The long-run effects of monetary policy

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How long do the effects of monetary interventions last?

Methods

data:	historical panel, 115 years x 17 ; GDP, capital, labor, TFP
identification:	trilemma of international macroeconomics
method:	local projections instrumental variables (LP-IV)
precedents:	check validity for US/UK

This paper

Outline of the key findings

Trilemma monetary shocks

- large persistent effects of monetary shocks
- labor returns to pre-trend level, capital and TFP persistently lower
  - asymmetry: tightening shocks exhibit the persistent effect

Other monetary shocks

- US
  - Brunnermeier, Palia, Sastry, and Sims (2021, AER)
  - Miranda-Agrippino and Ricco (2021, AEJ Macro)
- UK
  - Cesa-Bianchi, Thwaites, and Vicondoa (2020, EER)

Empirical analysis

Data

Annual 1900–2015 (excluding world wars) for 17 advanced economies

Data requirement: long span of data for outcomes/controls and the IV

Jordà, Schularick & Taylor (2017)
www.macrohistory.net/data/
Interest rates, output, inflation, investment, house & stock prices, consumption ...

Bergeaud, Cette & Lecat (2016)
www.longtermproductivity.com
hours worked, number of employees, capital stock (machines and buildings)...

17 advanced economies in our sample:
Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, U.K., and U.S.

The trilemma instrument. Jordà, Schularick and Taylor (2019, JME)

peg + open to capital $\rightarrow$ correlated interest rates

3 subpopulations: bases (b), pegs, floats

$k_{i,t}$ index $\in [0,1]$ Quinn, Schindler, and Toyoda (2011), 1 is open

$z^j_{i,t} = D^j_{i,t}\, k_{i,t}\, \Delta\widehat{R}_{b(i,t),t}$ (base “pre-cleaned” using $x_{b(i,t),t}$ controls) $j = P, F$

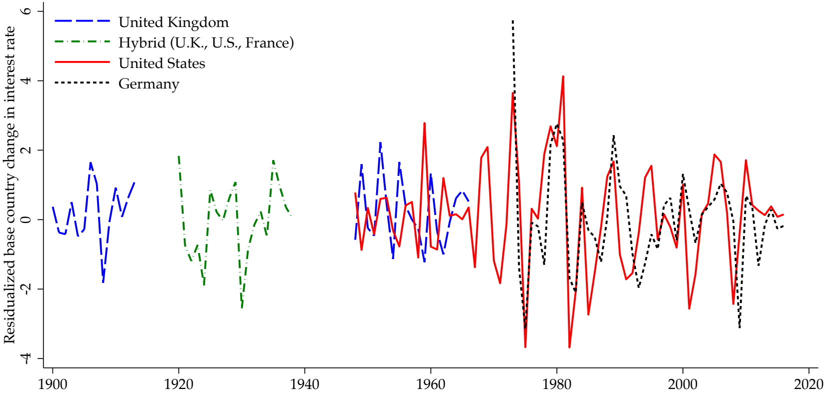
$j = P$ if peg in t and $t-1$

- *intervention:* $\Delta R_{i,t}$ short-rate proxy, 3-mo govt. bill
- *instrument:* $z_{i,t}$ trilemma IV
- *outcomes:* home output and its components (at $t, t+1, ..., t+H$)

home–base links | summary stats | exchange regime switches

IV construction

Residualized component $\Delta\widehat{R}_{b(i,t),t}$ of base country interest rates



$\Delta\widehat{R}_{b(i,t),t} = (\Delta R_{b(i,t),t} - \Delta\tilde{R}_{b(i,t),t})$ where $b(i,t)$ denotes the base for country i at time t and the final term is the predicted interest rate from a cleaning regression.

The instrument is relevant

First Stage: $\Delta R_{i,t} = \kappa_i + z^P_{i,t}\lambda_P + x_{i,t}g + \eta_{i,t}$

	All years	PostWW2
λ_{Pegs}	0.59^{***}	0.61^{***}
t-statistic	[9.47]	[9.02]
λ_{Floats}	0.27^{***}	0.26^{***}
t-statistic	[3.30]	[2.77]

coefficients ≈ Obstfeld, Shambaugh & Taylor (2005) list of controls and transformations

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Note: We need strong correlation. Identification *does not rely* on UIP.

Panel local projections with *external* instruments: LP-IV

assumption that instrument is valid, conditional on controls x (saturate)

$$\Delta R_{i,t} = \kappa_i + x_{i,t} g + + z^P_{i,t}\lambda_P + z^F_{i,t}\lambda_F + \eta_{i,t} \rightarrow \widehat{\Delta R}_{i,t} \qquad \textbf{(first stage)}$$

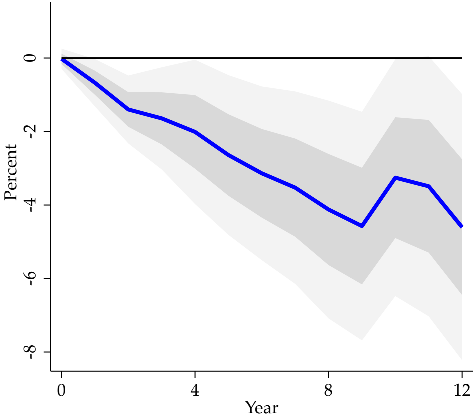
$$y_{i,t+h} - y_{i,t-1} = \alpha_{i,h} + x_{i,t}\gamma_h + \widehat{\Delta R}_{i,t}\beta_h + \nu_{i,t+h} \qquad \textbf{(second stage LP)}$$

Note: results robust with using one instrument $z^P_{i,t}$.

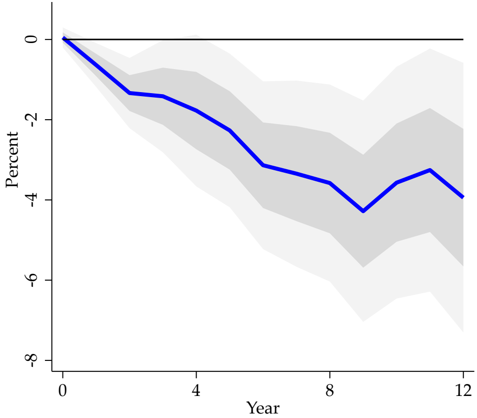
Empirics

baseline result: real GDP — the long shadow

(a) Full sample: 1900–2015



(b) Post-WW2 sample: 1948–2015

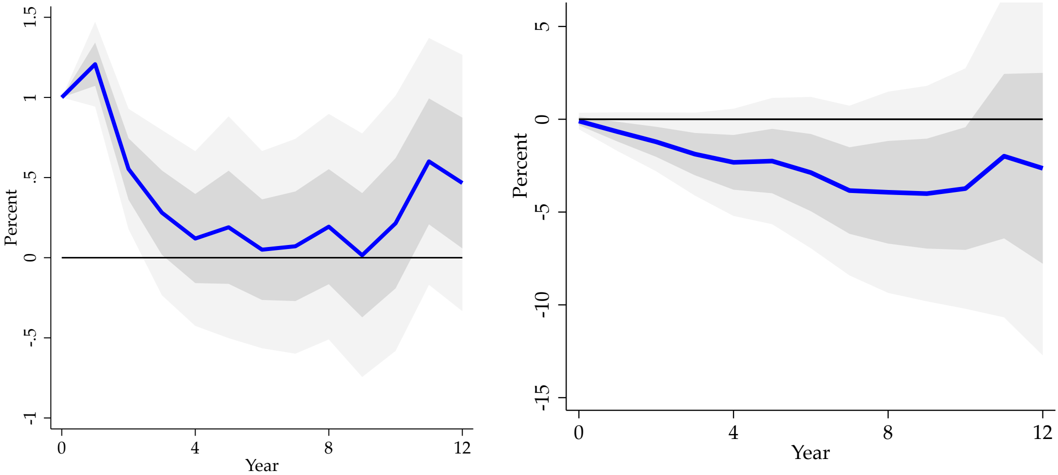


† confidence bands: 68% and 95% Driscoll & Kraay (1998) standard errors

short term nominal interest rate and CPI

(a) Short term nominal rate

(b) CPI



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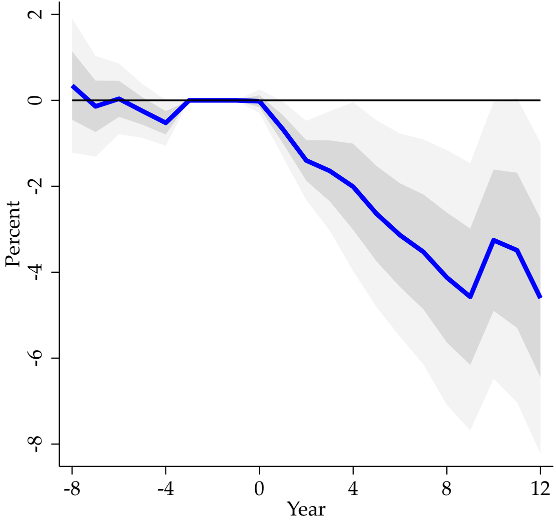
Robustness

Robustness with pre-trends: IRF of Real GDP



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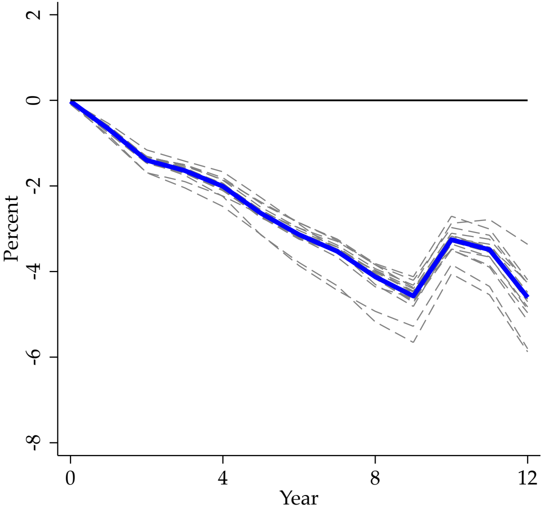
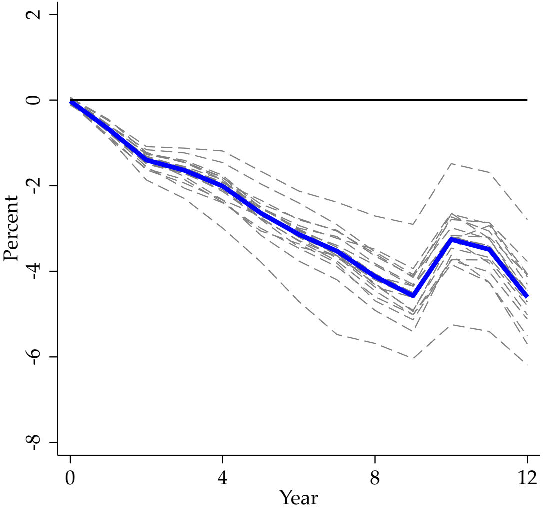
Dropping each country one at a time: IRF of Real GDP



Dropping successive 5-year windows one at a time : IRF of Real GDP



Spillover: exclusion restriction violation

If the instrument $z_{j,t}$ affects the outcome through other channels θ

$$y_{j,t+h} - y_{j,t} = \alpha_{j,h} + x_{j,t}\gamma_h + \widehat{\Delta i}_{j,t}\beta_h + z_{j,t}\theta + \nu_{j,t+h}$$

- e.g. a recession in base reduces demand for home exports

Spillover correction:

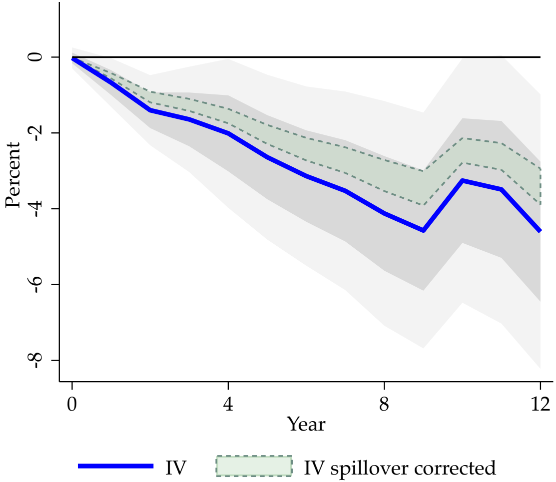
Employ a **control function approach**, by using the model to get a bound:

$$\theta = \underbrace{\begin{array}{c}\text{share of exported tradables}\\ \text{in home output}\end{array}}_{\text{calibrate: } \Phi \in [0,\ 0.3]} \times \underbrace{\begin{array}{c}\text{responsiveness of exported}\\ \text{tradable demand to base interest rate}\end{array}}_{\text{assumption: upper bound } = \beta_h}$$

$\rightarrow$ Estimate an augmented LP :

$$y_{j,t+h} - y_{j,t} = \alpha_{j,h} + +x_{j,t}\gamma_h + \left(\widehat{\Delta i}_{j,t} + \Phi z_{j,t}\right)\beta_h + \nu_{j,t+h}$$

Model-based spillover correction



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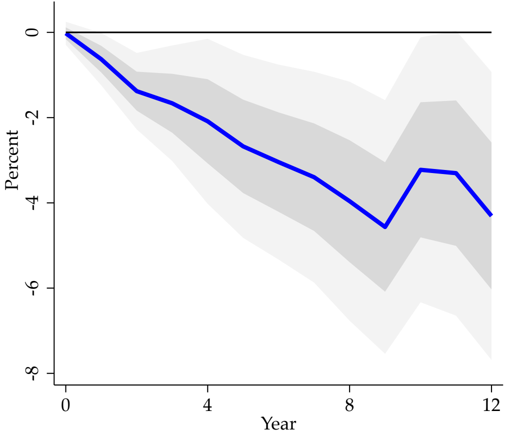
open economy variables: exclusion restriction

control for (i) base country GDP, (ii) global GDP, (iii) own current account and (iv) exchange rate wrt USD



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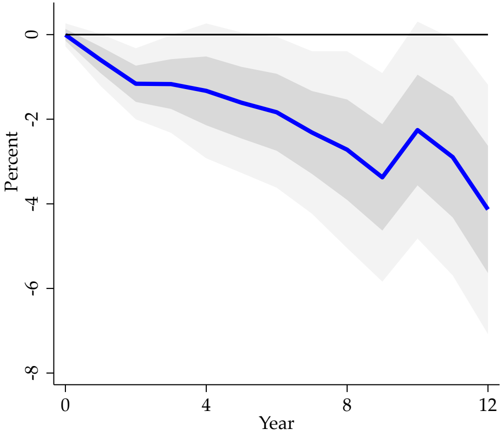
IRFs of real GDP: structural breaks in TFP

Fernald, 2007, 2014; Gordon 2016

Allow intercept to be regime-dependent based on Bai & Perron (1998)



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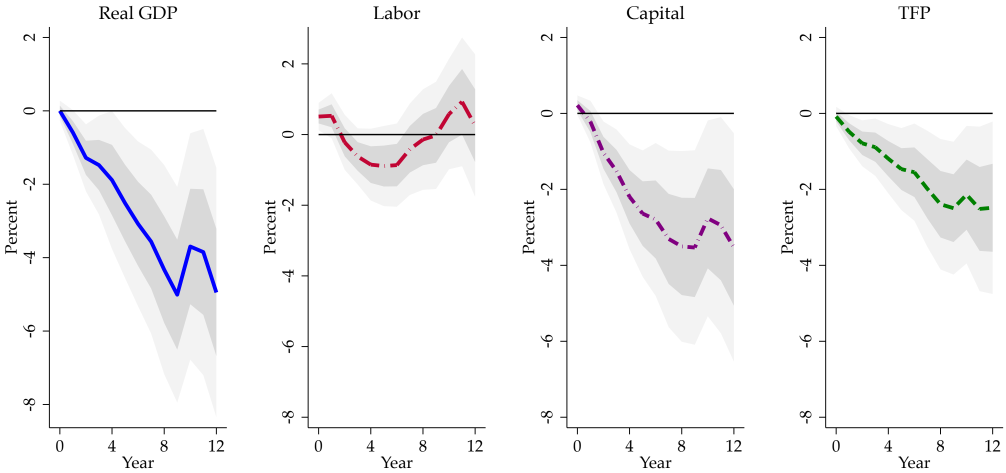
Solow decomposition & Asymmetry

Inspecting the mechanism – LPs for the Solow decomposition



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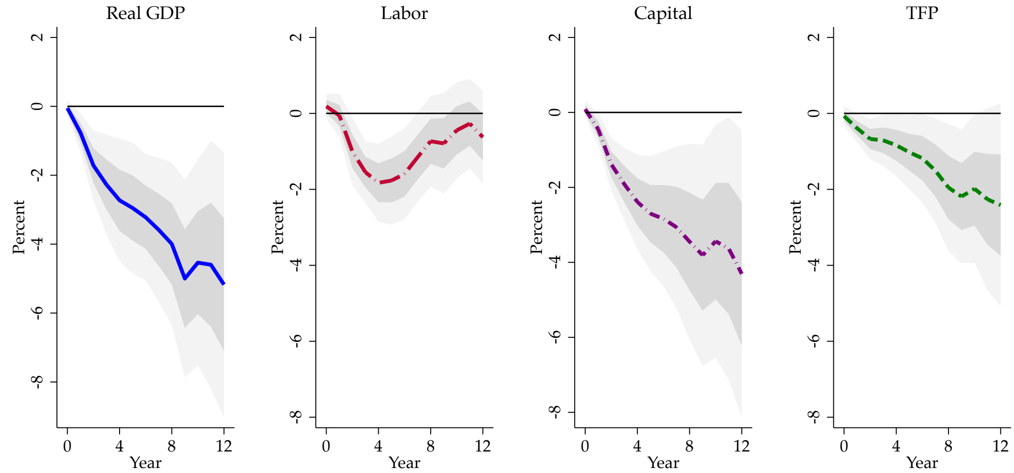
Asymmetric responses, contractionary shocks



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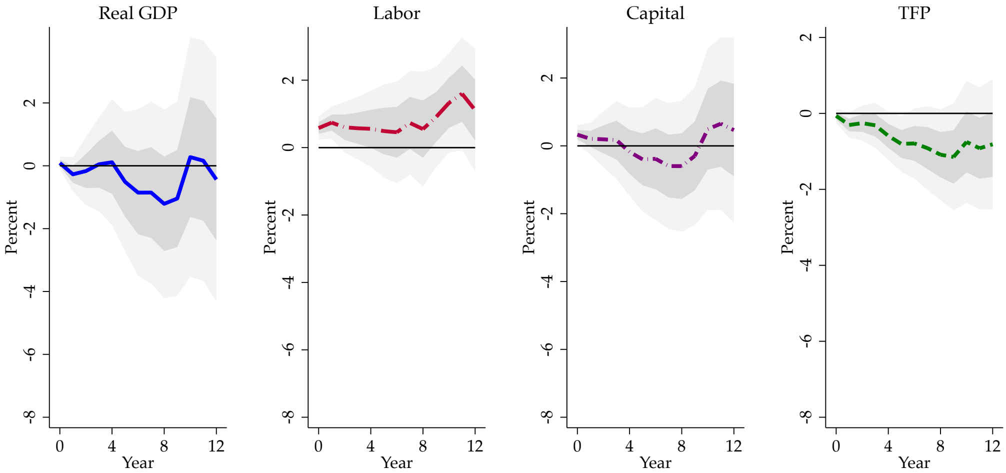
Asymmetric responses, expansionary shocks



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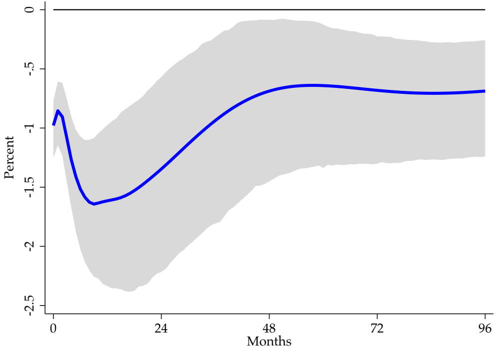
Other Monetary Shocks

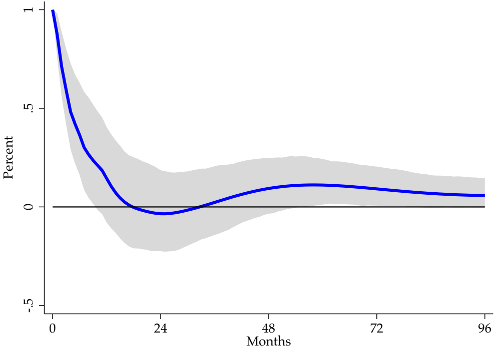
Miranda-Agrippino and Ricco (2021, AEJ Macro)

Extend replication code of published studies to 8-year horizon

(a) Industrial Production



(b) One-year T-bond



Shaded areas denote 90% posterior coverage bands in panels (a) and (b).

Brunnermeier, Palia, Sastry, and Sims (2021, AER)

Extend replication code of published studies to 8-year horizon

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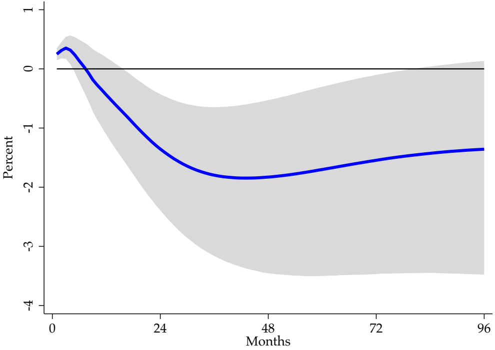
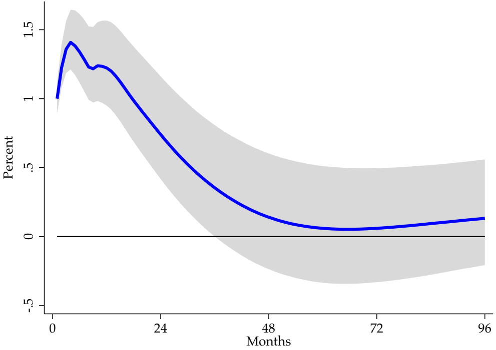


(b) Fed Funds Rate



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Cesa-Bianchi, Thwaites, and Vicondoa (2020, EER)

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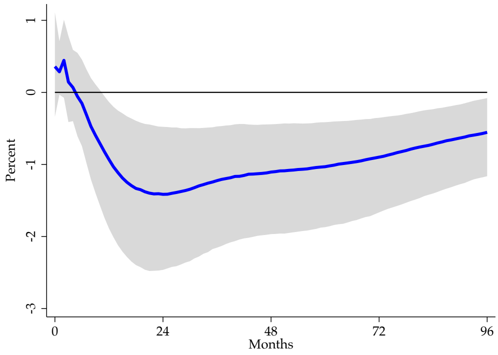
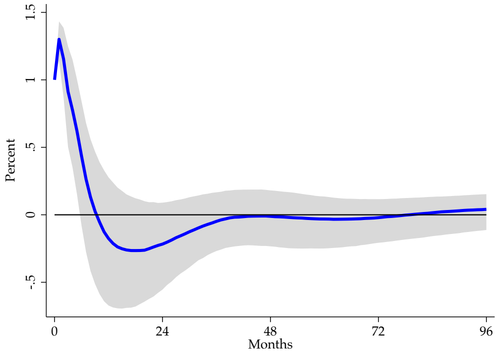
(a) Monthly estimate of GDP



(b) One-year Gilt Rate



Shaded areas denote 68% confidence intervals computed using moving block bootstrap with 5,000 replications.

Conclusion: Pushing on a long string?

long-run money neutrality may not hold

- a monetary tightening shock:
  - causes output to decline over a long period of time
  - because it causes the capital stock and TFP to decline

evidence based on

- small-open economy NK model to formalize identification
- LP-IV estimation using universe of available historical data
- various robustness exercises and alternative identification schemes

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additional slides

Households

$$\max_{\{C_t, l_t, B_{t+1}\}} \sum_{t=0}^{\infty} \zeta^t \left[\log(C_t) - \varphi \frac{l_t^{1+\nu}}{1+\nu} \right]$$

subject to

$$P_{Tt}C_{Tt} + P_{Nt}C_{Nt} + P_{Tt}d_t + B_t \; = \; W_t l_t + P_{Tt}Y_{Tt} + P_{Tt}\frac{d_{t+1}}{R_t} + \frac{B_{t+1}}{R_t^n} + T_t + Z_t$$

$$C_t = \left(\frac{C_{Tt}}{\omega}\right)^{\omega} \left(\frac{C_{Nt}}{1-\omega}\right)^{1-\omega}$$

ζ is the discount factor, ν is the (inverse) Frisch elasticity of labor supply, and φ is a scaling parameter, C_{Tt} is tradable good, C_{Nt} is non-tradable good, and $\omega \in (0, 1)$ is the tradable share

Production of non-tradables

A Dixit-Stiglitz aggregate over a continuum of products

$$C_{Nt} \equiv \left(\int_0^1 C_{Nt}(i)^{(\epsilon_p - 1)/\epsilon_p} di \right)^{\epsilon_p/(\epsilon_p - 1)}$$

where $\epsilon_p > 1$ is the elasticity of substitution.

Each monopolistically competitive firm has identical technology

$$Y_{Nt}(i) = L_{Nt}(i)$$

Prices are set one-period in advance as in Obstfeld and Rogoff (1995).

Policy and Market Clearing

Monetary Policy Rule in

1. the Benchmark Economy:

$$R_t^n = \bar{R}^n e^{\epsilon_t}; \quad (+\text{ equilibrium selection})$$

2. the Peg economy

$$\mathcal{E}_t = 1$$

Non-tradable goods and labor:

$$l_t = L_{Nt} = Y_{Nt} = C_{Nt}$$

External budget constraint:

$$C_{Tt} + d_t = Y_{Tt} + \frac{d_{t+1}}{R_t}$$

Assume constant weights on GDP aggregator

Equilibrium

- Analyze the economy starting at a deterministic steady state indexed by d_1.
- One-time unanticipated shock
    1. to a domestic policy rule in the benchmark economy configuration
    2. to a large economy interest rate in the peg economy configuration

Details

Home—base country links by era

Base country interest rate	Pre-WW1	Interwar	Bretton Woods	Post-BW
UK (Gold standard/BW base)	All countries		Sterling bloc: AUS*	
UK/USA/France composite (Gold standard base)		All countries		
USA (BW/Post-BW base)			All other countries	Dollar bloc: AUS, CAN, CHE, JPN, NOR
Germany (EMS/ERM/Eurozone base)				All other countries

* we treat AUS as moving to a dollar peg in 1967

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Summary statistics

average peg: 21 years (note: gold + Bretton Woods)
Obstfeld and Rogoff (1995): 5yrs (developing countries)

pegs are more open than floats

average degree of capital openness: $\bar{k}$

all years		postWW2	
pegs ($q = 1$)	floats ($q = 0$)	pegs ($q = 1$)	floats ($q = 0$)
0.87	0.70	0.76	0.74
(0.21)	(0.31)	(0.24)	(0.30)

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how often do countries switch exchange rate regime?

excluding wars

	1870–2013		1870–1939		1948–2015	
	Frequency	%	Frequency	%	Frequency	%
float to peg	19	2	6	3	13	2
no change	954	96	191	93	763	97
peg to float	19	2	8	4	11	1
Total	992	100	205	100	787	100

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What are the controls?

implementation details on choice of x:

- log real GDP; log real C; log real I
- log CPI
- short-term (3m) + long-term (5y) govt. rates
- log real stock prices; log real house prices
- credit to GDP
- log real global GDP: common global shocks
- log real base-country GDP: trade linkages

lags: 2

transformations: log differences $\times$ 100
(except interest rates and credit to GDP ratio)

sample: 1900–2015, 17 advanced economies, annual frequency

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Other Monetary Shocks: US Economy

Extend replication code of published studies to 8-year horizon

1. Miranda-Agrippino and Ricco (2021 AEJ Macro, 2023 JME)
   - high-frequency surprises around FOMC announcements + Greenbook forecasts
   - monthly Bayesian proxy-VAR(12)
   - Sample 1979:1– 2014:12
2. Brunnermeier, Palia, Sastry, and Sims (2021, AER)
   - identification by heteroskedasticity (Rigobon 2003)
   - ten-variable monthly Bayesian SVAR(10) model
   - Sample 1973:1–2015:6

Other Monetary Shocks: UK Economy

Extend replication code of published studies to 8-year horizon

1. Cesa-Bianchi, Thwaites, and Vicondoa (2020, EER)
   - series of monetary policy surprises for the UK using intra-day three-month Sterling futures data
   - monthly proxy SVAR(4)
   - Sample 1992:1–2015:1