

The long-run effects of monetary policy

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How long do the effects of monetary interventions last?

Methods

data: historical panel, 125 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

Empirical

- large persistent effects of monetary shocks
- labor returns to pre-trend level, capital and TFP persistently lower
 - asymmetry: loosening shocks harmless, tightening shocks harmful

Other monetary shocks

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

EMPIRICAL ANALYSIS

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

peg + open to capital \rightarrow correlated interest rates

3 subpopulations: bases (b), pegs, floats

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

$q_{j,t}$ indicator $\in \{0, 1\}$ if peg in t and $t - 1$

$z_{j,t} = k_{j,t}(\Delta i_{b(j,t),t} - \hat{\Delta i}_{b(j,t),t})$ (base “pre-cleaned” using $x_{b(j,t),t}$ controls, à la RR)

■ *intervention*: $\Delta i_{j,t}$ short-rate proxy, 3-mo govt. bill

■ *instrument*: $z_{j,t}$ trilemma IV (for $q_{j,t} = 1$; LATE)

■ *outcomes*: home output and its components (at $t, t + 1, \dots, t + H$)

[home-base links](#)

[summary stats](#)

[exchange regime switches](#)

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

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

$$\Delta i_{j,t} = a_j + x_{j,t}g + z_{j,t}b + \eta_{j,t} \rightarrow \hat{\Delta i}_{j,t} \quad (\text{first stage})$$

$$y_{j,t+h} - y_{j,t-1} = \alpha_{j,h} + x_{j,t}\gamma_h + \hat{\Delta i}_{j,t}\beta_h + v_{j,t+h} \quad (\text{second stage LP})$$

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

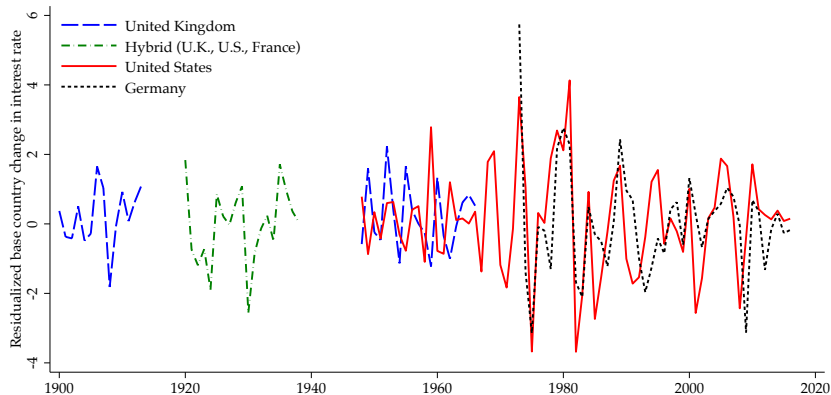
hours worked, number of employees, capital stock (machines and buildings)...

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.

IV construction

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



$\Delta \hat{R}_{b(i,t),t} = (\Delta R_{b(i,t),t} - \Delta \tilde{R}_{b(i,t),t})$ 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

- *intervention*: $\Delta i_{j,t}$ 3-mo govt. bill
- *instrument*: $z_{j,t}$ trilemma IV

First Stage: $\Delta i_{j,t} = a_j + z_{j,t}b + x_{j,t}g + \eta_{j,t}$

pegs ($q = 1$)

	All years	PostWW2
b	0.59***	0.61***
t -statistic	[9.47]	[9.02]

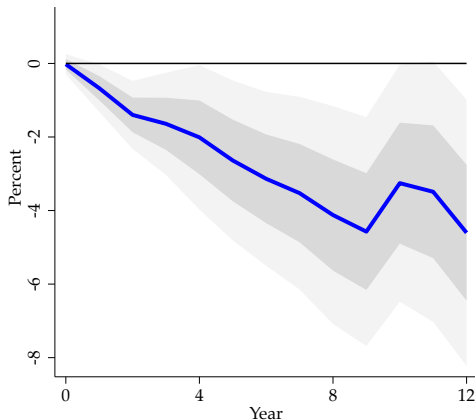
coefficients \approx Obstfeld, Shambaugh & Taylor (2005)

list of controls and transformations

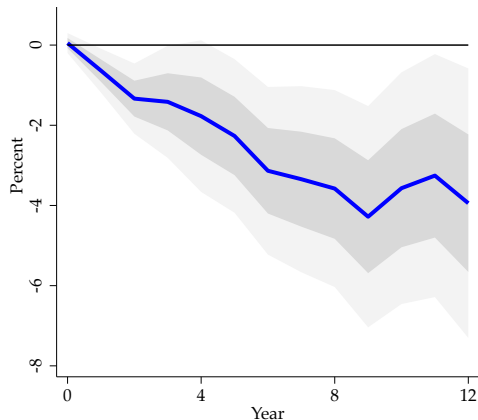
Empirics

baseline result: real GDP — the long shadow

(a) Full sample: 1900–2015



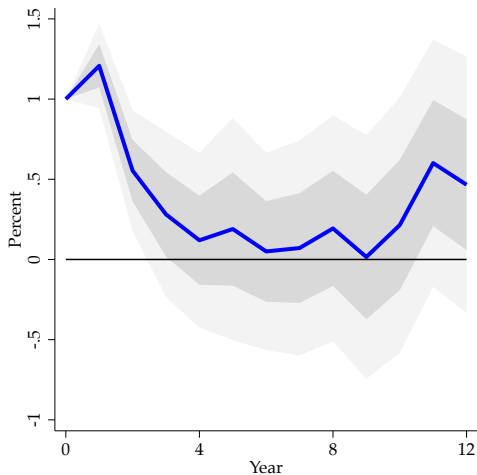
(b) Post-WW2 sample: 1948–2015



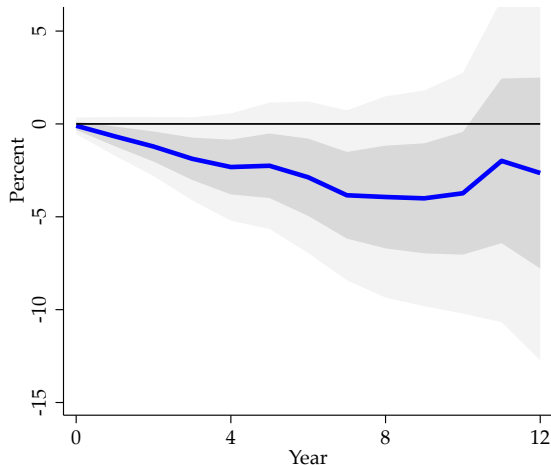
† confidence bands: 68% and 95% Driscoll & Kraay (1998) standard errors

short term nominal interest rate and CPI

(a) Short term nominal rate

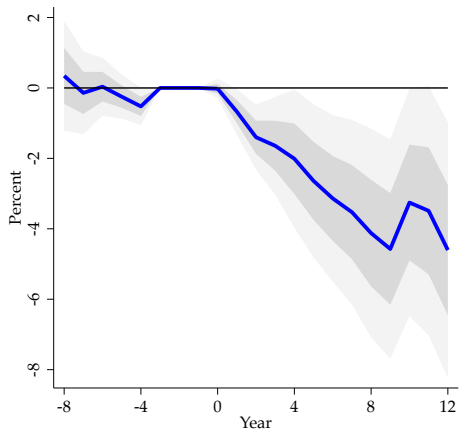


(b) CPI



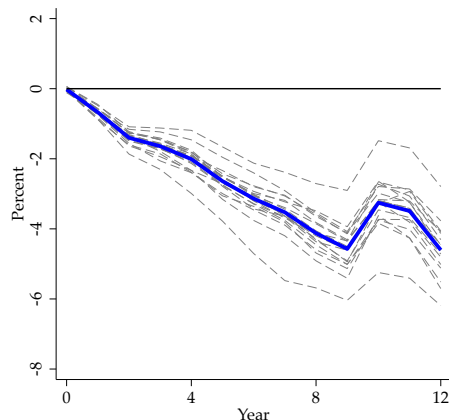
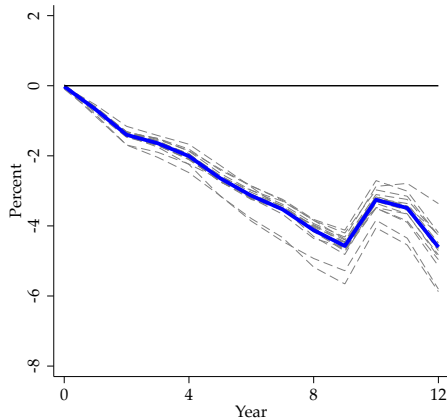
† confidence bands: 68% and 95% Driscoll & Kraay (1998) standard errors, sample: 1900–2015

Robustness with pre-trends: IRF of Real GDP



Robustness with hair-plots: IRF of Real GDP

- (a) Dropping each country one at a time (b) Dropping successive 5-year windows one at a time



Spillover: exclusion restriction violation

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

$$y_{j,t+h} - y_{j,t} = \alpha_{j,h} + x_{j,t}\gamma_h + \hat{\Delta}i_{j,t}\beta_h + z_{j,t}\theta + v_{j,t+h}$$

- 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:

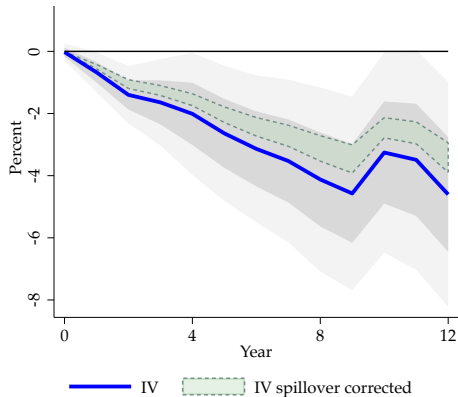
$$\theta = \underbrace{\text{share of exported tradables in home output}}_{\text{calibrate: } \Phi \in [0, 0.3]} \times \underbrace{\text{responsiveness of exported tradable demand to base interest rate}}_{\text{assumption: upper bound} = \beta_h}$$

→ Estimate an augmented LP :

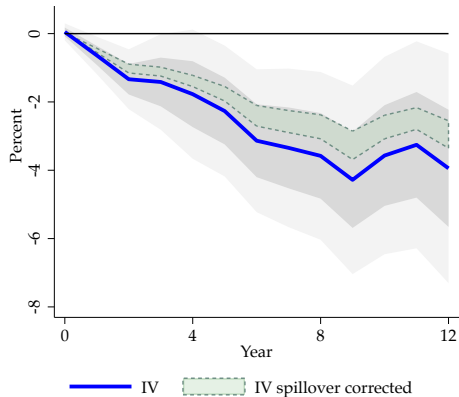
$$y_{j,t+h} - y_{j,t} = \alpha_{j,h} + x_{j,t}\gamma_h + \left(\hat{\Delta}i_{j,t} + \Phi z_{j,t} \right) \beta_h + v_{j,t+h}$$

Model-based spillover correction

(a) Real GDP: 1900–2015



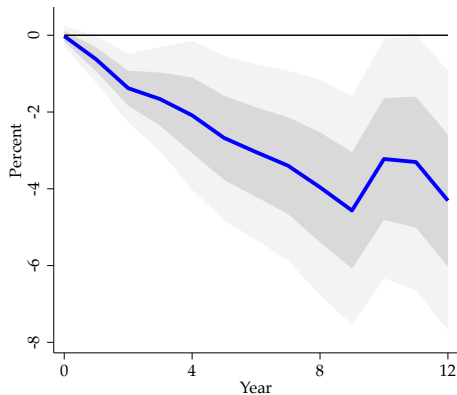
(b) Real GDP: 1948–2015



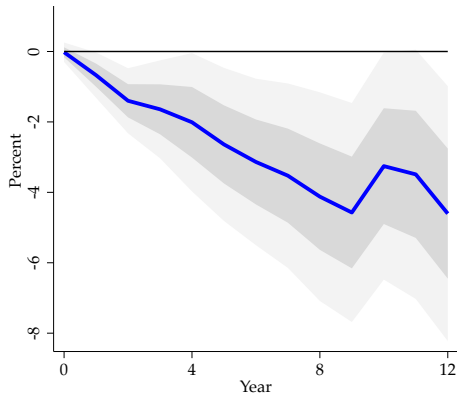
open economy variables: exclusion restriction

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

(a) “Open economy” controls



(b) Baseline IRF of real GDP

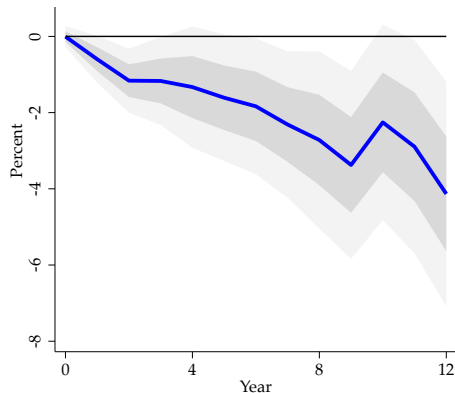


IRFs of real GDP: structural breaks in TFP

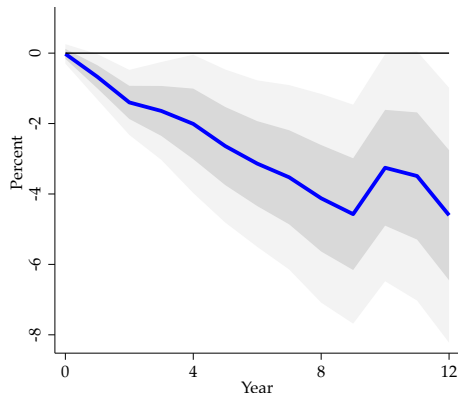
Fernald, 2007, 2014; Gordon 2016

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

(a) Structural breaks in TFP growth

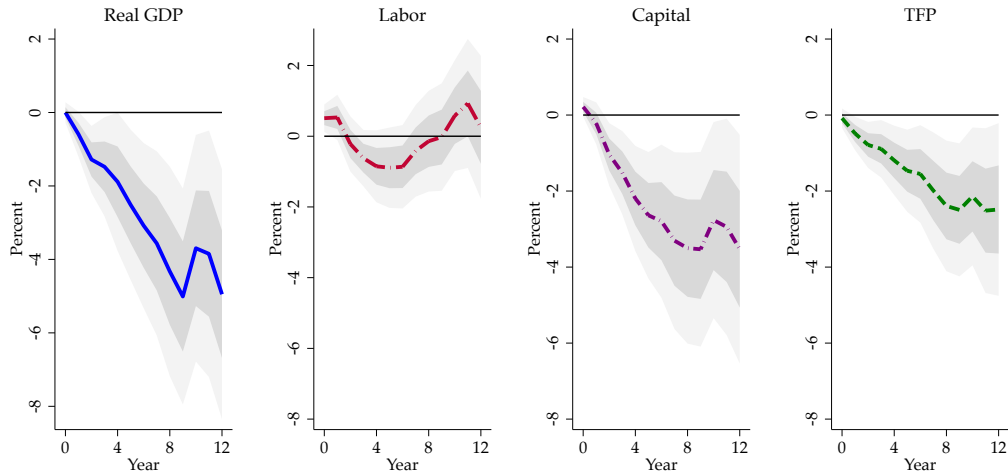


(b) Baseline IRF of real GDP



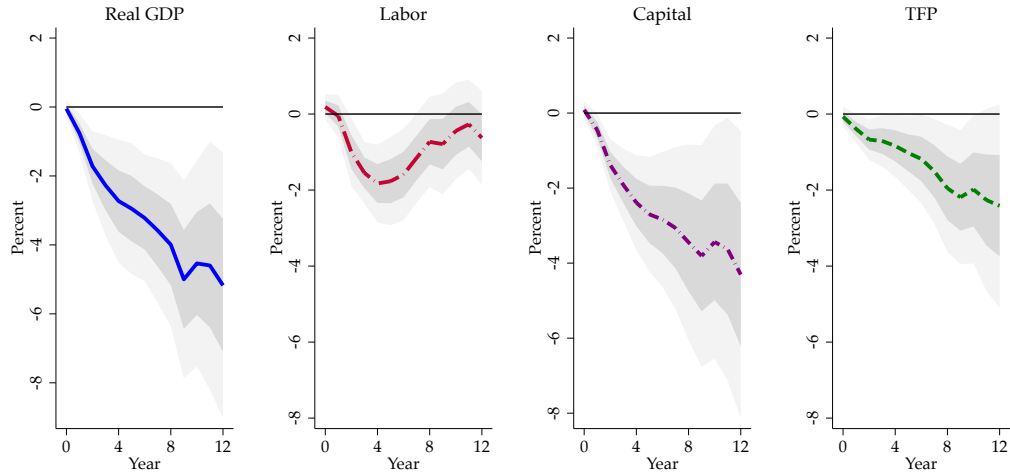
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Inspecting the mechanism – LPs for the Solow decomposition



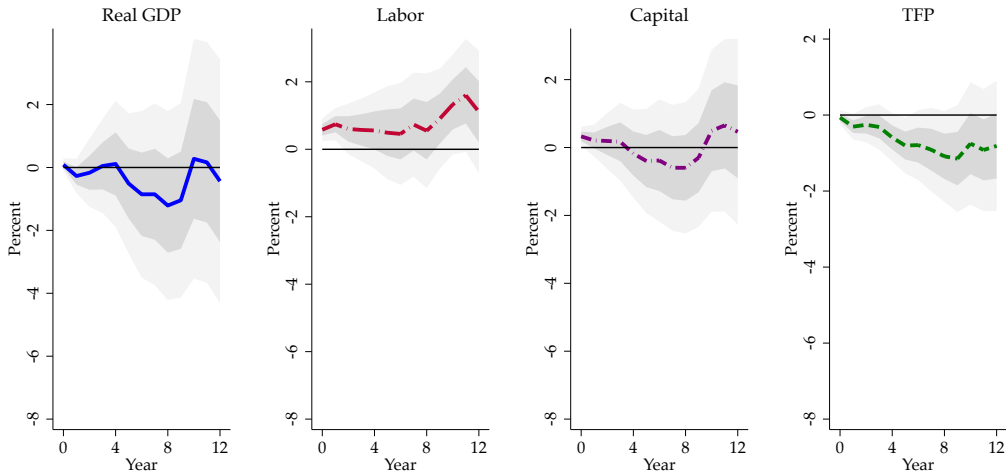
† confidence bands: 68% and 95% Driscoll & Kraay (1998) standard errors, sample: 1900–2015

Asymmetric responses, contractionary shocks



† confidence bands: 68% and 95% Driscoll & Kraay (1998) standard errors, sample: 1900–2015

Asymmetric responses, expansionary shocks



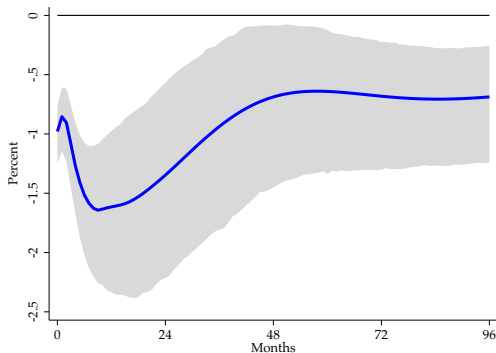
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OTHER MONETARY SHOCKS

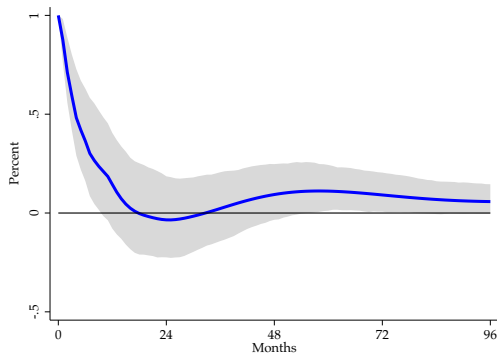
Miranda-Agrippino and Ricco (2021, AEJ Macro)

Extend replication code of published studies to 8-year horizon

(a) Industrial Production



(b) One-year T-bond

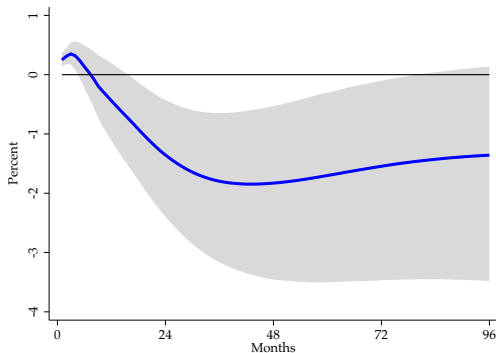


Shaded areas denote 90% posterior coverage bands in panels (a) and (b).

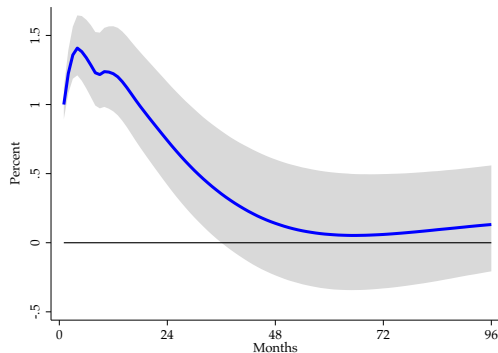
Brunnermeier, Palia, Sastry, and Sims (2021, AER)

Extend replication code of published studies to 8-year horizon

(a) Industrial Production



(b) Fed Funds Rate

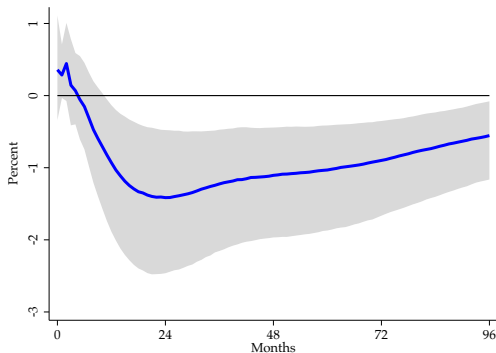


Shaded areas denote 90% posterior coverage bands in panels (a) and (b).

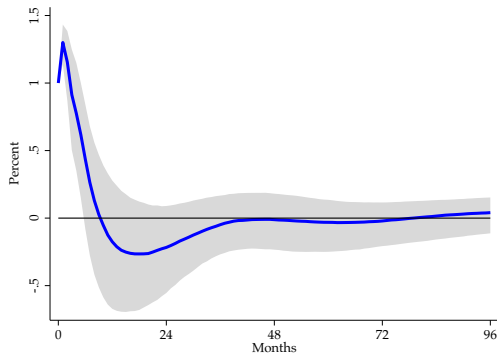
Cesa-Bianchi, Thwaites, and Vicondoa (2020, EER)

Extend replication code of published studies to 8-year horizon

(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 (0.21)	0.70 (0.31)	0.76 (0.24)	0.74 (0.30)

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

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 Viccondoa (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