Capital Flows and Exchange Rates

A Quantitative Assessment of the Dilemma Hypothesis*

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***The views expressed in this paper do not necessarily represent those of the Bank of England or any of its Committees.**

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- **Monetary policy tightening cycle in advanced economies**
  - Renewed interest on cross-country transmission of monetary policy (shocks)

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- Global Financial Cycle (Rey, 2013) $\rightarrow$ From Trilemma to Dilemma?
  - Does a flexible exchange rate regime provide enough insulation?
  - Are additional instruments necessary for domestic monetary policy independence?
- **Our contribution** $\rightarrow$ Revisit these questions in an estimated open economy DSGE model
  - Dominant currency paradigm in finance and trade
  - Consistent with Global Financial Cycle evidence

What We Do and What We Find

1. Panel VAR $\rightarrow$ Response of financial and macro variables to US monetary policy shock
   - Typical (small) open economy with flexible exchange rates
   - **Demand/financial channel dominates over expenditure-switching effect**

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   - Frictions in international financial intermediation and pricing
   - **Necessary to replicate empirical evidence**

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3. Policy analysis $\rightarrow$ Counterfactuals
   - Exchange rate targeting increases domestic macroeconomic volatility
   - Additional instruments (tax on capital flow / domestic credit) mitigate consequences of GFC
   - Taxes can limit volatility of economic activity under peg but with disinflationary side effect

Related Literature

- Empirical studies of global financial cycle and its drivers

  Rey (2013); Dedola, Rivolta and Stracca (2017); Cesa-Bianchi, Ferrero and Rebucci (2018); Cerutti, Claessens and Rose (2019); Corman and Lloyd (2019); Obstfeld, Ostry and Qureshi (2019); Miranda-Agrippino and Rey (2020); Degasperi, Hong and Ricco (2021); Ilzetzki and Jin (2021); Georgiadis, Muller, Schumann (2023a,b), Georgiadis and Jarocinski (2023)

- Financial frictions in open economy

  Farhi and Werning (2014); Gabaix and Maggiori (2015); Aoki, Benigno and Kiyotaki (2020); Gourinchas (2020); Adrian et al. (2020); Casas et al. (2020); Corsetti, Dedola, and Leduc (2020); Itskhoki and Mukhin (2021); Akinci and Queralto (2024); Camara, Christiano and Dalgic (2024)

- LCP and dominant currency paradigm

  Devereux and Engel (2003); Cook and Devereux (2006); Corsetti, Dedola and Leduc (2010); Engel (2011); Fujiwara and Wang (2017); Gopinath et al. (2020); Chen et al. (2021); Gopinath and Stein (2021)

1. Panel VAR

Data

- Panel of macro-financial variables for **15 countries with flexible exchange rate**
  - Australia, Canada, Chile, Germany, Japan, Korea, Mexico, New Zealand, Norway, Singapore, South Africa, Sweden, Switzerland, Thailand, United Kingdom
  - Robustness with a larger set of countries (24)

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  - **US:** Monetary policy surprise, excess bond premium, real GDP
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- Monthly frequency $\rightarrow$ 1997:M1–2019:M12 (subject to availability)
  - Corporate spreads constrain earlier starting date (robustness from 1985 without spreads)
  - Macro series interpolated from quarterly to monthly frequency (Miranda-Agrippino and Rey, 2020)

Panel VAR

- **Internal instrument** (Plagborg-Moeller and Wolf, 2021)

$$x_{it} = a_i + b_i t + \sum_{p=1}^{P} F_{i,p} x_{i,t-p} + u_{it}$$

where

$$x_{it} = \left[\epsilon_{mt}^{US} \quad EBP_t^{US} \quad Y_t^{US} \quad Y_{it} \quad EX_{it} \quad CPI_{it} \quad i_{it} \quad FX_{it} \quad CS_{it} \right]$$

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- $\epsilon_{mt}^{US} \rightarrow$ **Monetary policy surprises** from Jarocinski and Karadi (2020)

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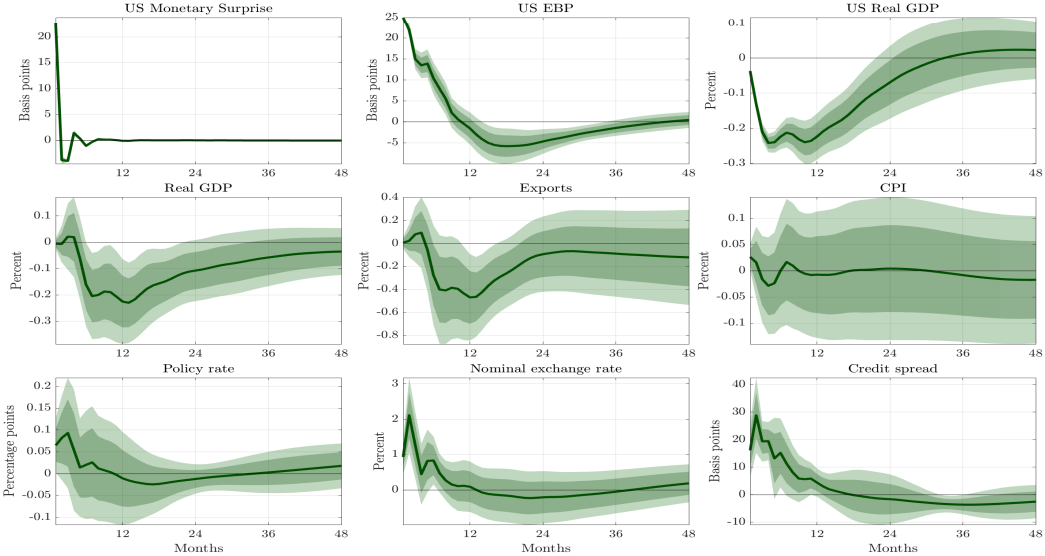
- $\epsilon_{mt}^{US} \rightarrow$ Monetary policy surprises from Jarocinski and Karadi (2020)

- Empirical model $\rightarrow$ Dynamic panel with heterogeneous slope coefficients
  - Set $P = 4$ (robustness with 3 lags)
  - **Mean group estimator** (Pesaran and Smith, 1995; Pesaran, 2006)
    - Estimate country-by-country VARs with OLS
    - Take average IRFs across countries $\rightarrow$ Response of typical country

IRFs to a US Monetary Policy Tightening



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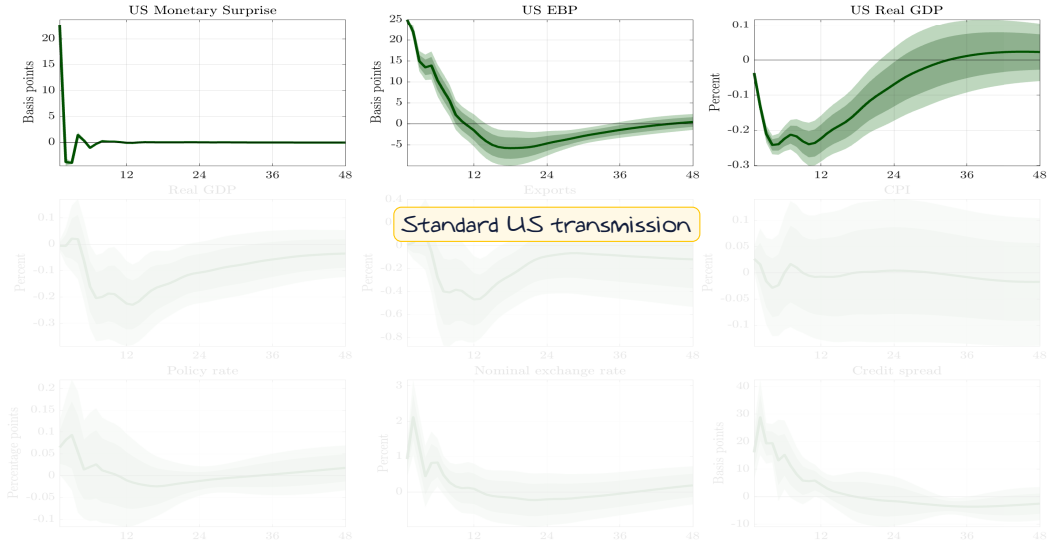

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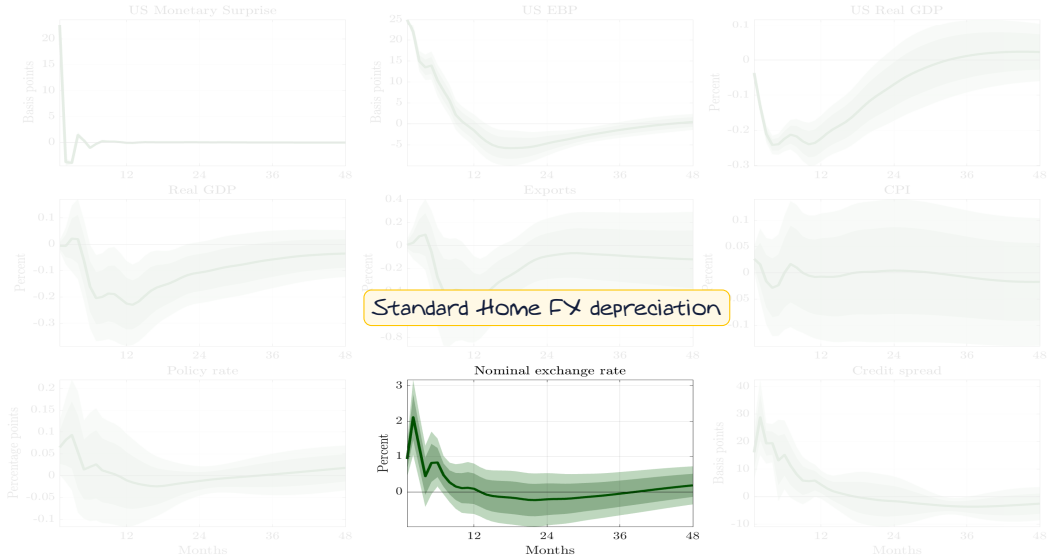

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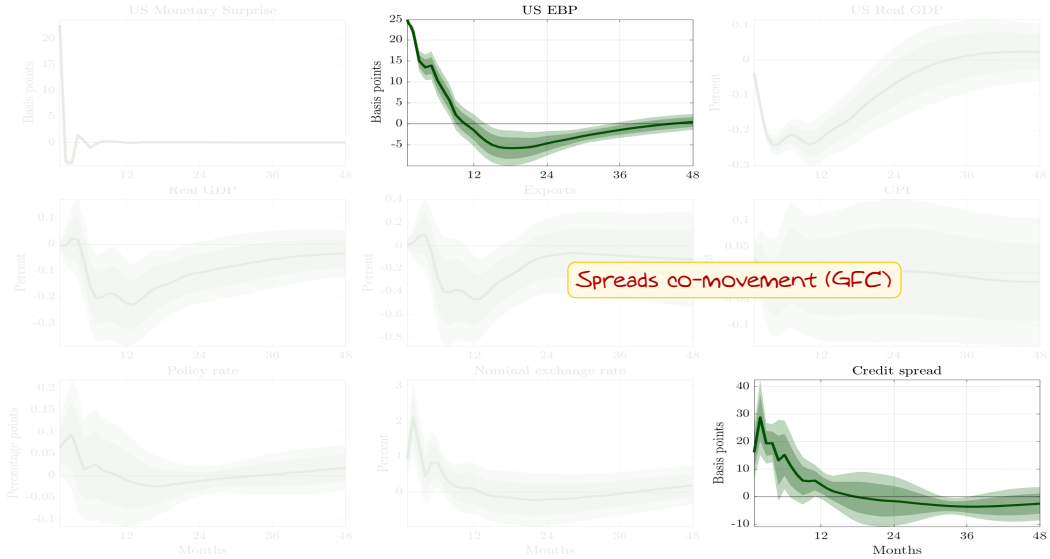

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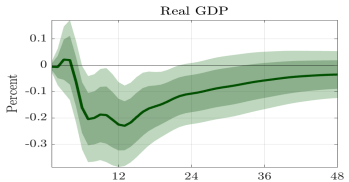

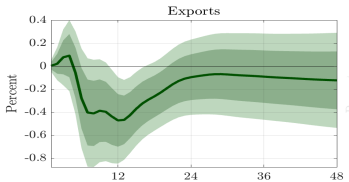

Expenditure-switching effect does not dominate (Dilemma?)

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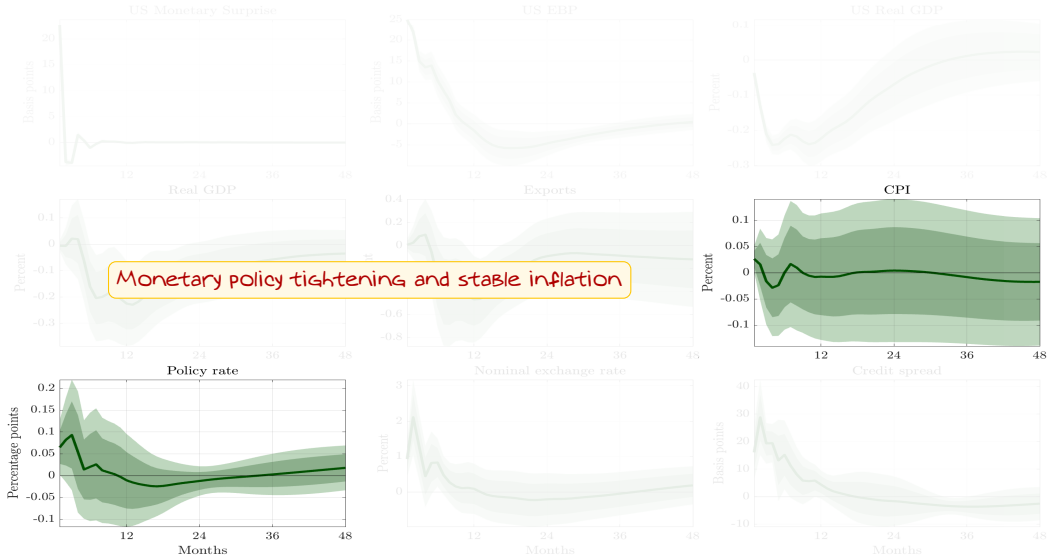

2. Two-Country DSGE Model

Overview

- Similar to Aoki, Benigno and Kiyotaki (2020) and Akinci and Queralto (2022)

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  - **Foreign banks** raise funds domestically, lend both domestically and internationally
  - **Home banks** raise funds domestically and internationally, lend only domestically

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- Multi-layer production (capital producers, importers, wholesale producers, retailers)
  - Home exporters price in Foreign currency (**LCP**)
  - **Imperfect pass-through** for Home import prices

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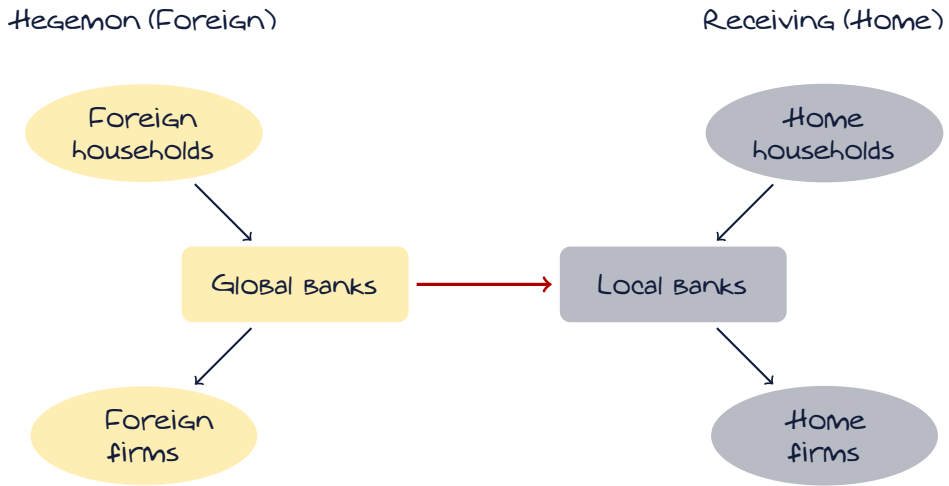
- **Dominant currency paradigm** in international goods and financial markets

Financial Flows



Financial Frictions

- **Foreign banks** $\rightarrow$ Standard (Gertler and Karadi, 2011), balance sheet fully in USD
  - Issue deposits to F households, lend to F firms and H banks

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- **Home banks** $\rightarrow$ Balance sheet currency mis-match

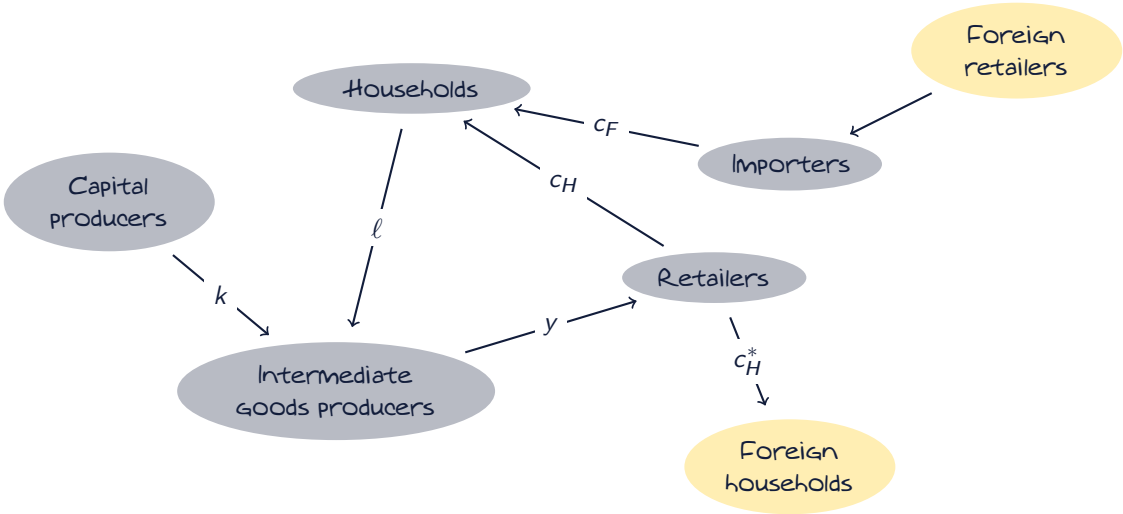
$$\underbrace{q_t z_t}_{\text{Assets}} = \underbrace{d_t + s_t b_t^* + n_t}_{\text{Liabilities}}$$

  - Can divert fraction of assets

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

    with $\gamma > 0$, where $x_t = s_t b_t^* / (q_t z_t)$ (foreign funds harder to recover than domestic funds)
  - Gives rise to **endogenous UIP wedge**

Production Structure (Home)



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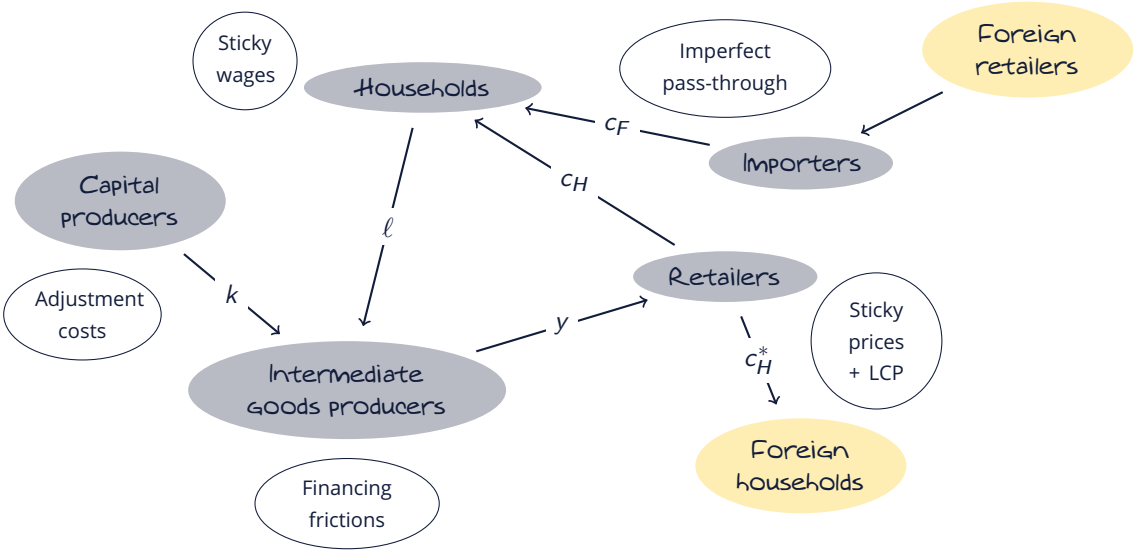

Policy

- Baseline $\rightarrow$ Monetary policy rule

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_R} \left[\Pi_t^{\phi_\pi} \left(\frac{y_t}{y_{t-1}}\right)^{\phi_y} \left(\frac{\mathcal{E}_t}{\mathcal{E}_{t-1}}\right)^{\phi_\mathcal{E}}\right]^{1-\rho_R},$$

  - **Home** $\rightarrow$ Estimate $\phi_\mathcal{E}$ (check exchange rate flexibility)
  - **Foreign** $\rightarrow \phi_\mathcal{E} = 0$ (impose flexible exchange rate)

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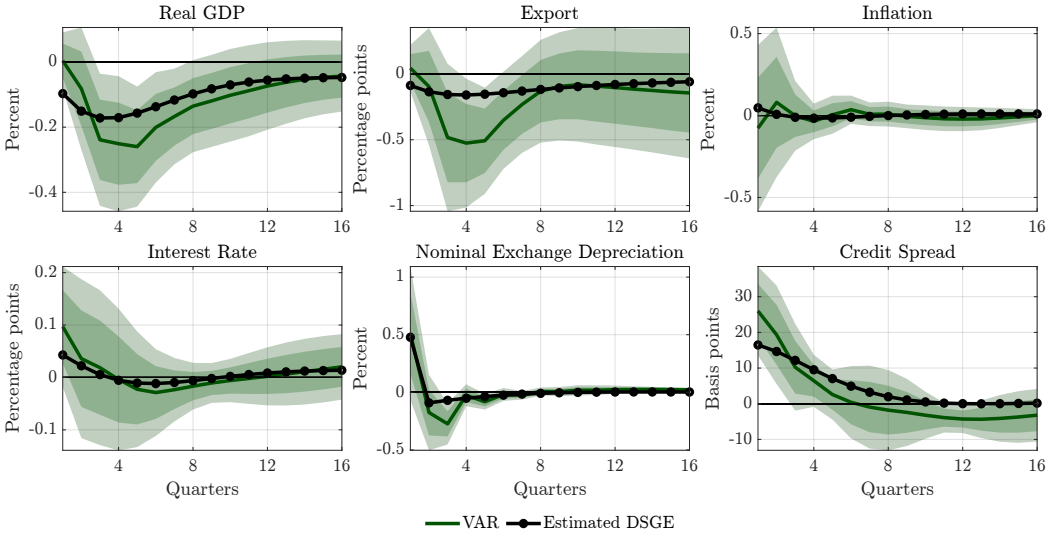
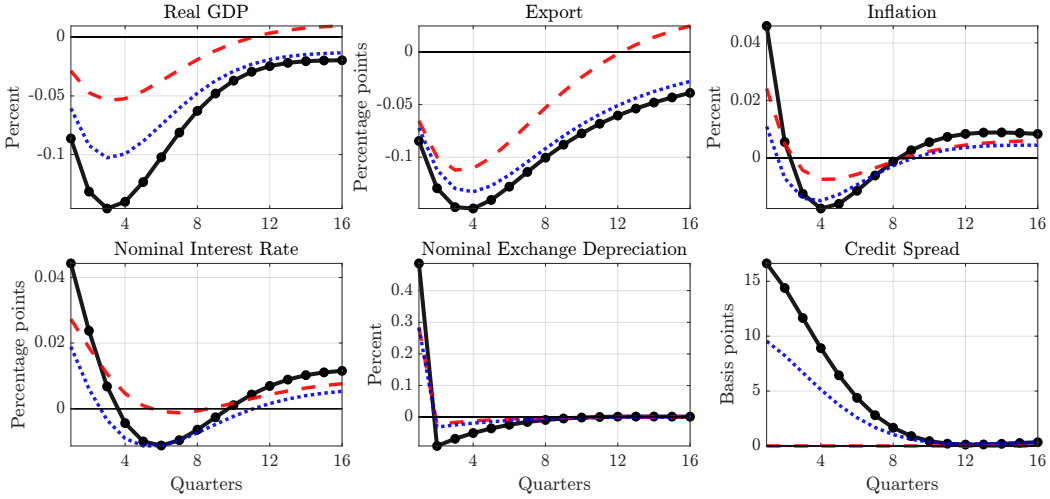
- **Policy experiments** (later) $\rightarrow$ In Home country
  - Stronger response to exchange rate
  - Taxes on
    - ⋆ Domestic credit (macro-prudential tool)
    - ⋆ Foreign liabilities (capital flows management tool)

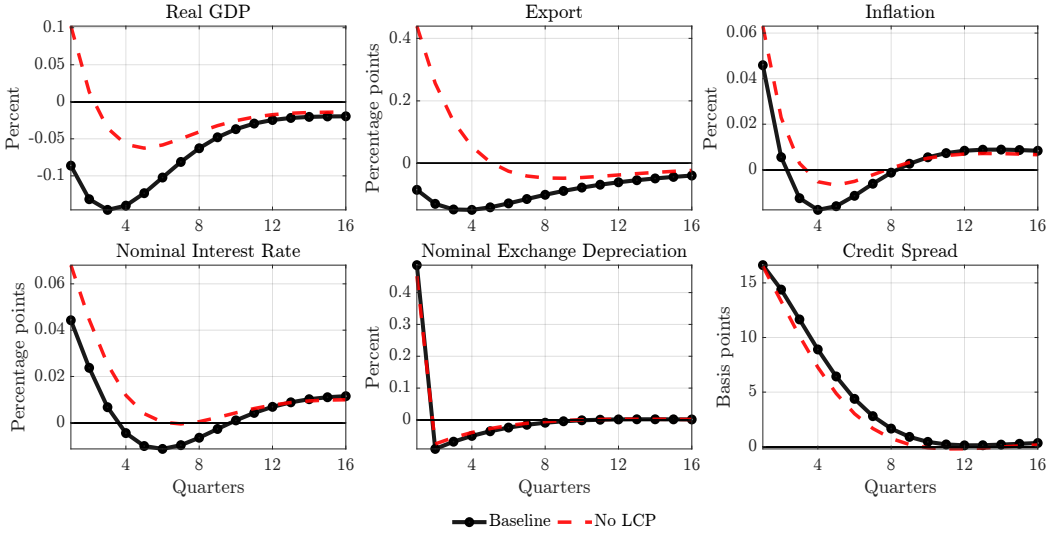
Impulse Response Matching



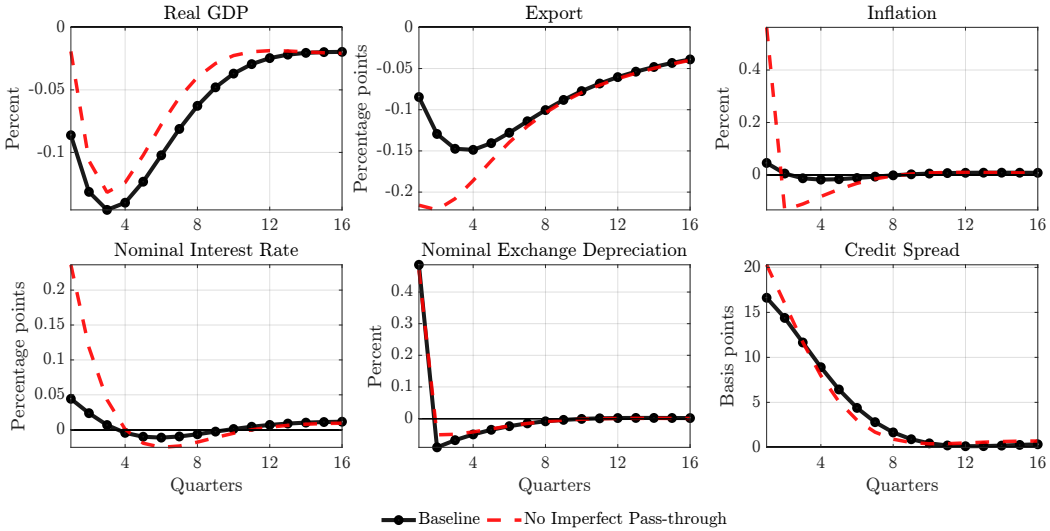
The Role of Financial Frictions



The Role of LCP



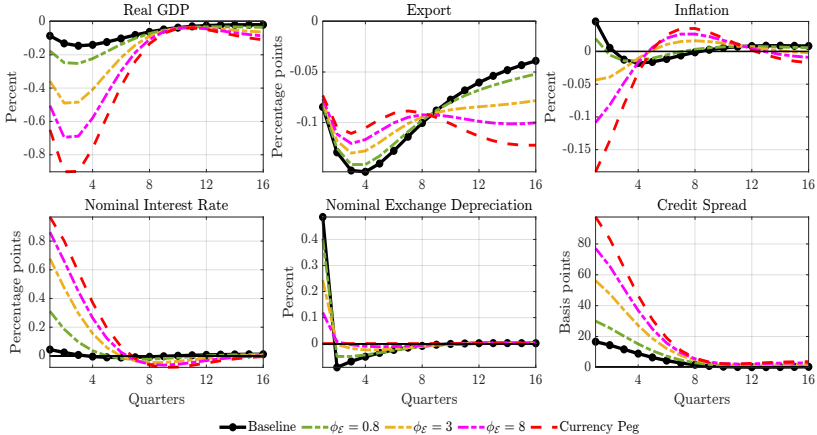
The Role of Imperfect Pass-Through



3. Policy Analysis

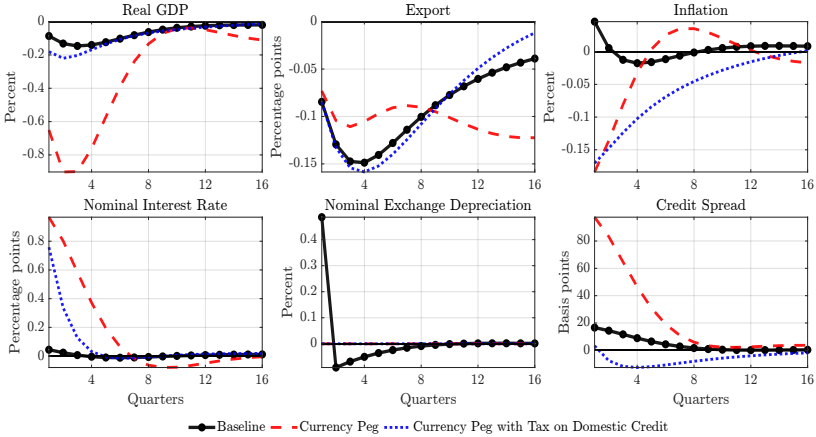
Exchange Rate Flexibility

- **Exchange rate regime not irrelevant**
  - Macroeconomic volatility increasing with weight on exchange rate in monetary policy rule



Peg + Tax on Domestic Credit

- Taxes on domestic credit or foreign borrowing dampens effects of GFC
  - **Both instruments can also alleviate (but not eliminate) negative consequences of peg**



Conclusions

1. Panel VAR $\rightarrow$ Consistent with idea of Global Financial Cycle
   - Contractionary US monetary policy shock leads to domestic recession
   - Despite domestic currency depreciation (expenditure-switching effect does not dominate)

2. Estimated two-country DSGE $\rightarrow$ Can match empirical evidence
   - Key role of financial frictions in banking sector and pricing frictions in international trade

3. Policy analysis
   - Peg exacerbates macroeconomic volatility (exchange rate regime not irrelevant)
   - Taxes on domestic credit or foreign borrowing reduce consequences of GFC
   - Both taxes can limit negative effects of peg on GDP but not on inflation

A1: Panel VAR

Interest Rate Surprises

- High frequency surprises s_t^i possibly contaminated by monetary policy "signalling" component
  - Potential bias in estimated effect of monetary policy shocks
- Decompose s_t^i into monetary (ϵ_t^m) and non-monetary (ϵ_t^{other}) shocks
  - Simple sign restriction approach (Jarocinski and Karadi, 2020)

	Monetary (ϵ_t^m)	Non-monetary (ϵ_t^{other})
Equity surprises (s_t^{eq})	$-$	$+$
Interest rate surprises (s_t^i)	$+$	$+$

Decomposition of Interest Rate Surprises

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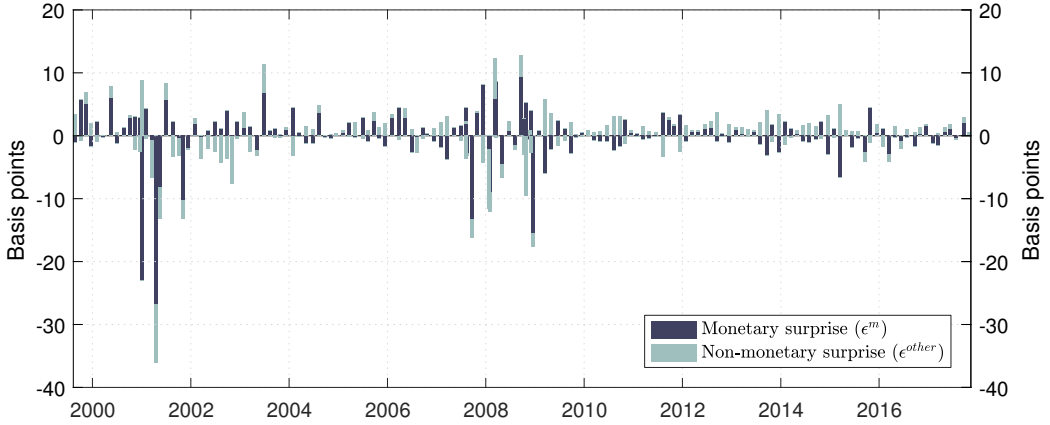
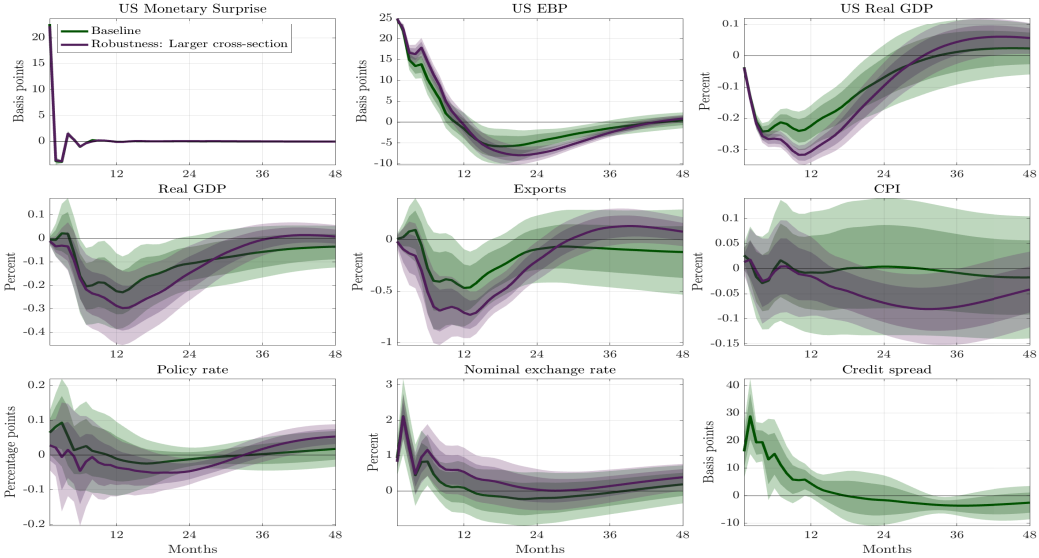
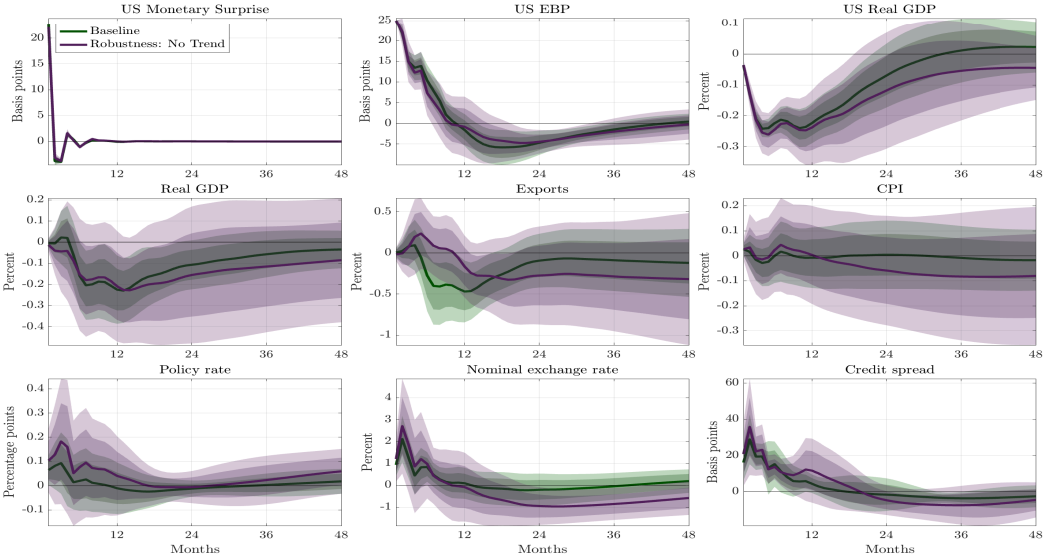


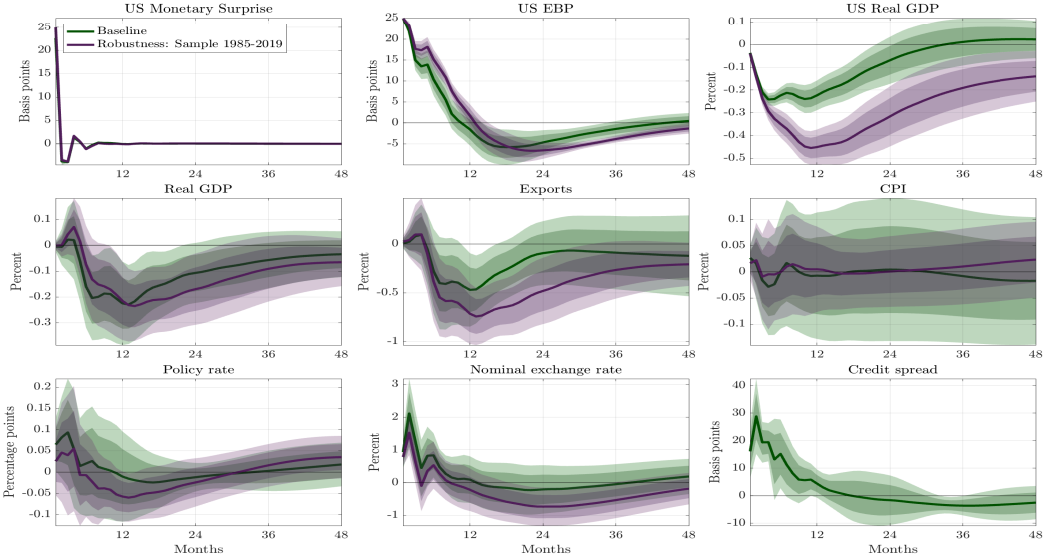
VAR Robustness: Larger Sample (24 countries)



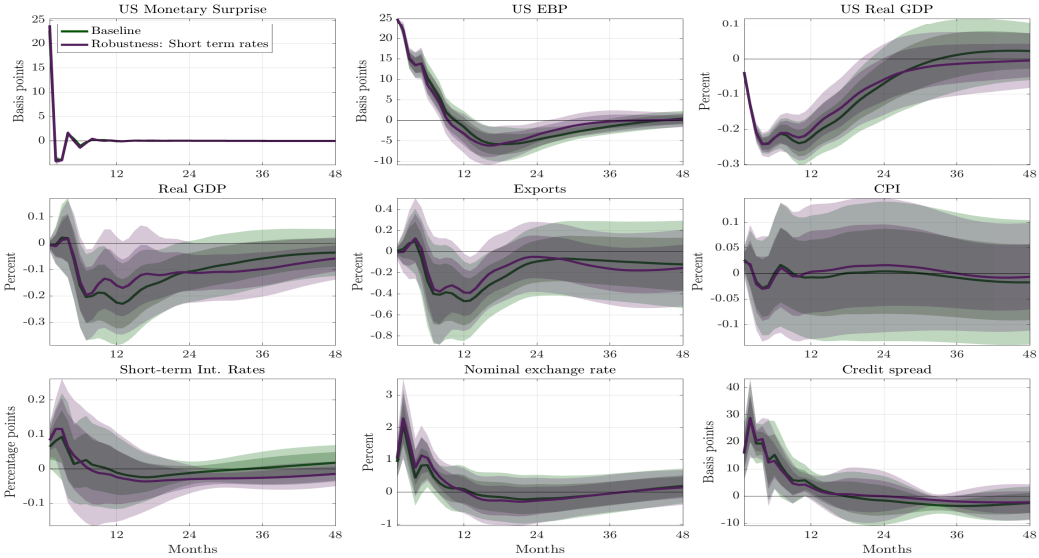
VAR Robustness: No Trend



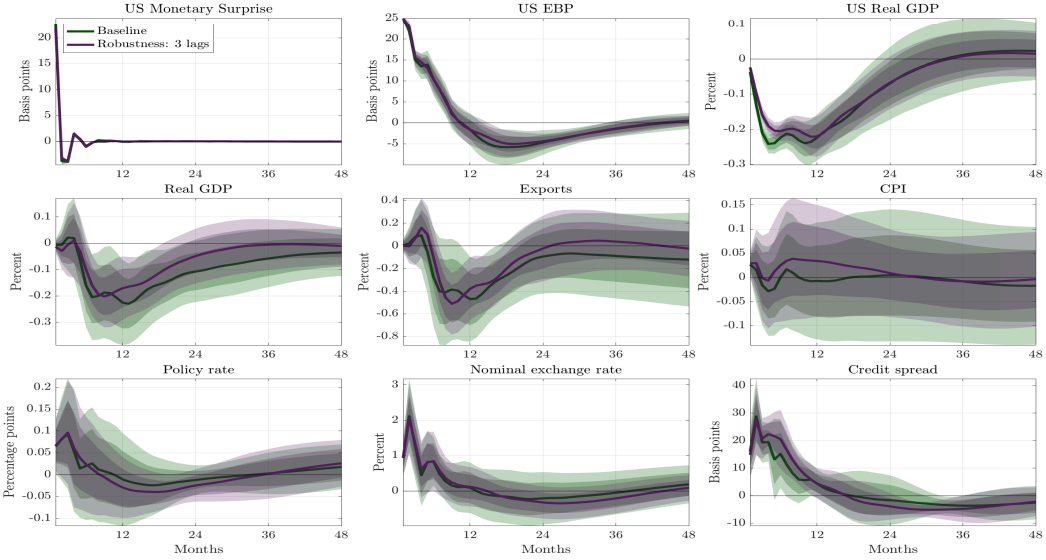
VAR Robustness: Longer Sample (1985-2019, no spreads)



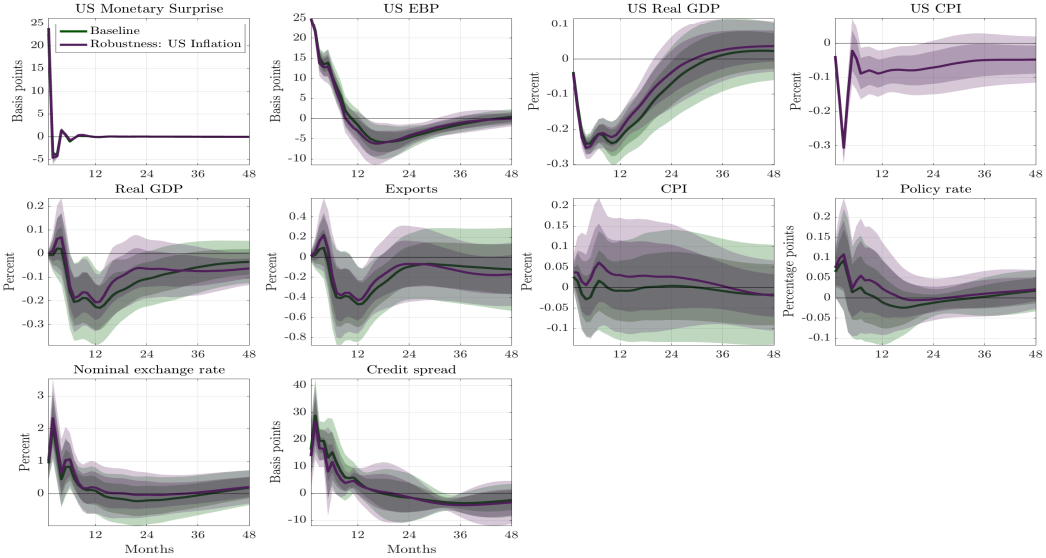
VAR Robustness: Short-Term Market Interest Rates



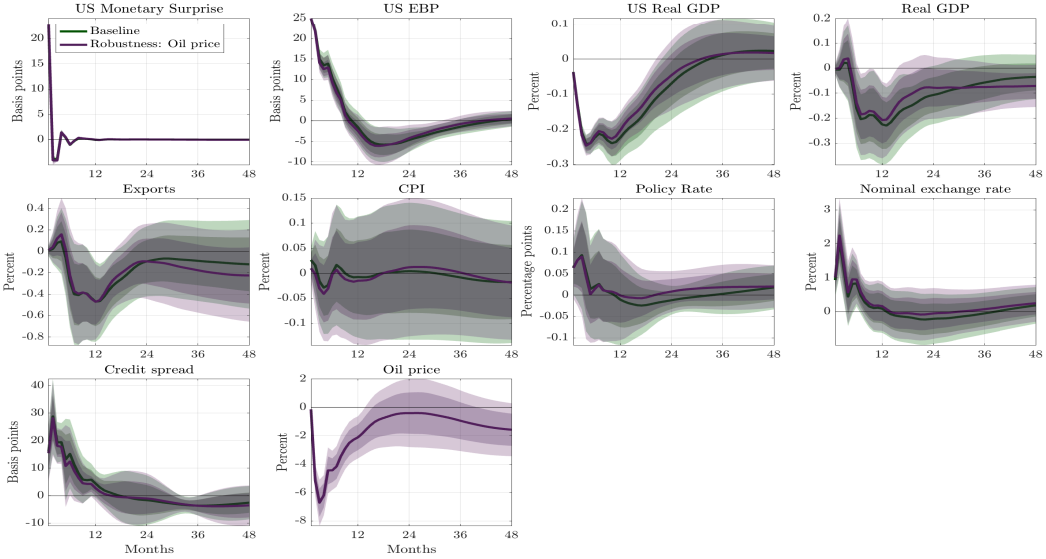
VAR Robustness: Alternative Lag Length (3 lags)



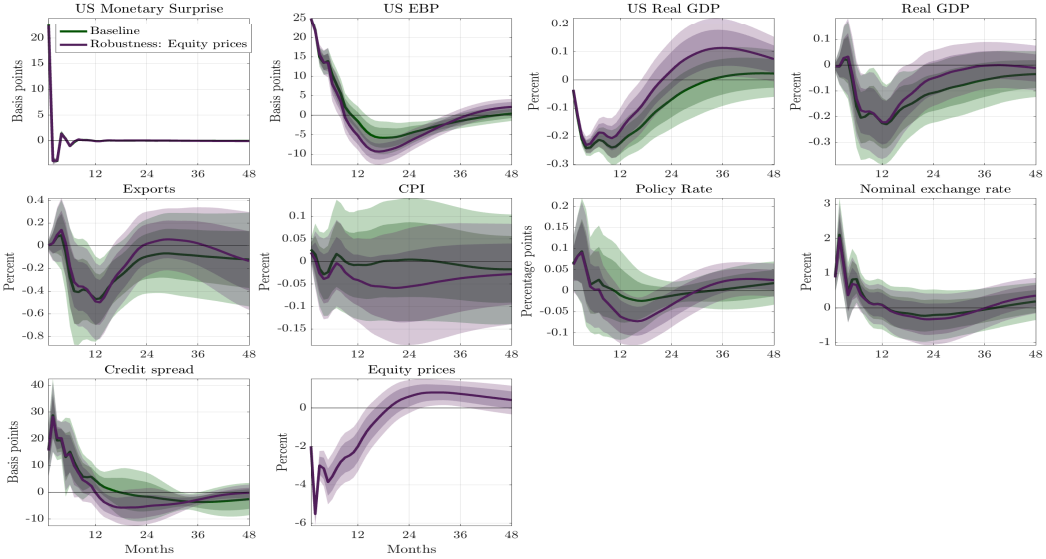
VAR Robustness: Adding US Inflation



VAR Robustness: Adding Oil Prices



VAR Robustness: Adding SOE Equity Prices



A2: DSGE Model

Home Banks

- Choose loans (z_t), deposits (d_t) and interbank borrowing (b_t^*) to solve

$$V(n_t) = \max \mathbb{E}_t \left\{ \mathcal{M}_{t,t+1} [(1-\omega) n_{t+1} + \omega V(n_{t+1})] \right\}$$

subject to

$$\begin{aligned} q_t z_t &= d_t + s_t b_t^* + n_t \\ V(n_t) &\geq \Theta(x_t) q_t z_t \\ n_t &= r_{Kt} q_{t-1} z_{t-1} - \frac{R_{t-1}}{\Pi_t} d_{t-1} - \frac{R_{Bt-1}^*}{\Pi_t^*} s_t b_{t-1}^* \end{aligned}$$

where

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

and $x_t = s_t b_t^* / (q_t z_t)$

Solution of Local Banks' Problem

- All bankers choose same leverage and same ratio of foreign liabilities (binding ICC)

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- **Optimal portfolio allocation**

$$\frac{\mu_{Kt}}{\mu_{Bt}} = \frac{\Theta(x_t)}{\Theta'(x_t)} - x_t$$

  - $\mu_{Kt} \rightarrow$ Discounted excess return of capital on deposits
  - $\mu_{Bt} \rightarrow$ Discounted excess return of deposits on interbank borrowing

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- Incentive compatibility constraint at equality

$$\phi_t = \frac{\mu_{Dt}}{\Theta(x_t) - (\mu_{Kt} + \mu_{Bt} x_t)}$$

  - $\mu_{Dt} \rightarrow$ Discounted return of deposits

UIP Wedge

- Without financial frictions, UIP would hold

$$1 = \mathbb{E}_t \left[\mathcal{M}_{t,t+1} \Omega_{t+1} \left(\frac{R_t}{\Pi_{t+1}} - \frac{R^*_{Bt}}{\Pi^*_{t+1}} \frac{s_{t+1}}{s_t} \right) \right]$$

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- Financial frictions create **wedge** between domestic and foreign interest rate

$$\mu_{Bt} = \mathbb{E}_t \left[\mathcal{M}_{t,t+1} \Omega_{t+1} \left(\frac{R_t}{\Pi_{t+1}} - \frac{R^*_{Bt}}{\Pi^*_{t+1}} \frac{s_{t+1}}{s_t} \right) \right]$$

  - Foreign funds harder to recover
  - Domestic currency must pay a premium relative to foreign currency

Calibrated Parameters

Parameter	Description	Home	Foreign
n	Relative size of country H	0.1	0.9
β	Individual discount factor	0.9926	0.9975
h	Habits in consumption	–	0.71
σ	Relative risk aversion	–	1.38
ζ	Inverse Frisch elasticity	1	1
ϱ	Elasticity of substitution among goods varieties	6	6
a	Home bias in consumption	0.66	0.96
ϵ	Elasticity of substitution between H and F goods	1.5	1.5
ν	Elasticity of substitution among labor varieties	6	6
ξ_w	Wage rigidity	0.66	0.66
ξ_p	Price rigidity	–	0.66
α	Capital share	0.33	0.33
δ	Depreciation rate	0.025	0.025
φ_i	Investment adjustment cost	–	5.74
ω	Bank survival rate	0.97	0.97
θ	Proportion of divertible funds	–	0.51
ξ_b	Bank transfer rate	–	0.002

Estimated Parameters

Parameter	Prior			Posterior			
	Distribution	Mean	SD	Mode	Median	5%	95%
h	Beta	0.650	0.1	0.715	0.709	0.558	0.841
σ	Gamma	1	0.375	1.126	1.260	0.765	1.811
λ	Gamma	5	1	4.727	4.831	3.429	6.293
$\varkappa$	Beta	0.240	0.15	0.110	0.168	0.022	0.323
φ_i	Gamma	2.850	2	0.589	0.726	0.167	1.596
ξ_p	Beta	0.660	0.15	0.833	0.777	0.544	0.957
ξ_{im}	Beta	0.660	0.15	0.697	0.665	0.410	0.873
ρ_R	Beta	0.750	0.1	0.769	0.769	0.603	0.913
ϕ_π	Gamma	1.500	0.25	1.485	1.518	1.158	1.881
ϕ_y	Gamma	0.125	0.05	0.110	0.120	0.047	0.202
$\phi_\mathcal{E}$	Gamma	0.100	0.05	0.074	0.093	0.022	0.168
ρ_R^*	Beta	0.750	0.1	0.798	0.742	0.613	0.853
ϕ_π^*	Gamma	1.500	0.25	1.466	1.518	1.162	1.900
ϕ_y^*	Gamma	0.125	0.05	0.107	0.119	0.044	0.204

"Macro-Prudential" Tool

- **Tax on domestic credit**

$$n_t = (1-\tau_t^k) r_{kt} - q_{t-1} z_{t-1} - \frac{R_{t-1} d_{t-1}}{\Pi_t} - \frac{R^*_{bt-1}}{\Pi^*_t} s_t b^*_{t-1}$$

  - Directly impacts credit spreads

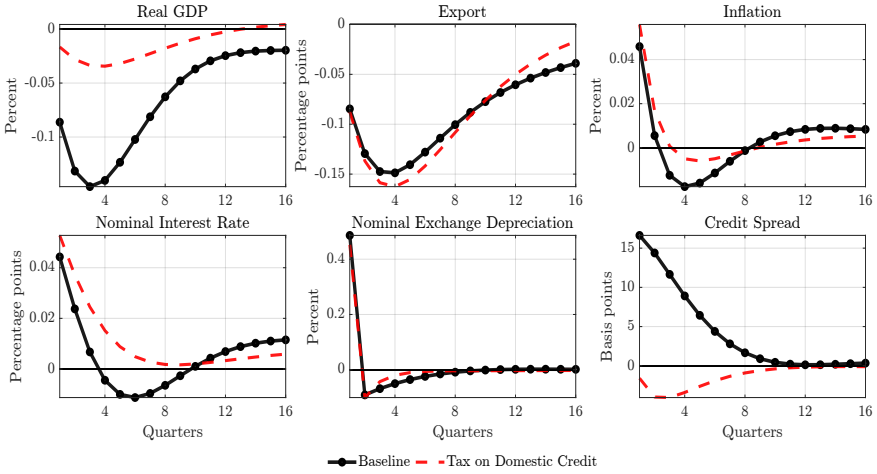
$$\mu_{kt} = \mathbb{E}_t \left\{ \mathcal{M}_{t,t+1} \Omega_{t,t+1} \left[(1-\tau^k_{t+1}) r_{kt+1} - \frac{R_t}{\Pi_{t+1}} \right] \right\}$$

- **Policy rule** (Borio and Lowe, 2002)

$$\tau_t^k = \phi_k \ln \left(\frac{q_t z_t}{qz} \right)$$

Tax on Domestic Credit

- **Significantly reduces GDP volatility** by compressing credit spreads



"Capital-Flow Management" Tool

- **Tax on foreign borrowing**

$$n_t = r_{kt} q_{t-1} z_{t-1} - \frac{R_{t-1} d_{t-1}}{\Pi_t} - (1 + \tau_t^b) \frac{R^*_{bt-1}}{\Pi^*_t} s_t b^*_{t-1}$$

  - Directly impacts UIP wedge

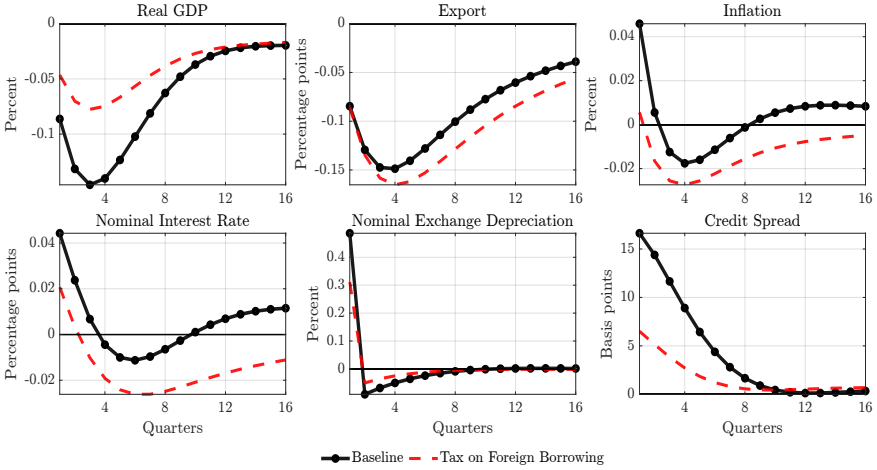
$$\mu_{bt} = \mathbb{E}_t \left\{ \mathcal{M}_{t,t+1} \Omega_{t,t+1} \left[\frac{R_{t+1}}{\Pi_{t+1}} - (1 + \tau^b_{t+1}) \frac{R^*_{bt}}{\Pi^*_{t+1}} \frac{s_{t+1}}{s_t} \right] \right\}$$

- **Policy rule**

$$\tau_t^b = \phi_b \ln \left(\frac{q_t z_t}{qz} \right)$$

Tax on Foreign Borrowing

- **Similar effects to those of tax on total credit** but acts on UIP wedge



Macroeconomic Volatility

- Standard deviation of real GDP and inflation across policy regimes

	Standard deviations (in %)	
Regime	Real GDP	Inflation
Fully flexible exchange rate	0.24	0.01
Baseline	0.28	0.01
Baseline + tax on domestic credit	0.02	0.01
Baseline + tax on foreign borrowing	0.09	0.01
Peg	8.52	0.17
Peg + tax on domestic credit	0.35	0.26
Peg + tax on foreign borrowing	0.69	0.13