## **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.

# **Question and Motivation**

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

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  - Are additional instruments necessary for domestic monetary policy independence?

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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?
- ullet Our contribution o Revisit these questions in an estimated open economy DSGE model
  - Dominant currency paradigm in finance and trade
  - Consistent with Global Financial Cycle evidence

Introduction

## What We Do and What We Find

- 1. <u>Panel VAR</u>  $\rightarrow$  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

Introduction

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- 2. <u>Two-country DSGE model</u>  $\rightarrow$  Estimated to match VAR impulse responses
  - Frictions in international financial intermediation and pricing
  - Necessary to replicate empirical evidence

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

Panel VAR	Two-Country DSGE Model	

### 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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### Data

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- Variables
  - **US:** Monetary policy surprise, excess bond premium, real GDP
  - > Domestic: Real GDP, CPI, exports, nominal interest rate, nominal FX (LC per USD), corporate spread

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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)

Introduction	Panel VAR	Two-Country DSGE Model	Policy Analysis	Appendix
Panel VA	R			
Internal	instrument (Plagbo	org-Moeller and Wolf, 2021)		
		$x_{it} = a_i + b_i t + \sum_{p=1}^{P} F_{i,p} x_{i,t-p}$	$v + u_{it}$	

where

$$x_{it} = \begin{bmatrix} \epsilon_{mt}^{US} & EBP_t^{US} & Y_t^{US} & Y_{it} & EX_{it} & CPI_{it} & i_{it} & FX_{it} & CS_{it} \end{bmatrix}$$

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

- ullet Empirical model o 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



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# 2. Two-Country DSGE Model

	Two-Country DSGE Model	
Overview		

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

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- Standard household sector symmetric across two countries (H small and F large)

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- Asymmetric international financial structure
  - 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 pricess

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- Dominant currency paradigm in international goods and financial markets



### **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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  - ▶ Issue deposits to *F* households, lend to *F* firms and *H* banks
- 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** 





Introduction	Panel VAR	Two-Country DSGE Model	Policy Analysis	Appendix
Policy				

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

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



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## **The Role of Financial Frictions**



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	Two-Country DSGE Model	

### 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



---Baseline - - Currency Peg ----- Currency Peg with Tax on Domestic Credit

ntroduction	Panel VAR	Two-Country DSGE Model	Policy Analysis	Appendix
Conclus	ions			
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- 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

- 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 ( $\epsilon_t^m$ ) and non-monetary ( $\epsilon_t^{other}$ ) shocks
  - Simple sign restriction approach (Jarocinski and Karadi, 2020)

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





## VAR Robustness: Larger Sample (24 countries)



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### VAR Robustness: No Trend



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



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### VAR Robustness: Short-Term Market Interest Rates



## VAR Robustness: Alternative Lag Length (3 lags)



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# VAR Robustness: Adding US Inflation



## **VAR Robustness: Adding Oil Prices**



## VAR Robustness: Adding SOE Equity Prices



# A2: DSGE Model

Introduction	Panel VAR	Two-Country DSGE Model	Policy Analysis	Appendix
Home Banks				
• Choose loans (	$z_t$ ), deposits ( $d_t$ ) and	l interbank borrowing ( $b_t^st$ ) 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

$$q_t z_t = d_t + s_t b_t^* + n_t$$

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

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

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

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

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- ►  $\mu_{Kt}$  → Discounted excess return of capital on deposits
- ▶  $\mu_{Bt}$  → Discounted excess return of deposits on interbank borrowing
- Incentive compatibility constraint at equality

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

►  $\mu_{Dt}$  → Discounted return of deposits

Introduction	Panel VAR	Two-Country DSGE Model	Policy Analysis	Appendix
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

Introduction	Panel VAR	Two-Country DSGE Model	Policy Analysis	Appendix

## **Calibrated Parameters**

Parameter	Description	Home	Foreign
п	Relative size of country <i>H</i>	0.1	0.9
β	Individual discount factor	0.9926	0.9975
ĥ	Habits in consumption	-	0.71
$\sigma$	Relative risk aversion	-	1.38
ζ	Inverse Frisch elasticity	1	1
Q	Elasticity of substitution among goods varieties	6	6
а	Home bias in consumption	0.66	0.96
$\epsilon$	Elasticity of substitution between <i>H</i> and <i>F</i> goods	1.5	1.5
ν	Elasticity of substitution among labor varieties	6	6
ξw	Wage rigidity	0.66	0.66
ξp	Price rigidity	-	0.66
α	Capital share	0.33	0.33
δ	Depreciation rate	0.025	0.025
$\varphi_i$	Investment adjustment cost	-	5.74
ω	Bank survival rate	0.97	0.97
$\theta$	Proportion of divertible funds	-	0.51
ξь	Bank transfer rate	-	0.002

	Two-Country DSGE Model	Appendix

## **Estimated Parameters**

Parameter	Р	Prior				Poste	rior	
	Distribution	Mean	SD		Mode	Median	5%	95%
h	Beta	0.650	0.1		0.715	0.709	0.558	0.841
$\sigma$	Gamma	1	0.375		1.126	1.260	0.765	1.811
$\lambda$	Gamma	5	1		4.727	4.831	3.429	6.293
x	Beta	0.240	0.15		0.110	0.168	0.022	0.323
$\varphi_i$	Gamma	2.850	2		0.589	0.726	0.167	1.596
ξp	Beta	0.660	0.15		0.833	0.777	0.544	0.957
ξim	Beta	0.660	0.15		0.697	0.665	0.410	0.873
$ ho_R$	Beta	0.750	0.1		0.769	0.769	0.603	0.913
$\phi_\pi$	Gamma	1.500	0.25		1.485	1.518	1.158	1.881
$\phi_y$	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
$ ho_R^*$	Beta	0.750	0.1		0.798	0.742	0.613	0.853
$\phi^*_\pi$	Gamma	1.500	0.25		1.466	1.518	1.162	1.900
$\phi_{v}^{*}$	Gamma	0.125	0.05		0.107	0.119	0.044	0.204

Introduction	Panel VAR	Two-Country DSGE Model	Policy Analysis	Appendix
"Macro-l	Prudential" To	ol		
• Tax on o	domestic credit			
	$n_t = (1 - $	$\tau_t^k)r_{kt}-q_{t-1}z_{t-1}-\frac{R_{t-1}d_t}{\Pi_t}$	$rac{-1}{1} - rac{R^*_{bt-1}}{\Pi^*_t} s_t b^*_{t-1}$	
► Dire	ctly impacts credit sprea	ads		
	$\mu_{kt} =$	$= \mathbb{E}_t \left\{ \mathcal{M}_{t,t+1} \Omega_{t,t+1} \left[ (1 - \tau_{t+1}^k) \right] \right\}$	$\left  r_{kt+1} - \frac{R_t}{\Pi_{t+1}} \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

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

• Policy rule

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

Appendix

## 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

Appendix