The Macroeconomic Consequences of Exchange Rate Depreciations

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Exchange Rates and Macroeconomy

- How does an exchange rate depreciation affect the economy?
- Surprisingly: It is not so clear!
  - Simple textbook logic suggests expansionary effect
    (Dornbusch 80, Obstfeld-Rogoff 96)
  - Long literature on contractionary depreciations
    (Diaz Alejandro 63, Cooper 69, Krugman-Taylor 78, Auclert et al. 21;
    Krugman 99, Aghion-Bacchetta-Banerjee 01)
  - Long literature on exchange rate disconnect
    (Meese-Rogoff 83, Baxter-Stockman 89, Flood-Rose 95,
    Obstfeld-Rogoff 00, Devereux-Engel 02, Itskhoki-Mukhin 21)
- Precious little consensus

The Challenge

- Exchange rates are endogenous
- For example: Bad domestic shock
    - Currency depreciates and economy does badly
    - Not evidence of contractionary effect of depreciation
    - Direct effect of the shock is a confound
- Hard to measure causal effect of exchange rate movements
- Is it even possible?

Our Approach

- Compare USD pegs versus floats when USD exchange rate changes
- Example:
  - Egypt pegs to USD, South Africa floats versus USD
  - When USD depreciates, EGP depreciates versus ZAR
  - How does this event affect other macro outcomes in Egypt versus South Africa?
- "Regime-induced" exchange rate fluctuations
  - Not all the variation in EGP and ZAR
  - Component of exchange rate fluctuations that is caused by earlier choice of exchange rate regime

Identification

- Assumption: Pegs and floats are not differentially exposed to other shocks that are correlated with the USD
- Time fixed effects absorb direct effect of shocks driving USD
  (and indirect effects through other channels than exchange rate)
- Exclude exchange rate fluctuations coming from domestic shocks
  - We consider USD vs. 24 “advanced economies” excluded from analysis
- What is left? “Regime-induce” effect of foreign exchange rate change
- Most obvious concern goes against our findings

Main Empirical Results

- Depreciation strongly expansionary:
  - 10% depreciation $\rightarrow$ 5.5% increase in GDP (over 5 years)
- Net exports fall
  - Rules out export-led boom from expenditure switching
- Nominal interest rates rise
  - Rules out monetary policy induced boom
- Inconsistent with a large class of models

Financially Driven Exchange Rates

- Show that a financially driven exchange rate model (FDX) can match our empirical results
  - UIP shocks make currency "cheap"
  - Household/firms borrow from abroad $\rightarrow$ boom
- Also consistent with unconditional exchange rate disconnect, Backus-Smith fact, Mussa fact
  - Multiple financial shocks drive the exchange rate
  - UIP shocks generate $\text{Cor}(E_t, Y_t) > 0$
  - Capital flight shocks generate $\text{Cor}(E_t, Y_t) < 0$
  - Pegging eliminates UIP shocks but effects of capital flight shocks worse

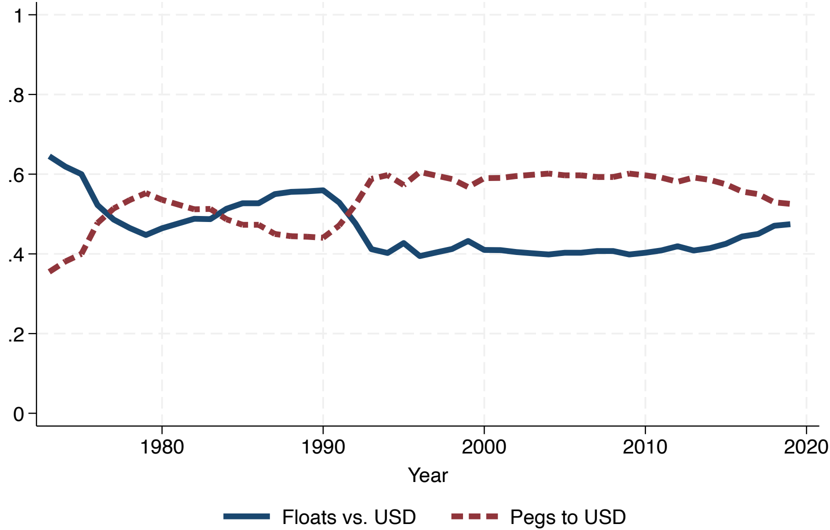
Empirical Results

Exchange Rate Regimes

- Sample period 1973-2019
- FX classification based on Ilzetzki-Reinhart-Rogoff 19 ▸ Regimes
  - Pegs: Fine classification codes 1-8 with USD anchor
  - Floats: Fine classification code 13 or with anchor other than USD
- Many “floats” are countries that peg to euro
- BIS Trade-weighted USD exchange rate relative to 24 countries:
  - Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom
- We exclude these countries from our pegger and floater samples

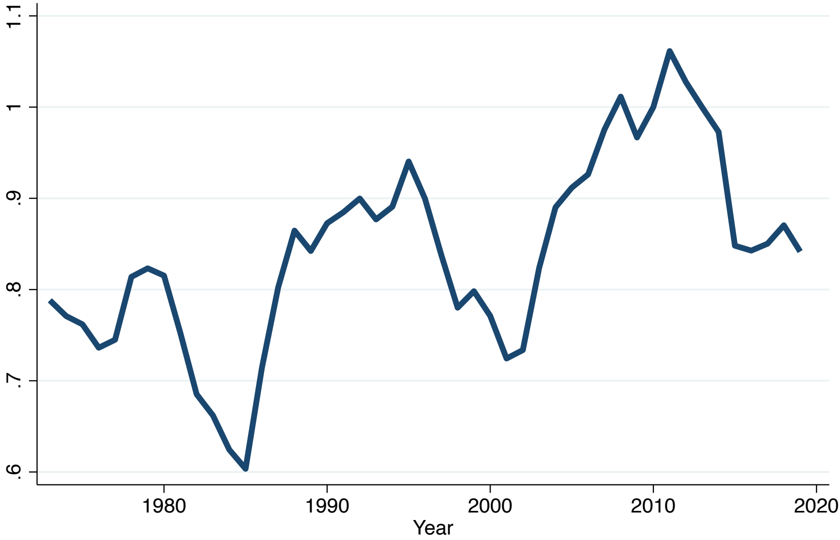
▸ Pegs More Exposed? ▸ Do Pegs Differ from Floats?

Exchange Rate Regimes



Pegs by Region

USD Nominal Effective Exchange Rate



High values are a more depreciated USD

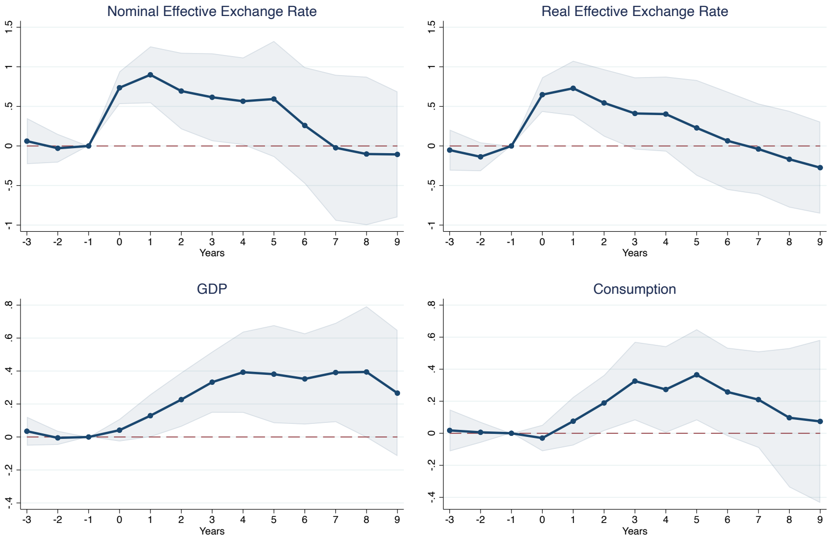
Empirical Specification

$$y_{i,t+h} - y_{i,t-1} = \alpha_{i,h} + \alpha_{r(i),t,h} + \beta_h \text{Peg}_{i,t} \times \Delta e_{USD,t} + \Gamma'_h \mathbf{X}_{i,t-1} + \gamma_h \text{Peg}_{i,t} + \epsilon_{i,t,h}$$

- Benchmark controls:
  - Lagged growth of $y_{i,t}$, real GDP, and treatment variable
- Standard errors are two-way clustered by country and time
- We drop top and bottom 0.5% of each outcome variable
- Drop year of and year after country switches exchange rate regime
- Regions: Europe, Americas, Africa, Asia-Oceania

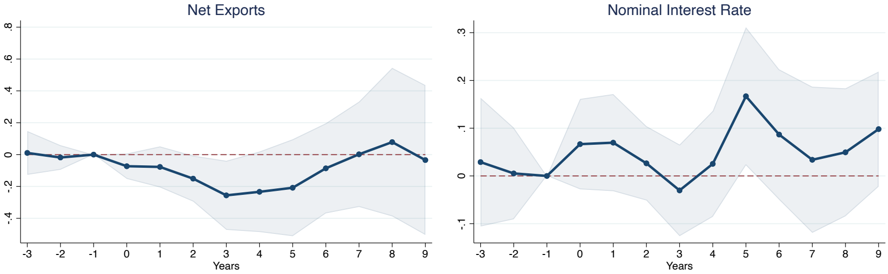
▸ Data Sources

Dynamic Response to Depreciation: Benchmark



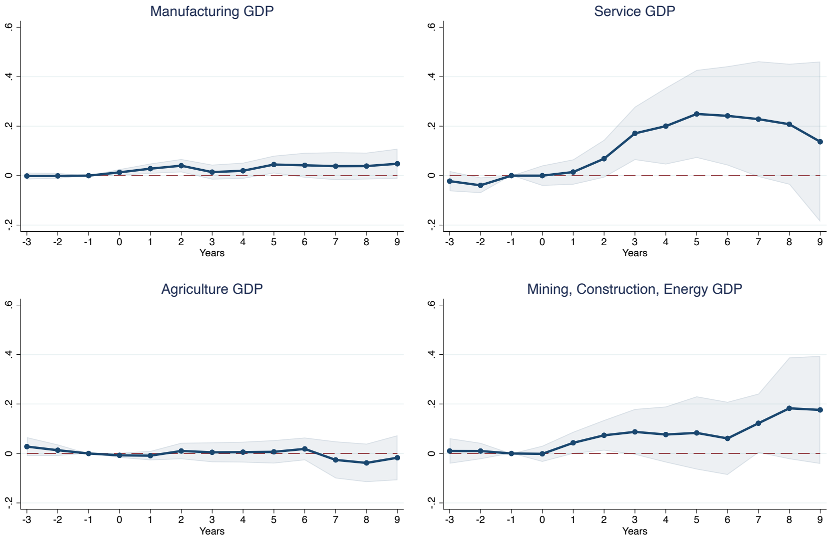
▸ No Controls ▸ Two lags ▸ X rate with USD

Net Exports and Nominal Interest Rate



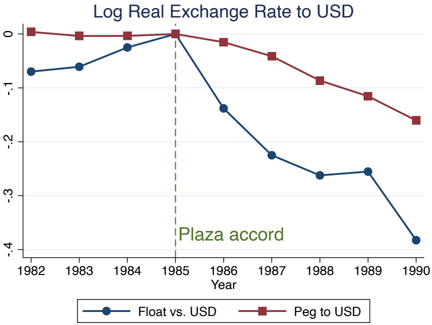
▸ Investment, Exports, Imports ▸ Terms of Trade, CPI, Real Rate

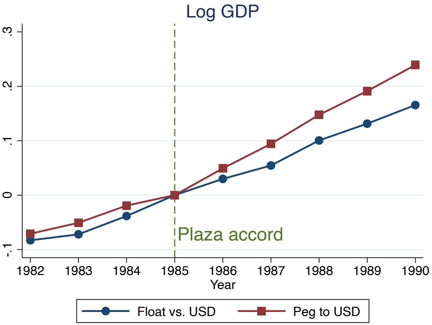
Response by Sector



▸ Het. by CA Opennes ▸ Early / Late

- January 1985: James Baker becomes Treasury Secretary
- September 22, 1985: G5 jointly agreement to depreciate USD





ROBUSTNESS

- Time FE rather than region x time FE ▸ Result
- No controls (except FE) ▸ Result Two lags ▸ Result
- Drop more outliers ▸ Result
- Classify 9-12 as Floats ▸ Result
- Classify 9-12 as Pegs ▸ Result
- GDP-weighted USD exchange rate ▸ Result
- Control for interaction between peg and:
  - US GDP, inflation, and T-Bill rate ▸ Result
  - Commodity price index ▸ Result
- Balanced panel ▸ Result
- Include 24 "advanced" economies ▸ Result

A Financially Driven Exchange Rate Model

Theoretical Challenge

- How does an exchange rate depreciation stimulate the economy?
- Expenditure switching:
  - Home goods cheaper / foreign goods more expensive
  - Net exports should rise
  - In our results: net exports fall
- Monetary expansion:
  - Looser monetary policy decreciates the exchange rate and boosts output
  - Nominal interest rate should fall
  - In our results: nominal interest does not fall
- So, what is going on?

Financially Driven Exchange Rates

- We propose a financially driven exchange rate (FDX) model to match our empirical results
- Builds on Itskhoki and Muhkin (2021)
- Two important additions:
  - Households and firms can borrow abroad subject to financial frictions
  - Two types of financial shocks
    1. UIP shocks
    2. Capital flight (and flight to safety) shocks
- Having two shocks is important to match exchange rate disconnect, Backus-Smith fact, and Mussa fact.

Logic of the Model

- US UIP shock makes pegger's currency "cheap"
- Expected return on holding pegger's currency is high
- Money flows into pegger
- Pegger booms

Standard Parts of the Model

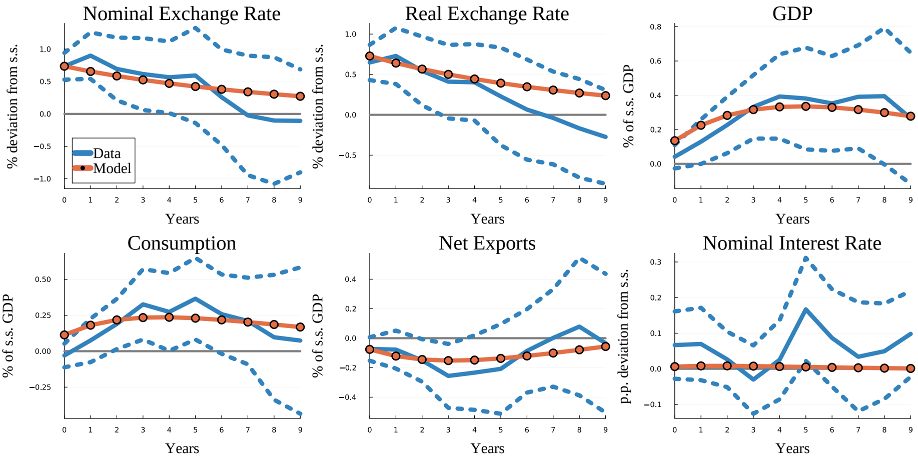
- Three-region New Keynesian model
  - Regions: US, Pegs, Floats
- Households with habit formation preferences ▸ Households
- Unions set sticky wages as in Erceg-Henderson-Levin 00 ▸ EHL 00
- Firms with intermediate inputs, investment adjustment costs, and Calvo-type sticky prices. Set prices in local currency (LCP) ▸ Firms
- US and Float monetary policy is an interest rate rule ▸ Monetary Policy

International Financial Frictions

- No deep-pocketed investors
- Noise traders cause exogenous fluctuations in demand for curreny j
- Households, firms, and international bond traders trade against them
- But have limited capacity to arbitrage away return differentials
- Noise traders cause UIP deviations
- Later we will introduce a second financial shock (capital flight shock)

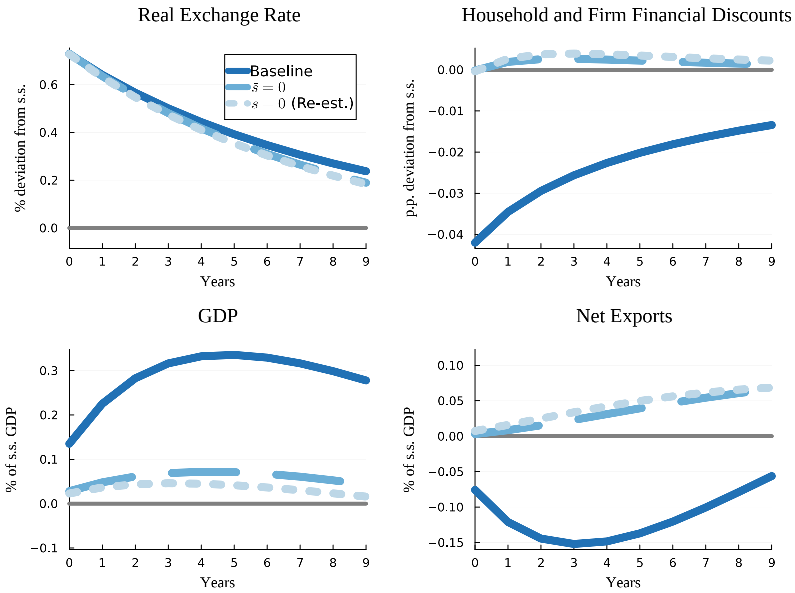
▸ Households and Firms ▸ Noise Traders ▸ Arbitrageurs ▸ UIP

Response to a US Dollar UIP Shock



▸ Calibration
▸ Other Variables
▸ Other Shocks
▸ Robustness

COMPARISON TO ITSKHOKI-MUHKIN 21 ($\bar{s} = 0$)



What About Exchange Rate Disconnect?

Our model matches large conditional responses we estimate:

- 10% regime-induced depreciation $\rightarrow$ 5.5% increase in GDP

Does this mean it is inconsistent with FX disconnect / Mussa facts?

Conditional vs. Unconditional Moments

Not necessarily:

- Multiple shocks drive exchange rate
- Regime-induced depreciations only a subset of shocks

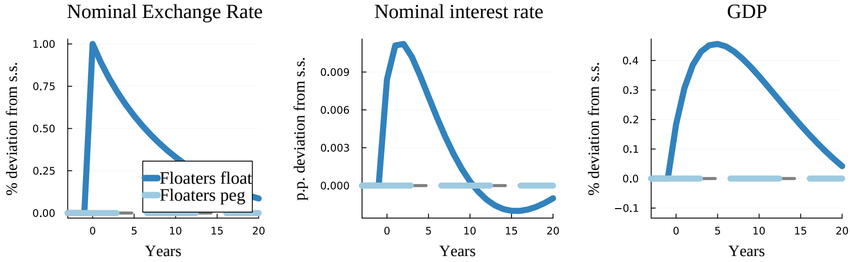
Second shock: "capital flight" shock

- UIP shock: Noise traders spooked about currency
  (UIP shock $\Rightarrow$ depreciation $\Rightarrow$ boom)
- Capital flight shock: Everyone spooked about currency
  (Capital flight shock $\Rightarrow$ depreciation & recession)

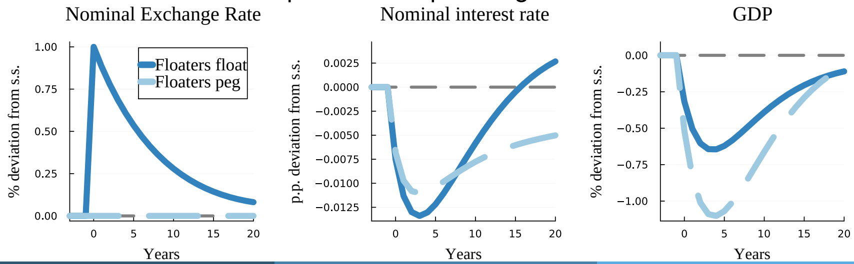
▸ Capital Flight Shock ▸ Calibration

Response to UIP vs. Capital Flight Shocks

Response to UIP Shock



Response to Capital Flight Shock



Exchange Rate Disconnect

	Data	Model						
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
		(ψ, ζ)	(ψ, A)	ψ	ζ	A	m	(ψ, A)
		Baseline						$\bar{s} = 0$
A. Volatility								
std(ΔNER)	0.114	0.114	0.114	0.141	0.093	0.006	0.075	0.114
std(ΔRER)	0.091	0.113	0.113	0.140	0.093	0.005	0.075	0.114
std(ΔGDP)	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037
std(ΔC)	0.042	0.045	0.030	0.036	0.049	0.017	0.035	0.018
std(ΔNX)	0.032	0.016	0.022	0.022	0.009	0.021	0.010	0.022
std($\Delta(1+i)$)	0.031	0.001	0.002	0.001	0.001	0.004	0.085	0.004
B. Correlation								
corr($\Delta RER, \Delta NER$)	0.712	1.000	1.000	1.000	1.000	0.781	1.000	0.999
corr($\Delta RER, \Delta GDP$)	-0.068	-0.068	0.504	0.607	-0.710	0.878	0.720	0.123
corr($\Delta RER, \Delta C$)	-0.137	-0.121	0.665	0.699	-0.693	0.674	0.759	-0.093
corr($\Delta RER, \Delta NX$)	0.213	-0.297	-0.501	-0.629	0.421	0.910	-0.718	0.003
corr($\Delta RER, \Delta(1+i)$)	0.130	0.206	0.355	0.849	-0.739	-0.930	-1.000	0.166

▸ RER-NEX

MUSSA FACTS

	(ψ, ζ)		ψ only		ζ only		(ψ, A)	
	Float	Peg	Float	Peg	Float	Peg	Float	Peg
std(ΔNER)	0.114	0.000	0.088	0.000	0.073	0.000	0.114	0.000
std(ΔRER)	0.113	0.001	0.087	0.000	0.073	0.001	0.113	0.002
std(ΔGDP)	0.037	0.049	0.023	0.000	0.029	0.049	0.037	0.016
std(ΔC)	0.045	0.057	0.022	0.000	0.039	0.057	0.030	0.008
std(ΔNX)	0.016	0.016	0.014	0.000	0.007	0.016	0.022	0.014
std($\Delta(1+i)$)	0.001	0.001	0.001	0.000	0.001	0.001	0.002	0.001

Pegging does two things:

- Eliminates UIP shocks $\rightarrow$ less volatility
- No MP stabilization after capital flight shocks $\rightarrow$ more volatility

Conclusion

- Use "regime-induced" exchange rate variation to identify the causal effect of an exchange rate depreciation
- 10% depreciation $\rightarrow$ 5.5% increase in GDP (over 5 years)
  - Net exports fall (not export led boom)
  - Interest rates rise (not MP led boom)
- Financially driven exchange rate (FDX) model can explain findings
- Also consistent with exchange rate disconnect / Mussa facts

Appendix

Fine Code	Coarse Code	Description
1	1	No separate legal tender or currency union
2	1	Pre announced peg or currency board
3	1	Pre announced horizontal band that is narrower than or equal to $\pm 2\%$
4	1	De facto Peg
5	2	Pre announced crawling peg; de facto moving band narrower than or equal to $\pm 1\%$
6	2	Pre announced crawling band that is narrower than or equal to $\pm 2\%$ or de facto horizontal band that is narrower than or equal to $\pm 2\%$
7	2	De facto crawling peg
8	2	De facto crawling band that is narrower than or equal to $\pm 2\%$
9	3	Pre announced crawling band that is wider than or equal to $\pm 2\%$
10	3	De facto crawling band that is narrower than or equal to $\pm 5\%$
11	3	Moving band that is narrower than or equal to $\pm 2\%$
12	3	De facto moving band $\pm 5\%$ / Managed floating
13	4	Freely floating
13.1		Other anchor and course classification 1 to that anchor
13.2		Other anchor and course classification 2 to that anchor
13.3		Other anchor and course classification 3 to that anchor

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ARE PEGS REALLY MORE EXPOSED?

- Assess sensitivity of exchange rate to USD by IRR classification:

$$\Delta e_{i,t} = \alpha_{r(i),t} + \sum_k \gamma_k \mathbb{I}_{i,t}(k) \times \Delta e_{USD,t} + \Gamma_h' \mathbf{X}_{i,t-1} + \epsilon_{i,t},$$

  - $\Delta e_{i,t}$: Change in USD exchange rate of country i from $t-1$ to t
  - $\mathbb{I}_{i,t}(k)$: Indicator for exchange rate regime k for country i at time t
  - $\Delta e_{USD,t}$: Change USD nominal effective exchange rate from $t-1$ to t
  - $\alpha_{r(i),t}$: `Region` $\times$ `time` fixed effects
    (Regions: Americas, Europe, Africa, Asia/Oceania)
- Do this for IRR's fine classification (15 categories)
- We normalize $\gamma_k = 0$ for k = 13 ("freely floating")

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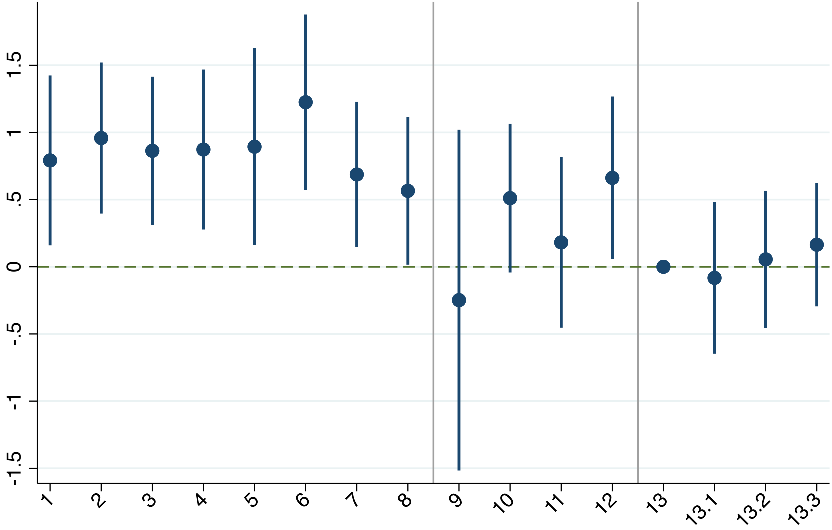
Are Pegs Really More Exposed?



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How Do Pegs Differ from Floats?

Variable	No control	Time FE	Region x Time FE
Log Population	-0.02	-0.09	0.74*
	(0.31)	(0.31)	(0.39)
Log Real GDP Per Capita	0.36	0.32	-0.17
	(0.22)	(0.22)	(0.23)
Export to GDP	-0.01	-0.01	0.00
	(0.04)	(0.04)	(0.04)
Import to GDP	-0.03	-0.03	-0.03
	(0.04)	(0.04)	(0.04)
Export Share to the US	0.04***	0.04***	-0.00
	(0.01)	(0.01)	(0.01)
Import Share to the US	0.05***	0.05***	0.00
	(0.01)	(0.01)	(0.00)
NFA to GDP	0.05	0.06	-0.10
	(0.18)	(0.19)	(0.26)
Inflation Rate (p.p.)	-0.89	-0.65	2.21***
	(1.51)	(1.41)	(0.69)
TBill Rate (p.p.)	1.01	0.89	2.86***
	(0.84)	(0.90)	(0.96)
Commodity Exports to GDP	0.05*	0.06**	0.04
	(0.03)	(0.03)	(0.03)
Commodity Imports to GDP	0.01	0.01	-0.01
	(0.02)	(0.02)	(0.02)

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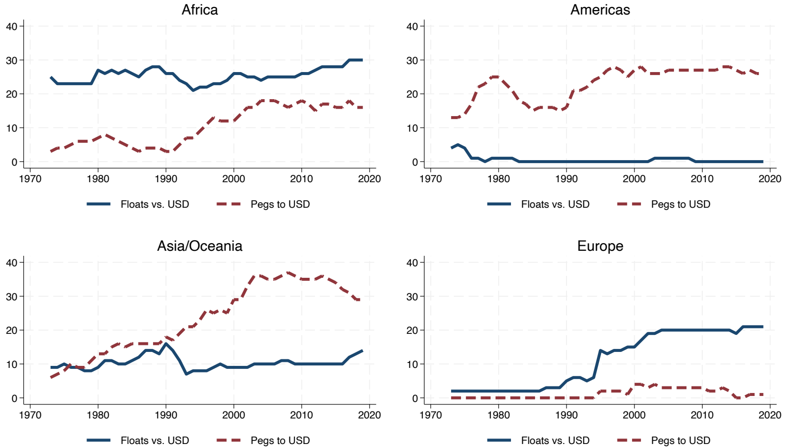
Exchange Rate Regimes by Region



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Data

Variable	Source	Observations	Countries
Nominal effective exchange rate	Darvas (2021)	5012	149
Real effective exchange rate	Darvas (2021)	4905	149
Exchange rate to USD	IFS	4997	150
GDP	WDI	4975	158
Consumption	WDI	3244	137
Investment	WDI	3220	136
Export	WDI	3319	142
Import	WDI	3319	142
Net Exports	Constructed	3319	142
Nominal Interest Rate	IFS	2409	98
CPI	IFS	4462	153
Ex-post Real Interest Rate	Constructed	2139	92
Export Unit Value	UNCTAD	3831	158
Import Unit Value	UNCTAD	3697	158
Terms of Trade	Constructed	3697	158
Manufacturing GDP	WDI	3773	146
Service GDP	WDI	3899	148
Agriculture GDP	WDI	4184	151
Mining, Construction, Energy GDP	WDI	3643	144

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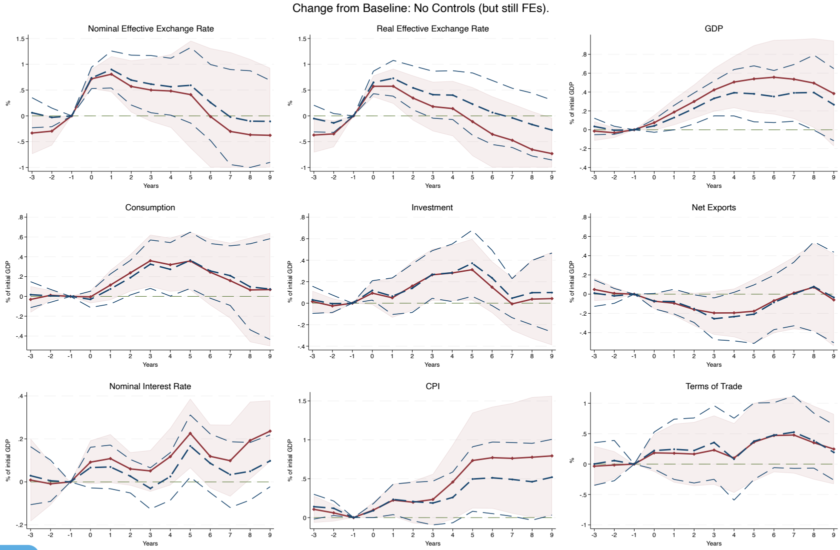
Dynamic Response to Depreciation: No Controls



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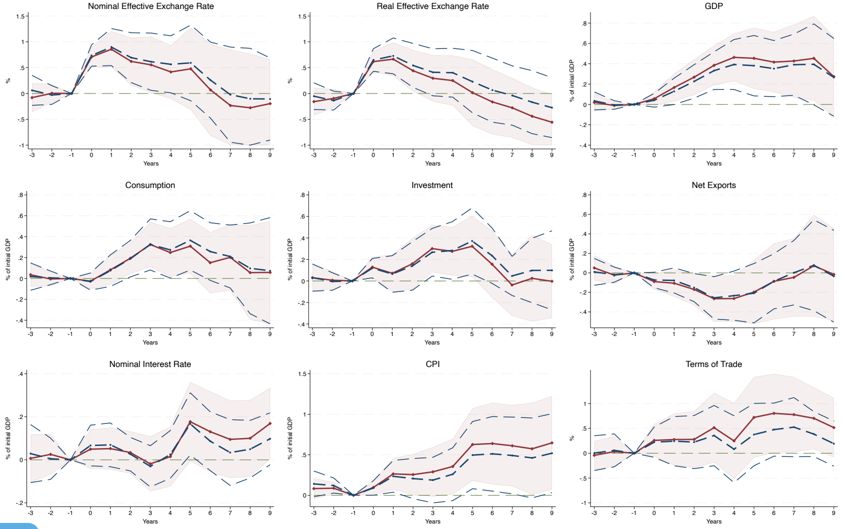
Dynamic Response to Devaluation: Two Lags

Change from Baseline: Two lags of controls, instead of one.



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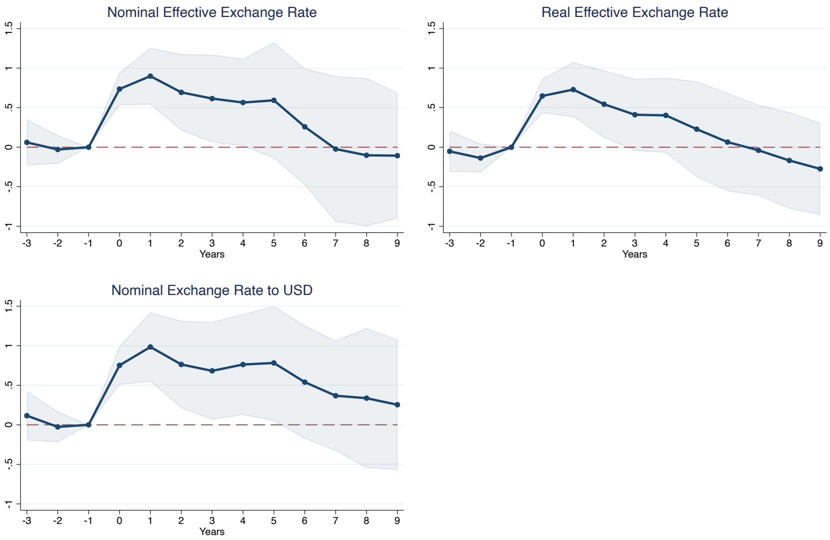
Dynamic Response of the Exchange Rate



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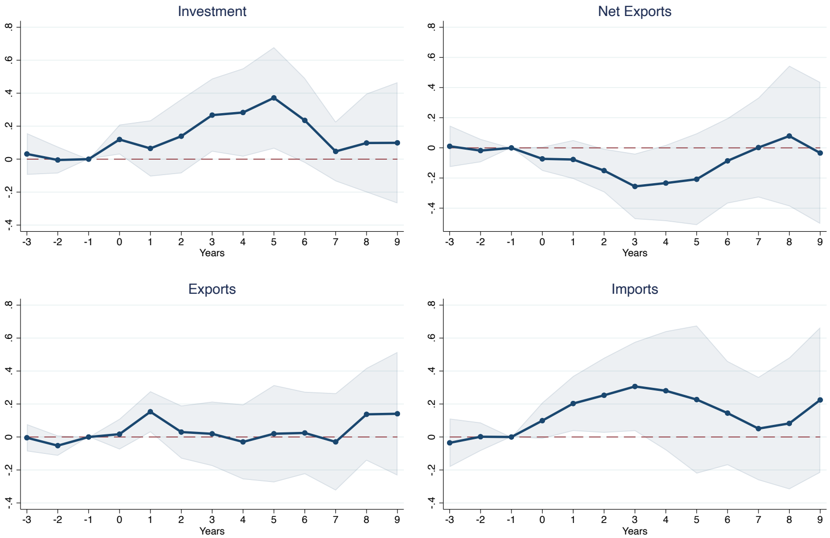
Investment and Net Exports



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Dynamic Response to Depreciation

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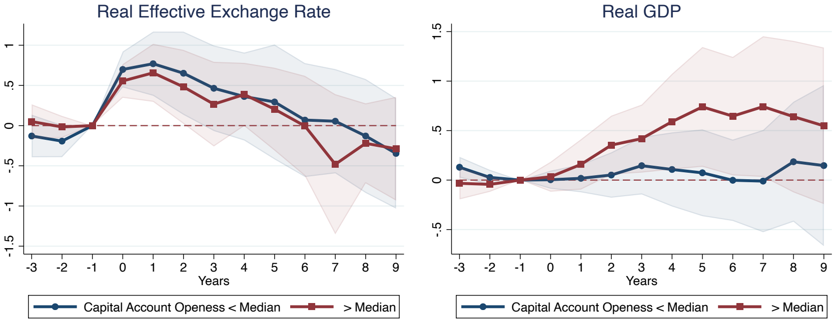
Heterogeneity by CA Openness



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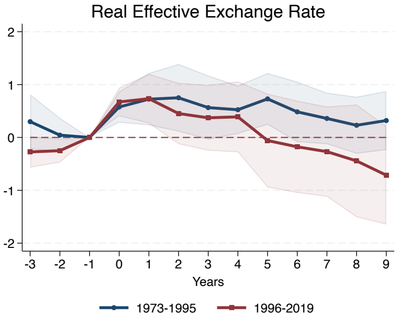
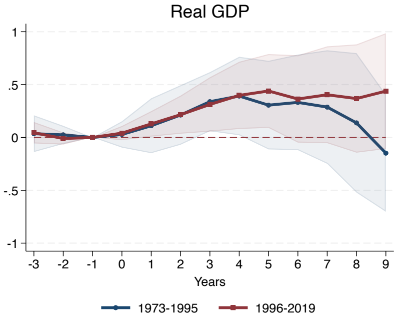
Early and Late Sample





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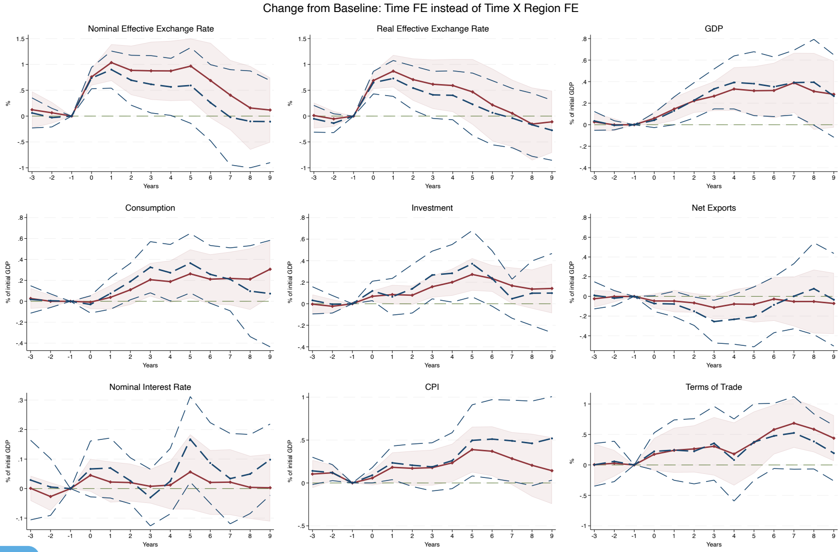
Robustness: Time FE



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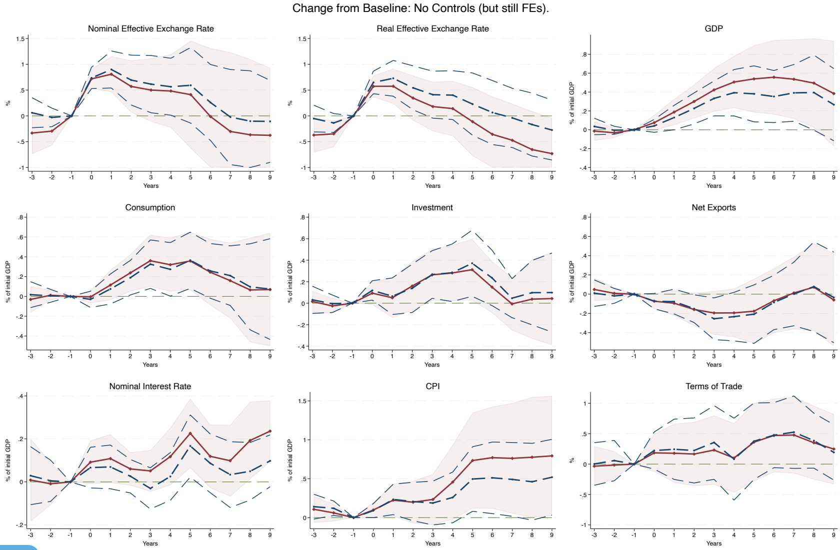
Robustness: no controls (except for FE)



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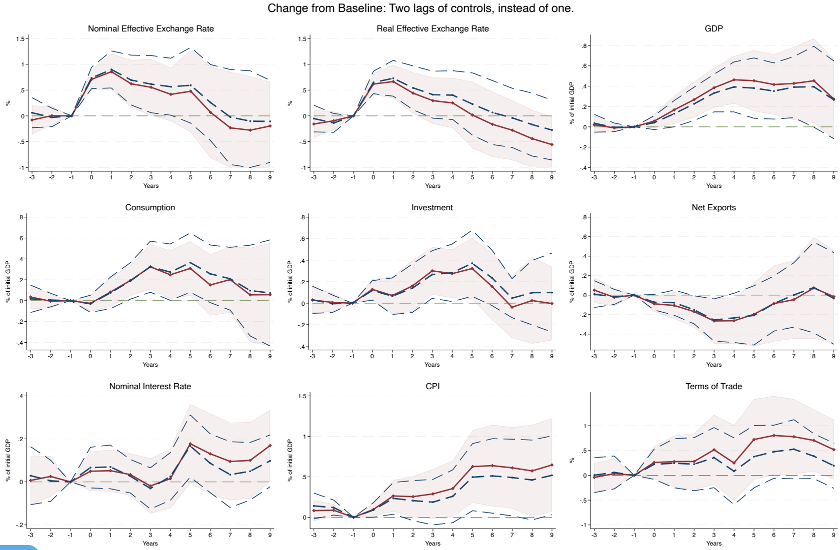
Robustness: Two lags



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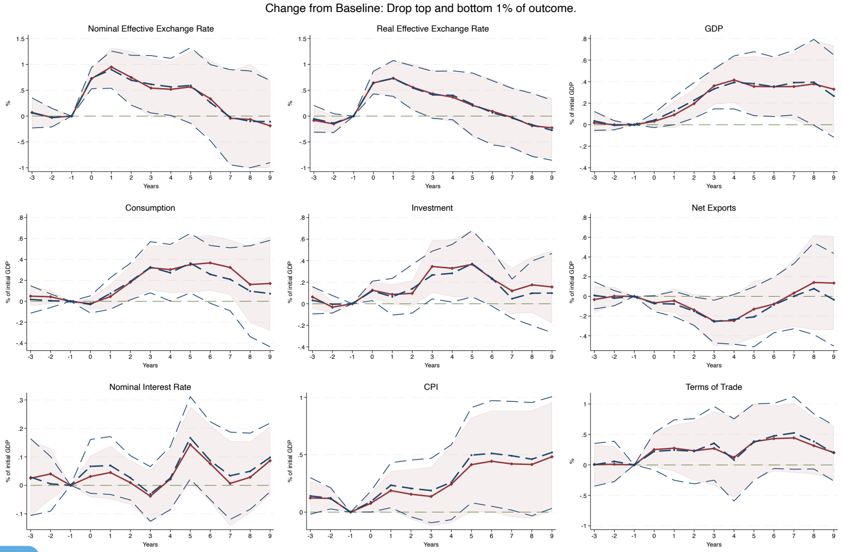
Robustness: Drop Top and Bottom 1%



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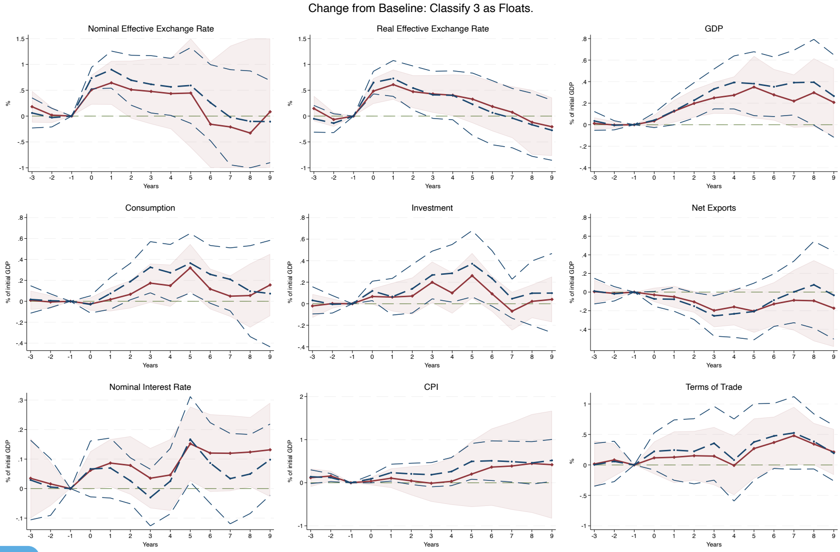
Classify 9-12 as Floats



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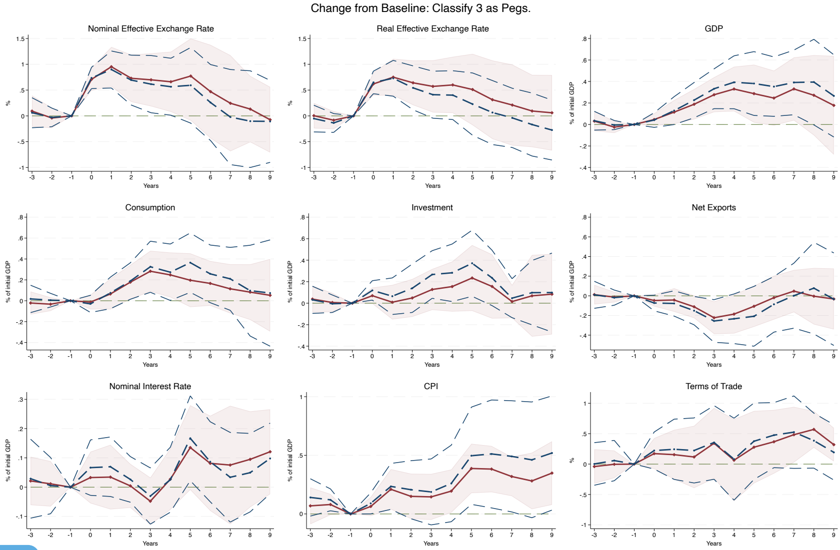
Classify 9-12 as Pegs



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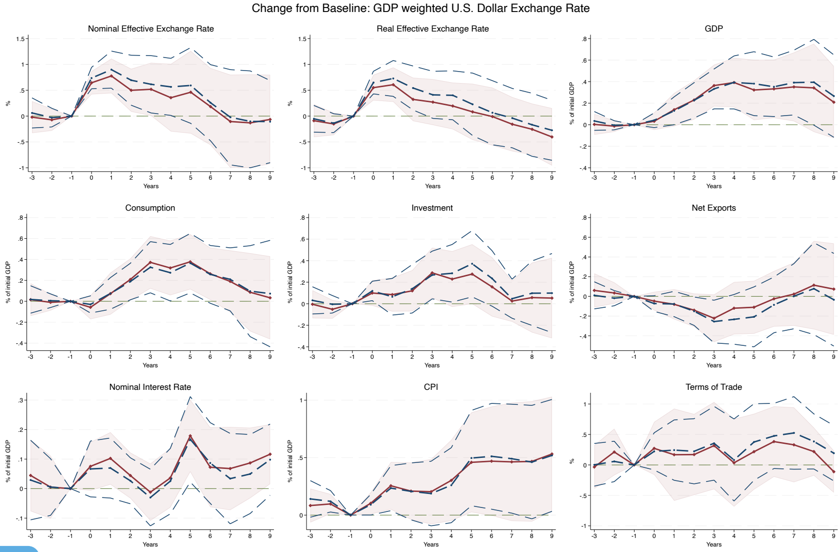
GDP-weighted USD Exchange Rate



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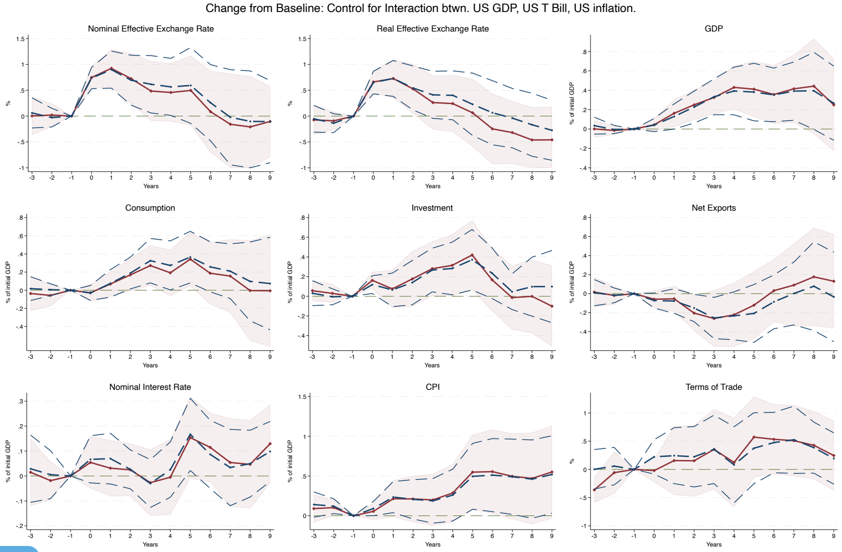
Control Peg X US GDP, Inflation, T-Bill



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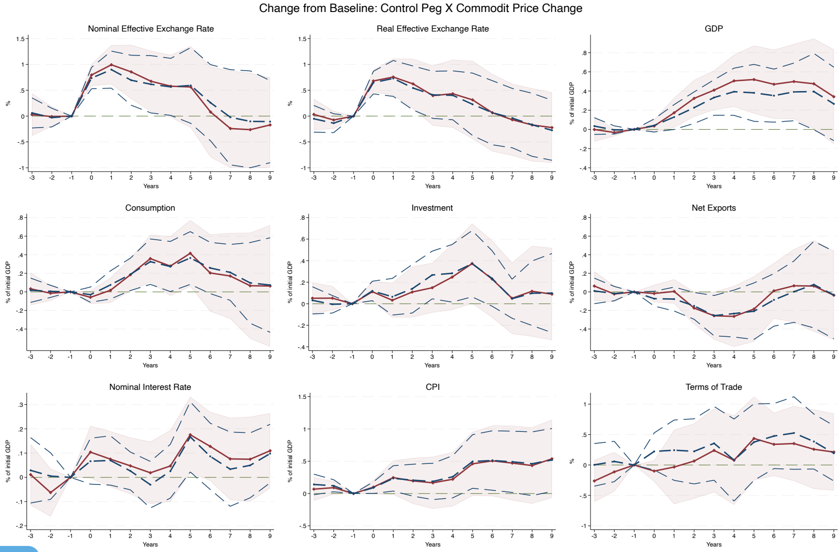
Control Peg X Commodity Price Index Change



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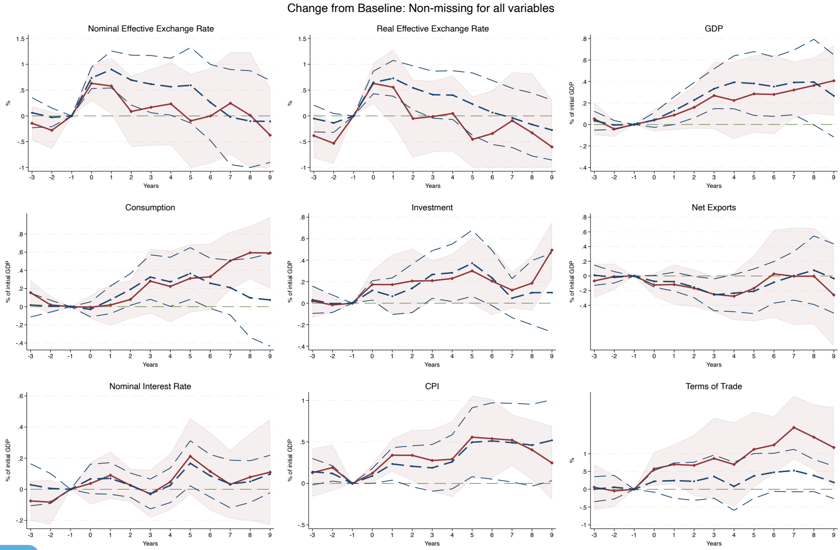
Non-missing Obs. for All Variables



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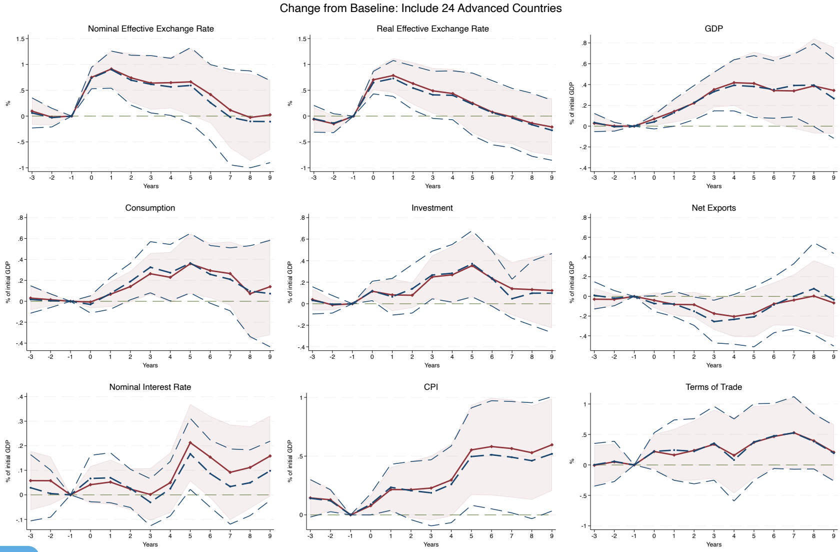
INCLUDE 24 "ADVANCED" ECONOMIES



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Households

- Households maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[u(C_{it} - hC_{it-1}) - \chi(n_{it}) \right]$$

where

$$u(C_{it} - hC_{it-1}) = \frac{(C_{it} - hC_{it-1})^{1-\sigma}}{1-\sigma} \qquad \chi(n_{it}) = \frac{n_{it}^{1+\nu}}{1+\nu}$$

and

$$C_{it} = \left((1-\alpha)^{1/\eta} (c_{iit})^{\frac{\eta-1}{\eta}} + \alpha^{1/\eta} \int_0^1 (c_{jit})^{\frac{\eta-1}{\eta}} dj \right)^{\frac{\eta}{\eta-1}},$$

and c_{jit} is a CES basket with elasticity of substitution $\epsilon_p > 1$

Back

Labor Unions and Sticky Wages

- Households supply labor through a continuum of unions which differentiate n_{it} into specialized types $N_{it}(\ell)$
- These enter firm production function through CES basket

$$N_{it} = \left(\int_0^1 (N_{it}(\ell))^{\frac{\epsilon_w - 1}{\epsilon_w}} d\ell \right)^{\frac{\epsilon_w}{\epsilon_w - 1}}$$

- Firm cost minimization yields

$$N_{it}(\ell) = \left(\frac{W_{it}(\ell)}{W_{it}} \right)^{-\epsilon_w} N_{it}, \quad \text{where} \quad W_{it} = \left(\int_0^1 W_{it}(\ell)^{1-\epsilon_w} d\ell \right)^{1/(1-\epsilon_w)}$$

- Labor unions choose wage $W_{it}(\ell)$ to maximize household utility. Can reoptimize wage with probability $1 - \delta_w$.

Back

FIRMS 1

- Two types of firms: production and price-setting
- Production firms produce country-specific good and sell it in a competitive country-specific wholesale market at price p_{it}^{mc}
- Production function:

$$Y_{it} = A_{it}(K_{it}^{\varkappa} N_{it}^{1-\varkappa})^{1-\omega} X_{it}^{\omega},$$

- Productivity:

$$\ln A_{it} = \rho^A \ln A_{it-1} + \epsilon_{it}^A$$

- Capital:

$$K_{it+1} = K_{it}(1 - \delta_k) + I_{it}$$

- I_{it} and X_{it} are same basket as C_{it}

Back

Firms 2

- Production firms own a diversified portfolio of price-setting firms and face investment adjustment costs

$$S(I_{it}/I_{it-1}) = \frac{\phi_I}{2}(I_{it}/I_{it-1} - 1)^2$$

- They maximize the value of their real earnings:

$$D_{it} = \frac{1}{P_{it}}\left[p_{it}^{mc}Y_{it} - P_{it}I_{it}\left(1 + S\left(\frac{I_{it}}{I_{it-1}}\right)\right) - W_{it}N_{it} - P_{it}X_{it} + \Pi_{it}^{p}\right],$$

Back

FIRMS 3

- Price-setting firms purchase local goods at price $p_{it}^{mc}(1-\tau_i^p)$
- They differentiate them and sell their brand/variety as a monopolist
- They sell both domestically and abroad
- They price in local currency (LCP)
- They reoptimize prices with probability $1-\delta_p$

◂ Back

Monetary Policy

- Central banks in US and F follow an interest rate rule:

$$\ln(1 + i_{jt}) = \ln \bar{R} + \rho^m \ln(1 + i_{jt-1}) + (1 - \rho^m)\phi_\pi \pi_{jt} + \epsilon^m_{jt}$$

for $j \in \{F, U\}$

- Central bank in P fix nominal exchange rate to US dollar:

$$\mathcal{E}_{jUt} = \bar{\mathcal{E}}_{jU}$$

for $j \in P$

Back

Household and Firm Portfolio Choice

- Households invest in domestic equity/bonds and foreign bonds
- Firms issue domestic equity/bonds and foreign bonds
- Real return on domestic equity/bonds is r_{it+1}
- Real return on foreign bonds is r_{ijt+1}

$$(1 + r_{ijt+1}) = (1 + r_{jt+1}) \frac{Q_{jit+1}}{Q_{jit}}$$

- Importantly, in our model:

$$\mathbb{E}_t(1 + r_{it+1}) \neq \mathbb{E}_t(1 + r_{ijt+1})$$

due to financial frictions.

Back

Household Portfolio Choice

- Households seek to maximize the return on their portfolio net of adjustment costs:

$$\max_{\{s_{ijt}^h\}} \mathbb{E}_t \left[\left(1 - \int_0^1 s_{ijt}^h dj\right)(1 + r_{it+1}) + \int_0^1 \left(s_{ijt}^h (1 + r_{ijt+1}) - \Phi_{ij}^h(s_{ijt}^h) \right) dj \right]$$

  - s_{ijt}^h is portfolio share in country j bonds
  - Adjustment cost:

$$\Phi_{ij}^h(s_{ijt}) = \frac{\Gamma^h}{2\bar{s}_{ij}} (s_{ijt}^h - \bar{s}_{ij})^2$$

  - $\bar{s}_{ij}$ is steady state portfolio share
  - Indeterminate to first order. We treat as free parameter and calibrate.

Back

Household Portfolio Choice

- Solution of portfolio problem yields

$$s^h_{ijt} - \bar{s}_{ij} = \frac{\bar{s}_{ij}}{\Gamma^h} [\mathbb{E}_t(1 + r_{ijt+1}) - \mathbb{E}_t(1 + r_{it+1})]$$

- Households increase s^h_{ijt} when returns are high
- This trading is limited by adjustment costs
- Severity of adjustment costs governed by Γ^h
- Return differential remains in equilibrium

Back

Firm Funding Choice

- Firms seek to minimize their funding costs net of adjustment costs:

$$\min_{\{s^f_{ijt}\}} \mathbb{E}_t \left[\left(1 - \int_0^1 s^f_{ijt} dj \right) (1 + r_{it+1}) + \int_0^1 \left(s^f_{ijt}(1 + r_{ijt+1}) - \Phi^f_{ij}(s^f_{ijt}) \right) dj \right]$$

  - s^f_{ijt} is funding share in country j bonds
  - Adjustment cost:

$$\Phi^f_{ij}(s_{ijt}) = \frac{\Gamma^f}{2\bar{s}_{ij}} (s^f_{ijt} - \bar{s}_{ij})^2$$

  - $\bar{s}_{ij}$ is steady state funding share
  - We assume country net foreign position is zero in steady state (firm liabilities equal household assets in steady state)

Back

Firm Funding Choice

- Solution of funding problem yields

$$s_{ijt}^{f} - \bar{s}_{ij} = -\frac{\bar{s}_{ij}}{\Gamma^{f}}\left[\mathbb{E}_t(1 + r_{ijt+1}) - \mathbb{E}_t(1 + r_{it+1})\right]$$

- Firms increase s_{ijt}^{f} when returns are low (cheap foreign financing)
- This trading is limited by adjustment costs
- Severity of adjustment costs governed by Γ^{f}
- Return differential remains in equilibrium

◂ Back

Noise Traders

- Noise traders sell US bonds and buy country *j* bonds
- Position in country *j* bonds is

$$\psi_{jt} = \rho^{\psi}\psi_{jt-1} + \epsilon_{jt}^{\psi}$$

- ϵ_{jt}^{ψ} is the country *j* "UIP shock"

Back

International Bond Arbitrageurs

- International bond arbitrageurs go long one currency and short another to arbitrage expected return differentials
- Maximize CARA utility over real returns:

$$\max_{B^I_{Ujt}} -\mathbb{E}_t \frac{1}{\gamma} \exp\left(-\gamma \left[\frac{\tilde{R}_{Ujt+1}}{P_{Ut+1}} B^I_{Ujt}\right]\right)$$

  - B^I_{Ujt} is quantity invested (long currency j, short USD)
  - Per dollar nominal return:

$$\tilde{R}_{Ujt+1} \equiv (1 + i_{jt}) \frac{\mathcal{E}_{jUt+1}}{\mathcal{E}_{jUt}} - (1 + i_{Ut})$$

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- Solution to international bond arbitrageurs' problem:

$$B^I_{Ujt} = \frac{1}{\Gamma^B}\left[\ln(1+i_{jt}) - \ln(1+i_{Ut}) + \mathbb{E}_t \Delta \ln \mathcal{E}_{jUt+1}\right]$$

where $\Gamma^B \equiv \gamma \text{var}(\Delta \ln \mathcal{E}_{jU})$

- Position proportional to expected return
- Position limited by risk aversion and risk (Γ^B)

Back

UIP Deviations

- Noise trader asset demand creates UIP deviations
- Households, firms, and international bond arbitrageurs trade against the noise traders

$$d \ln(1 + r^h_{it+1}) = d \ln(1 + r_{it+1}) - \bar{s} d\Omega(\{NFA_{kt}\}_k, \psi_{Ft})$$

- Limited arbitrage capacity implies UIP deviations not eliminated

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UIP Deviations

- Adding up demand for currency $j \in F$ bonds yields (to 1st order)

$$(1 + i_{j,t}) = \mathbb{E}_t (1 + i_{U,t}) \frac{\mathcal{E}_{jU,t+1}}{\mathcal{E}_{jU,t}} \exp(\Omega(\{NFA_{kt}\}_k, \psi_{jt}))$$

where the UIP deviation is

$$\Omega(\{NFA_{kt}\}_k, \psi_{jt}) \equiv -\Gamma \left[\left(1 - \int \bar{s}_{ji} di \right) NFA_{jt} + \int \bar{s}_{ij} NFA_{it} di + n^{\psi} \psi_{jt} \right]$$

and

$$\Gamma \equiv 1 / \left(\frac{1}{\Gamma^B} + \left[\frac{1}{\Gamma^h} + \frac{1}{\Gamma^f} \right] \frac{\bar{a}}{\beta} \int_{i \in \{P,U\}} (\bar{s}_{ji} + \bar{s}_{ij}) di \right)$$

Back

UIP for Peggers

- In contrast to floaters, UIP holds for peggers

$$(1 + i_{jt}) = \mathbb{E}_t (1 + i_{Ut}) \frac{\mathcal{E}_{jUt+1}}{\mathcal{E}_{jUt}} \quad \text{for } j \in P$$

- There is no exchange rate risk
- International bond arbitrageur willing to take large positions to offset noise traders
- Central bank also willing to take large positions
  (Peg assumed to be perfectly credible)

Back

CALIBRATION

- Most parameters externally calibrated to standard values ▸ Calibration
- Regions sizes: $|U| = 0.3$, $|F| = 0.5$, $|P| = 0.2$
- Trade elasticity: $\eta = 1.5$
- Gross foreign asset positions: $\bar{s} = 0.24$ (Benetrix, Lane, Shambough 15)
- Choose n^{ψ}, Γ, $\text{var}(\epsilon_{jt}^{\psi})$ so that effect of NFA on UIP deviations is small
- Choose slopes of price and wage Phillips curves (κ_p and κ_w) and habit parameter (h) to best fit our empirical responses

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Calibration

◀ Back

Parameter	Description	Value	Notes & Targets
β	Discount factor	0.96	Annual interest rate 4%
$1/\sigma$	EIS	1	Standard
$1/\nu$	Frisch elasticity	0.5	Standard
ω	Intermediate inputs share	0.5	Itskhoki-Mukhin (2021)
α	Openness	0.2	Imports-to-GDP ratio 40%
$\varkappa$	Capital share in value-added	0.43	Investment-to-GDP ratio 22%
δ	Capital depreciation rate	0.04	Penn World Table 10.0
ϕ_I	Investment adjustment cost	2.0	Christiano et al. (2005)
ϕ_π	Taylor coefficient	1.5	Standard
ρ_m	Monetary policy inertia	0.43	Smets-Wouters (2007)
η	Trade elasticity	1.5	Standard
$\bar{s}$	Foreign currency assets & liabilities	0.52	Benetrix et al. (2015)
ρ	Shock persistence	0.89	Itskhoki-Mukhin (2021)
$\{\theta_{ij}^k\}$	Pricing regime	LCP	Itskhoki-Mukhin (2021)
Γ	Bond demand inverse elasticity	0.001	Itskhoki-Mukhin (2021)

Estimated Parameters			Standard error
κ_p	Price Phillips curve slope	0.024	(0.006)
κ_w	Wage Phillips curve slope	0.010	(0.003)
h	Habit	0.819	(0.039)

Response to US Dolar UIP Shock

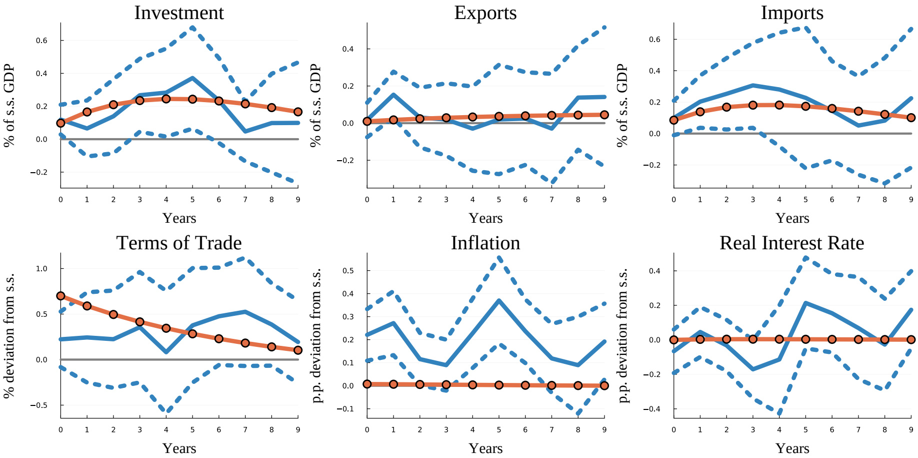

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TABLE: Alternative Shocks Driving US Dollar

	Impact Response		5Y Average Response	
	e	i	e	i
Data	0.74	0.07	0.70	0.03
Model				
US UIP Shock	0.74	0.01	0.59	0.01
US Monetary Policy Shock	0.74	-0.41	0.26	-0.14
US Technology Shock	0.74	-0.72	-0.97	-0.87

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ROBUSTNESS

- Large nominal rigidity necessary for fitting IRF ▸ IRF
- Other pricing regimes (PCP and DCP) cannot fit NX and ToT ▸ IRF
- Extension of the model to tradable and non-tradable sector
  $\Rightarrow$ bulk of GDP response from non-tradable (consistent with data) ▸ IRF
- Results robust to introducing hand-to-mouth households ▸ IRF
- Range of other models with $\bar{s} = 0$ don't work ▸ Table

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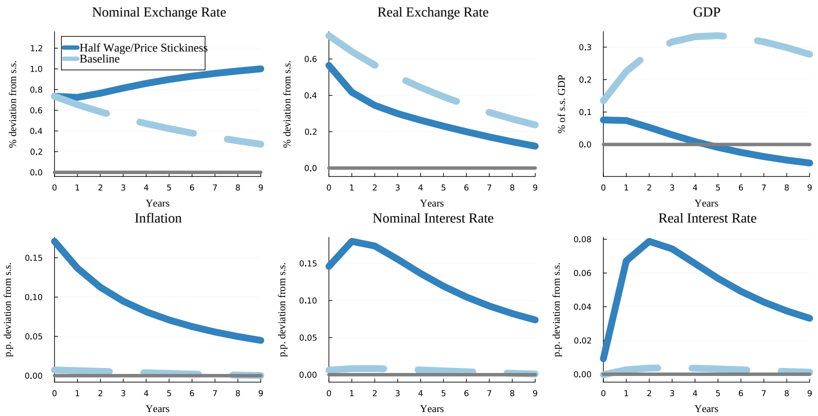
Half Nominal Rigidity



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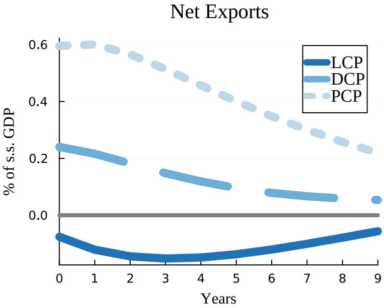
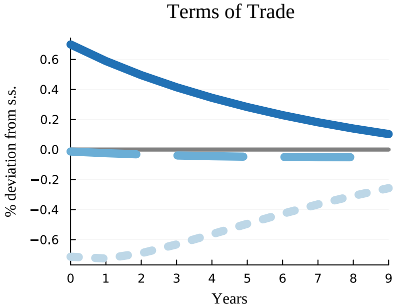
DCP and PCP





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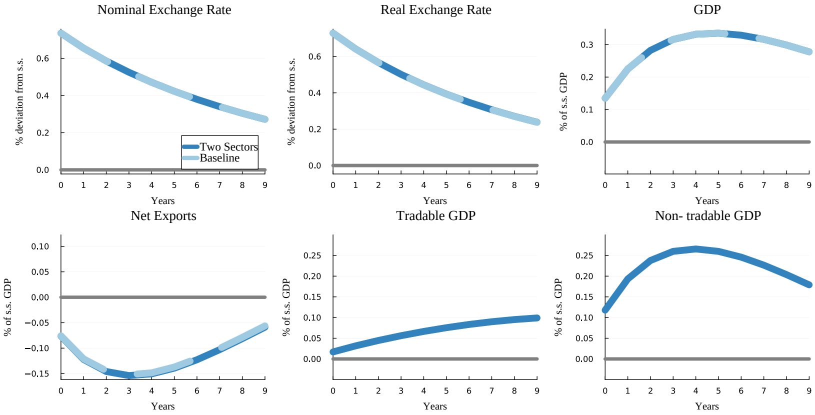
Tradable and Non-tradable Sectors



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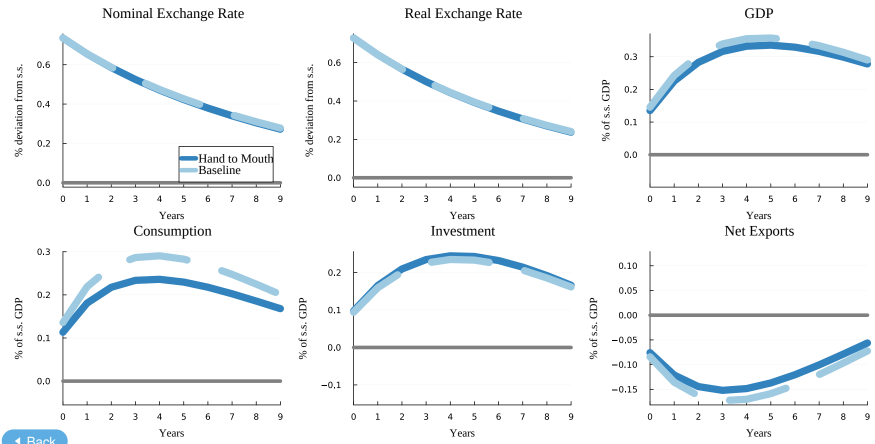
HAND-TO-MOUTH AGENTS



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Models with $\bar{s} = 0$

TABLE: Models without Foreign Credit Channel

	Fixed Parameters		Re-estimated	
5Y Average Response of:	*GDP*	*NX*	*GDP*	*NX*
Data	0.22	-0.16	0.22	-0.16
Baseline Model	0.22	-0.07	0.22	-0.07
Models with $\bar{s} = 0$				
(a) Benchmark	0.03	0.12	0.04	0.08
(b) PCP	0.31	0.61	0.26	0.49
(c) DCP	0.17	0.34	0.32	0.24
(d) Low η	0.00	0.06	0.02	0.02
(e) Hand-to-Mouth	0.03	0.11	0.04	0.03

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Capital Flight Shock

- Households and firms trade foreign bonds through banks
- This introduces stochastic intermediation wedge:

$$(1 + r_{ijt+1}) = (1 + r_{jt}) \frac{Q_{jit+1}}{Q_{jit}} (1 + \zeta_{it})$$

- Micro-foundation based on Bianchi-Lorenzoni 21 ▸ Details
- We assume that:

$$\zeta_{it} = \rho^{\zeta} \zeta_{it-1} + \epsilon_{it}^{\zeta}$$

and call $\{\epsilon_{it}^{\zeta}\}$ a capital flight shock

◂ Back

Capital Flight Shock: Microfoundation ◂ Back

- Households and firms trade foreign bonds through banks
- Banks face stochastic borrowing constraints (Bianchi-Lorenzoni 21)
- Banks solve

$$\max_{b_{ijt}} (1 + r_{ijt+1}) b_{ijt} - (1 + r_{jt+1}) \frac{Q_{jit+1}}{Q_{jit}} b_{ijt}$$

  subject to $b_{ijt} \leq \bar{b}_{it}$
- Here: r_{ijt+1} is rate bank lends at domestically in currency j, $(1 + r_{jt+1}) Q_{jit+1} / Q_{jit}$ is rate it finances itself at, b_{ijt} is net issuance of foreign currency bonds j in country i
- Solution to bank's problem:

$$(1 + r_{ijt+1}) = (1 + r_{jt}) \frac{Q_{jit+1}}{Q_{jit}} (1 + \zeta_{it})$$

  where ζ_{it} is the Lagrange multiplier on the bank's borrowing constraint

UIP Deviations with Capital Flight Shocks

- Adding up demand for currency $j \in F$ bonds yields (to 1st order)

$$(1 + i_{j,t}) = \mathbb{E}_t (1 + i_{U,t}) \frac{\mathcal{E}_{jU,t+1}}{\mathcal{E}_{jU,t}} \exp(\Omega(\{NFA_{kt}\}_k, \psi_{jt}, \{\zeta_{kt}\}_k))$$

where the UIP deviation is

$$\Omega(\{NFA_{kt}\}_k, \psi_{jt}, \{\zeta_{kt}\}_k) \equiv -\Gamma \Big[\left(1 - \int \bar{s}_{ji} di\right) NFA_{jt} + \int \bar{s}_{ij} NFA_{it} di + n^{\psi} \psi_{jt} + n^{\zeta} \left(- \int \bar{s}_{ji} di \zeta_{jt} + \int \bar{s}_{ij} \zeta_{it} di\right) \Big]$$

- But capital flight shock also affects funding costs of households and firms directly (last slide)

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Two Financial Shocks Model

- Consider case with both UIP and capital flight shocks
- Calibrate volatility of shocks to hit volatility of NER and GDP
- Calibrate m^{ζ} so as to match corr$(\Delta RER, \Delta GDP)$
  - m^{ζ} governs degree to which capital flight shocks affects UIP condition

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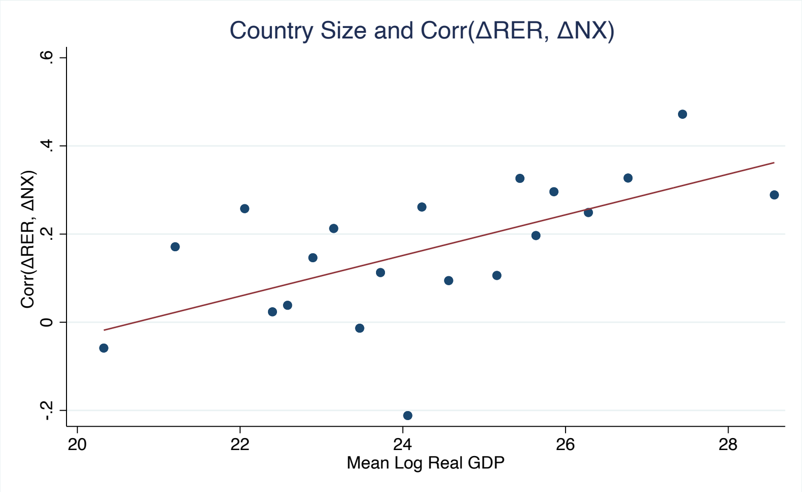
Correlation of RER and Net Exports



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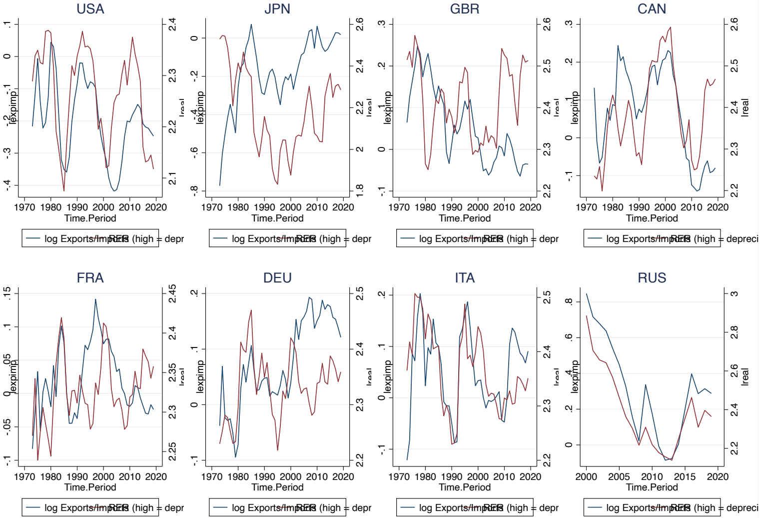
RER and Exports Imports



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