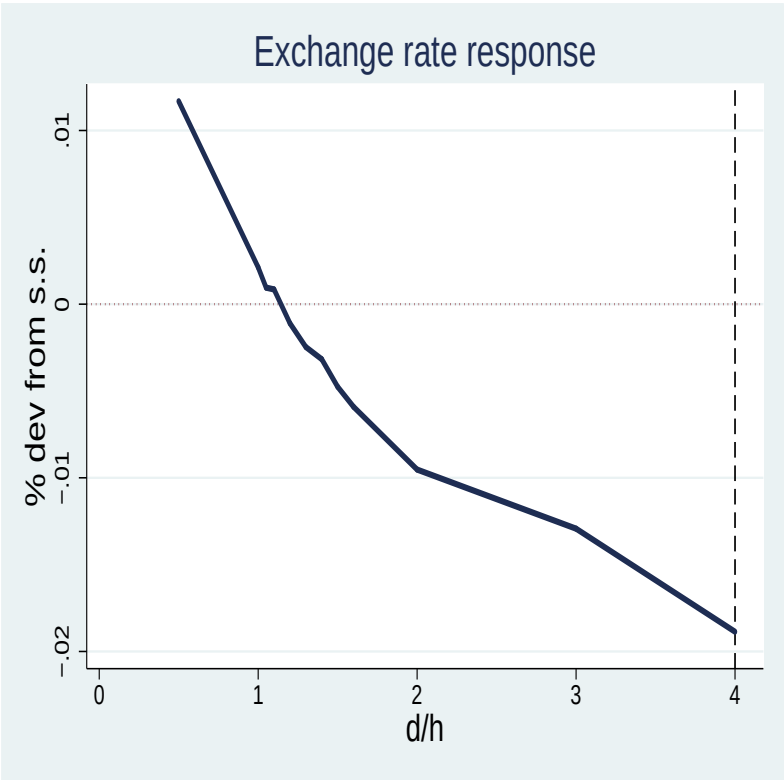
Exchange rate determination: Intuition

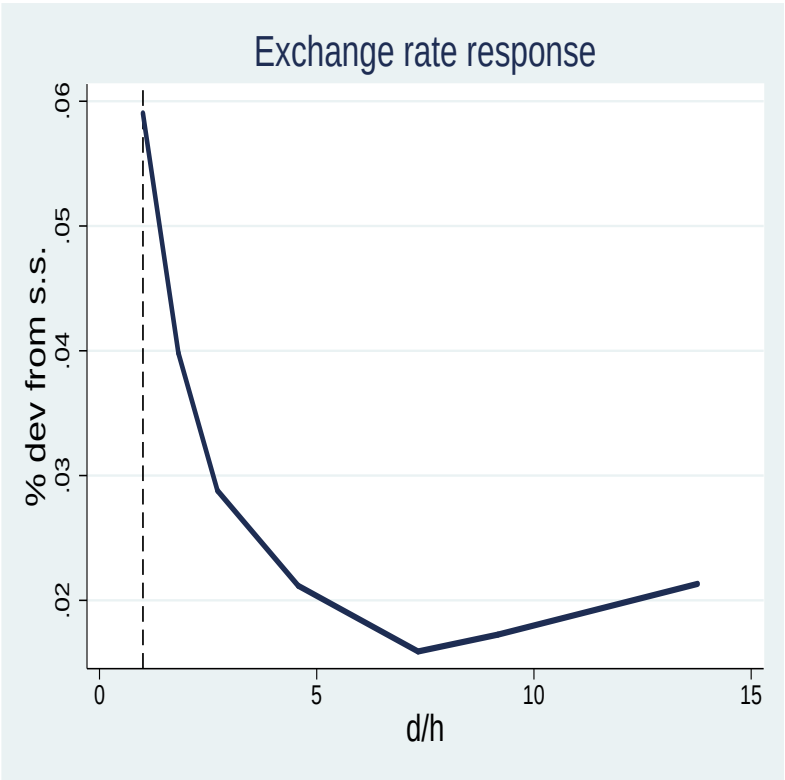
$$\frac{dL}{di^g} > 0 \Longrightarrow E \ appreciates$$
$$\frac{dL}{di^g} < 0 \Longrightarrow E \ depreciates$$

Two key factors affect L:

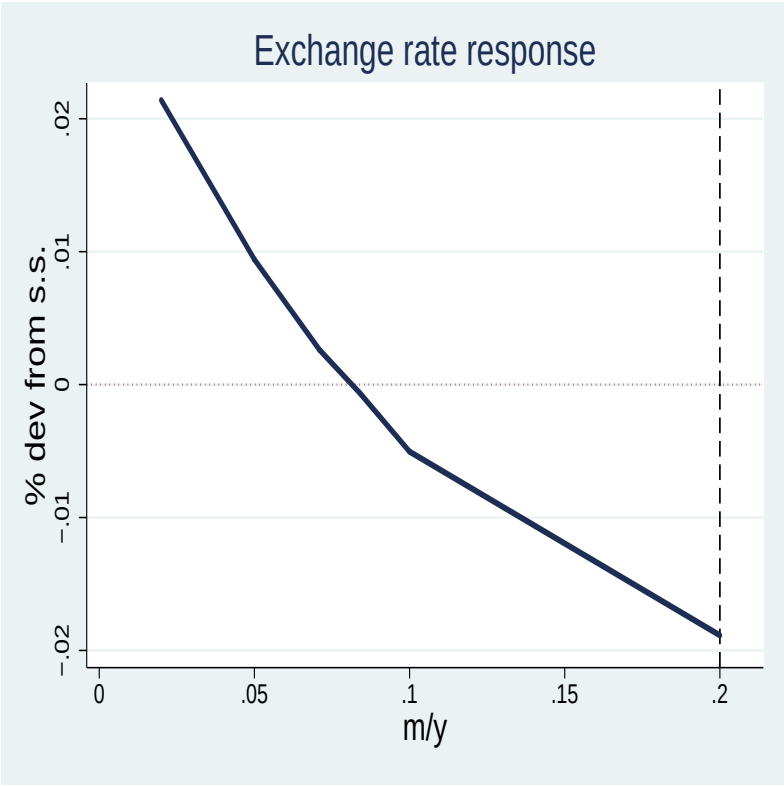
- $\frac{d}{h}$: the higher this ratio, the more likely appreciation is
- i: which in turn is determined by
  - the money base, $h + \theta d$ – liquidity demand effect
  - the fiscal spending, τ – fiscal effect
  - the amount of outstanding private loans n, which in turn pins down government bonds – output effect

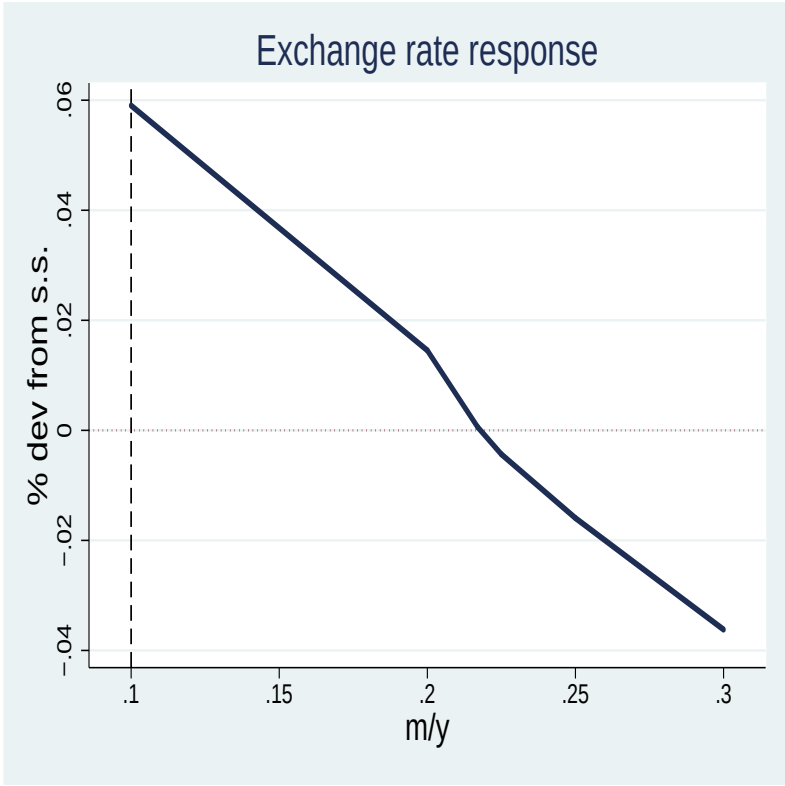
Counterfactual experiments: $\frac{d}{h}$



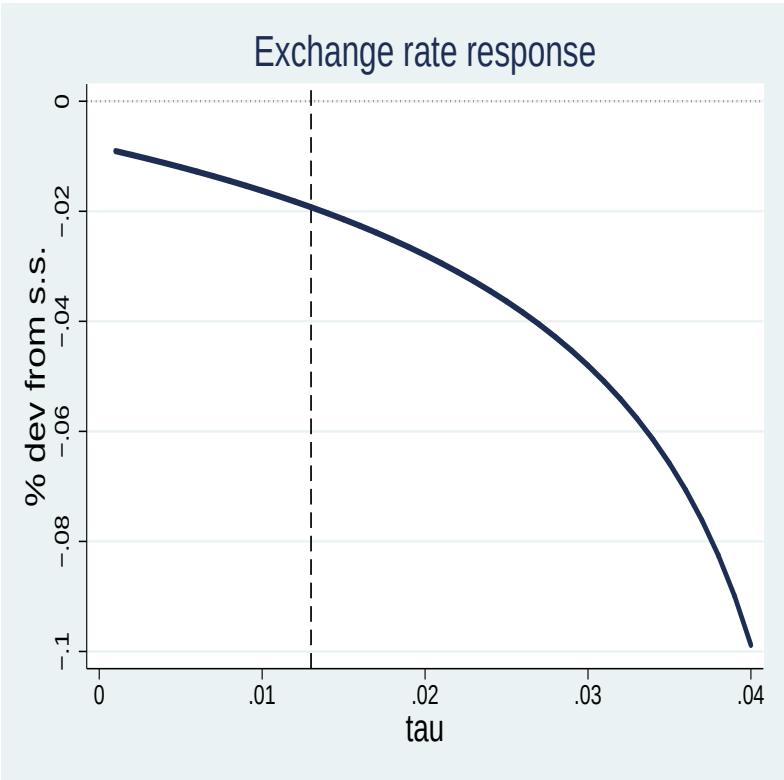


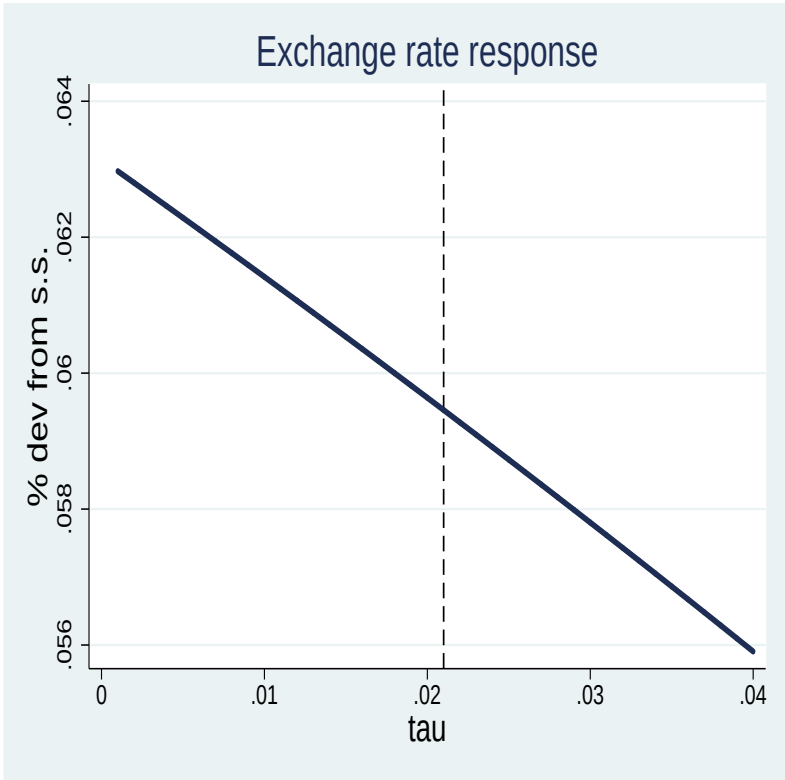
Counterfactual experiments: $\frac{m}{y}$



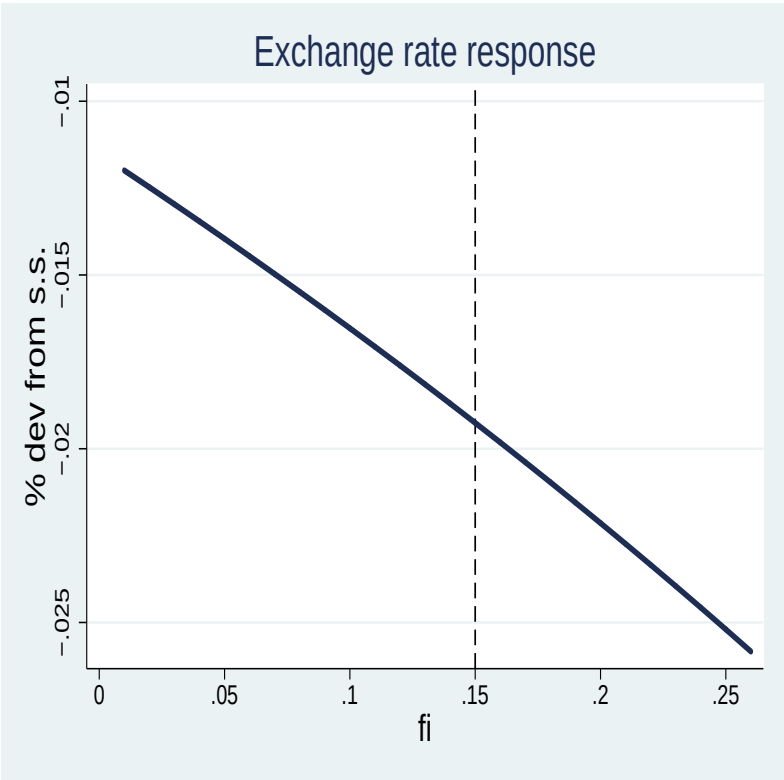


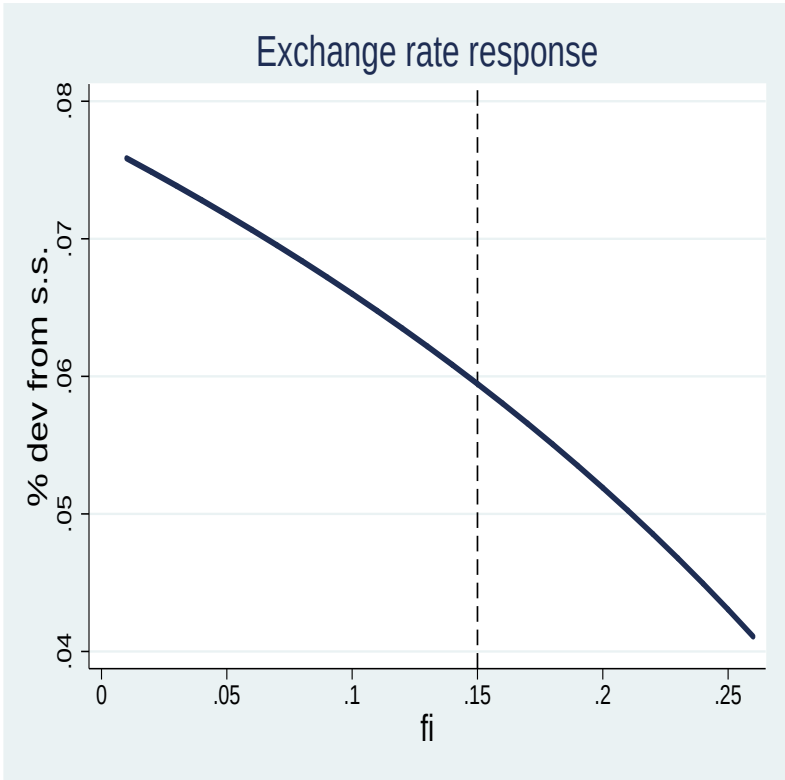
Counterfactual experiments: τ





Counterfactual experiments: ϕ





Evidence on the mechanism

Dependent variable: 1–appreciation, 0–depreciation

	(i)	(ii)	(iii)	(iv)
1-developing, 0-developed	-0.4073***	-0.1835	0.0362	0.2452
	(0.1658)	(0.2763)	(0.2577)	(0.3467)
d/h		0.0440		0.0460
		(0.0336)		(0.0498)
m/y			0.0545***	0.0551***
			(0.0164)	(0.0169)
N	36	36	36	36

Conclusion

- Uncovered a new data fact
  - exchange rate response to monetary policy changes differs systematically between developed and developing countries
- Finding contradicts predictions of the typical monetary models currently used
- Key to rationalize the difference is the different strength of the typical effects of monetary policy