

The long-run effects of monetary policy

Òscar Jordà^{*} Sanjay R. Singh[§] Alan M. Taylor[‡]

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^{*} Federal Reserve Bank of San Francisco; University of California, Davis

[§] Federal Reserve Bank of San Francisco; University of California, Davis

[‡] University of California, Davis; NBER; CEPR

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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

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

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

$k_{j,t}$ 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 $t, t + 1, \dots, t + H$)

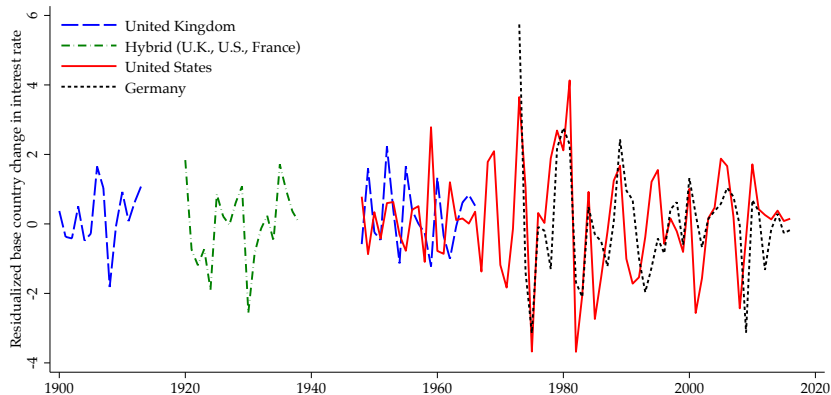
[home-base links](#)

[summary stats](#)

[exchange regime switches](#)

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

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

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

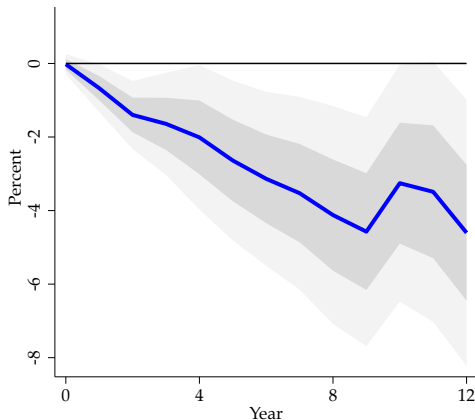
$$\Delta i_{j,t} = a_j + x_{j,t}g + z_{j,t}b + \eta_{j,t} \rightarrow \hat{\Delta i}_{j,t} \quad (\text{first stage})$$

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

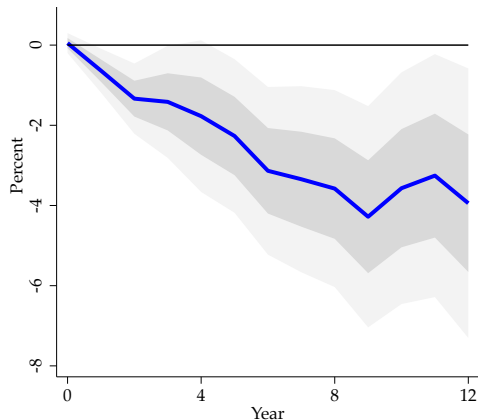
Empirics

baseline result: real GDP — the long shadow

(a) Full sample: 1900–2015



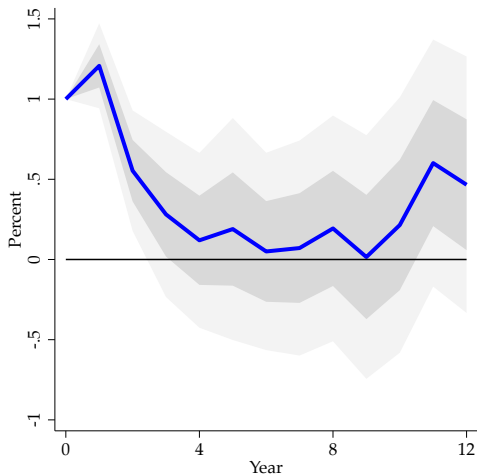
(b) Post-WW2 sample: 1948–2015



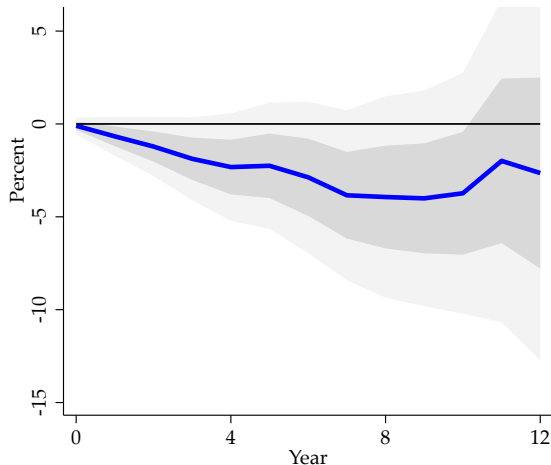
† confidence bands: 68% and 95% Driscoll & Kraay (1998) standard errors

short term nominal interest rate and CPI

(a) Short term nominal rate



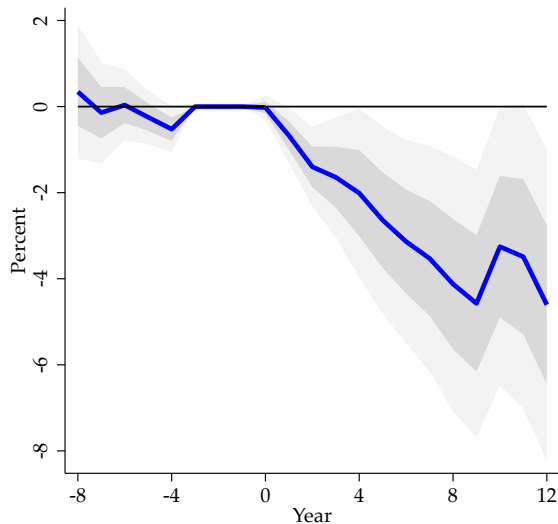
(b) CPI



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

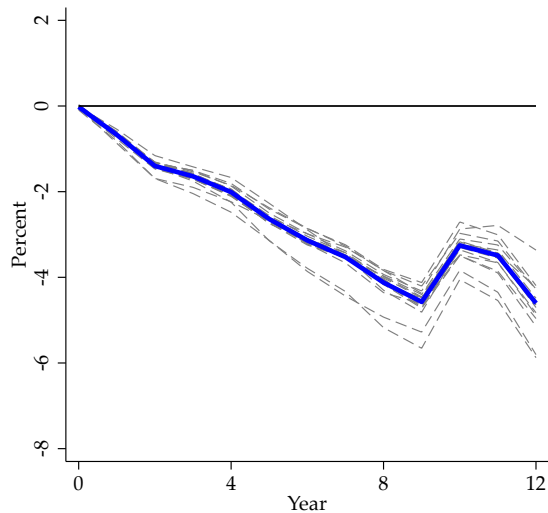
ROBUSTNESS

Robustness with pre-trends: IRF of Real GDP

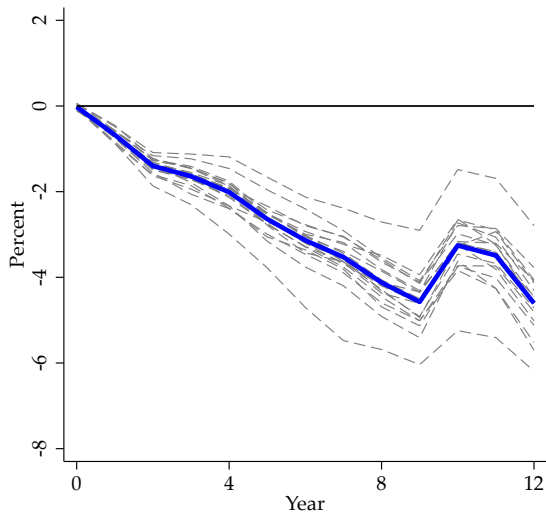


† confidence bands: 68% and 95% Driscoll & Kraay (1998) standard errors, sample: 1900–2015

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

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

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

Spillover correction:

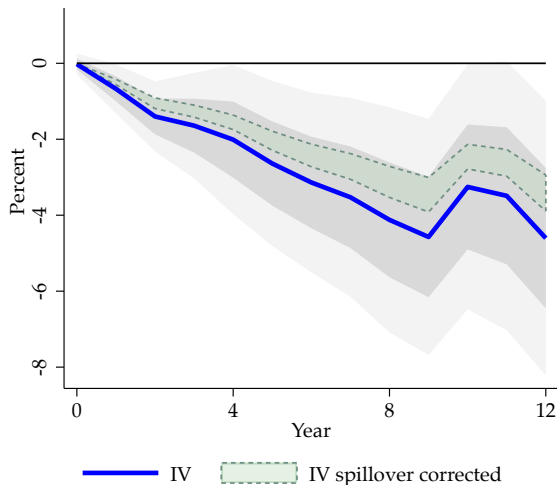
Employ a **control function approach**, by using the model to get a bound:

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

→ Estimate an augmented LP :

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

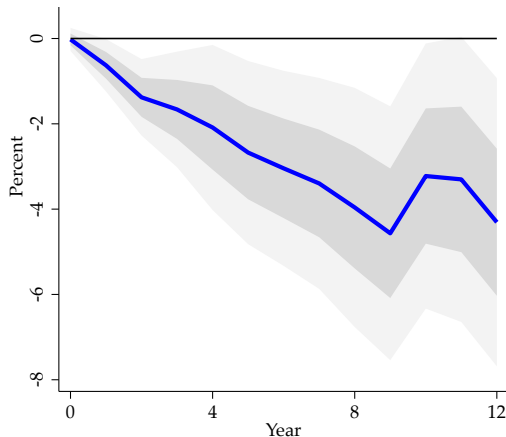
Model-based spillover correction



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

open economy variables: exclusion restriction

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

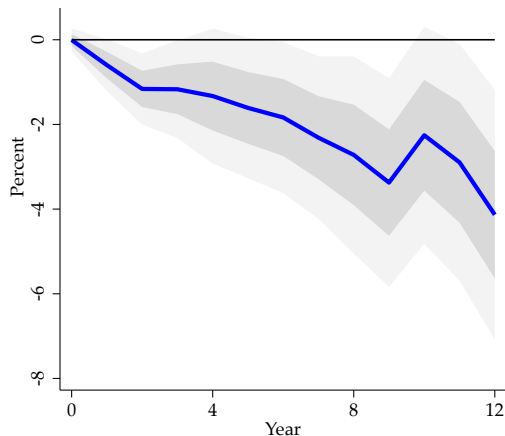


† confidence bands: 68% and 95% Driscoll & Kraay (1998) standard errors, sample: 1900–2015

IRFs of real GDP: structural breaks in TFP

Fernald, 2007, 2014; Gordon 2016

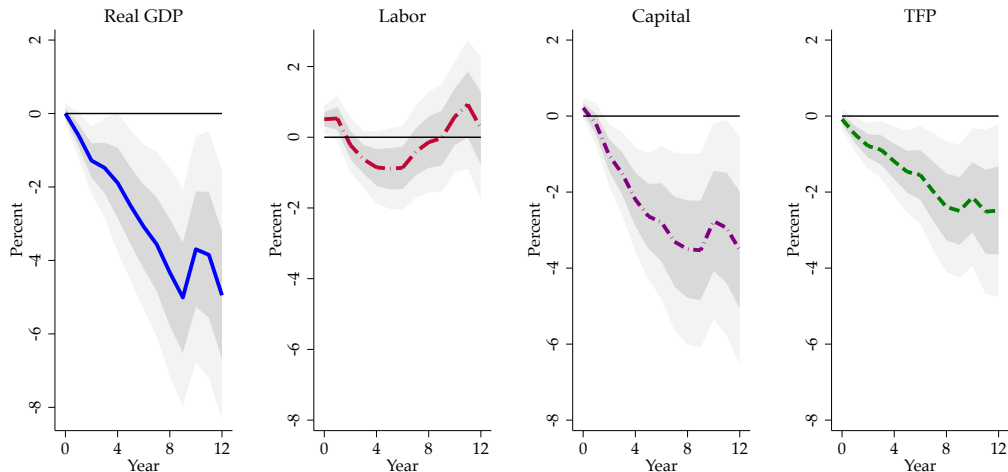
Allow intercept to be regime-dependent based on Bai & Perron (1998)



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

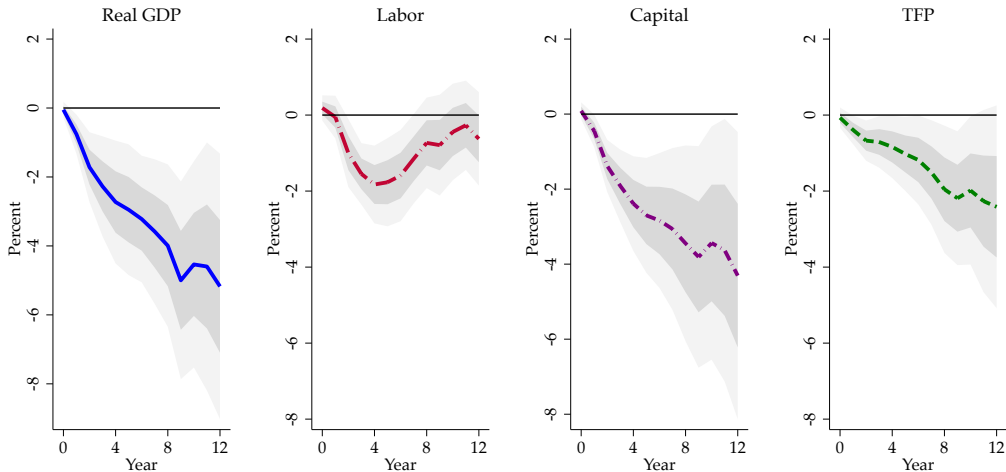
SOLOW DECOMPOSITION & ASYMMETRY

Inspecting the mechanism – LPs for the Solow decomposition



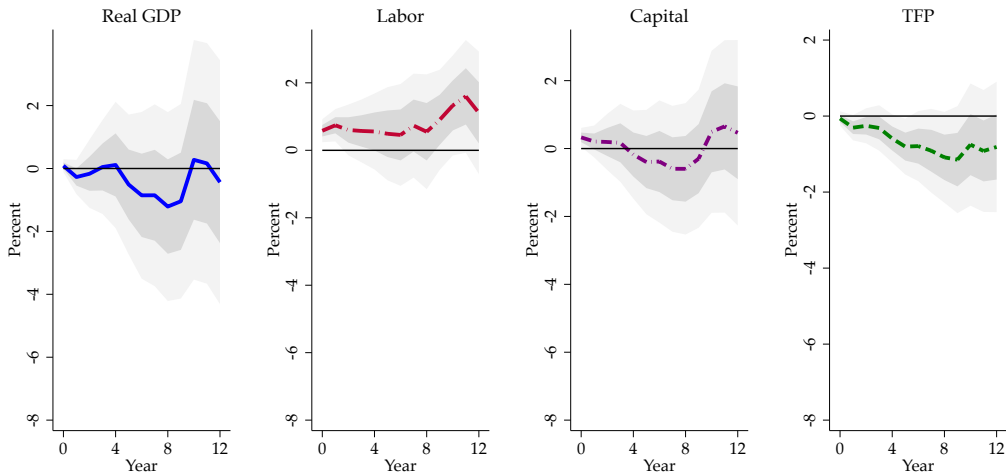
† confidence bands: 68% and 95% Driscoll & Kraay (1998) standard errors, sample: 1900–2015

Asymmetric responses, contractionary shocks



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

Asymmetric responses, expansionary shocks



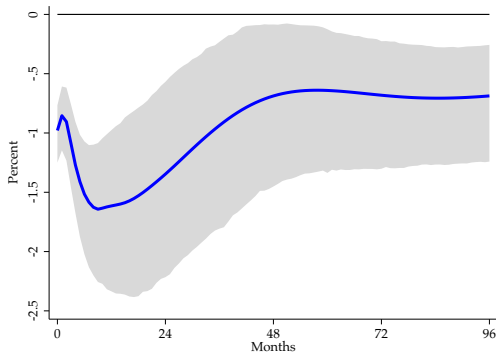
† confidence bands: 68% and 95% Driscoll & Kraay (1998) standard errors, sample: 1900–2015

OTHER MONETARY SHOCKS

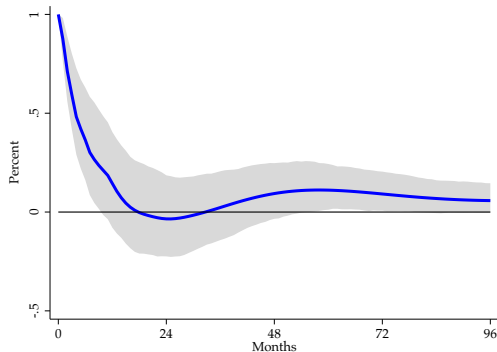
Miranda-Agrippino and Ricco (2021, AEJ Macro)

Extend replication code of published studies to 8-year horizon

(a) Industrial Production



(b) One-year T-bond

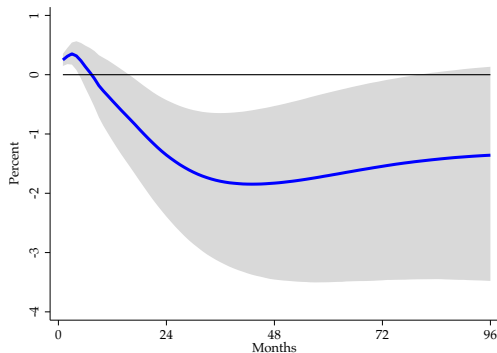


Shaded areas denote 90% posterior coverage bands in panels (a) and (b).

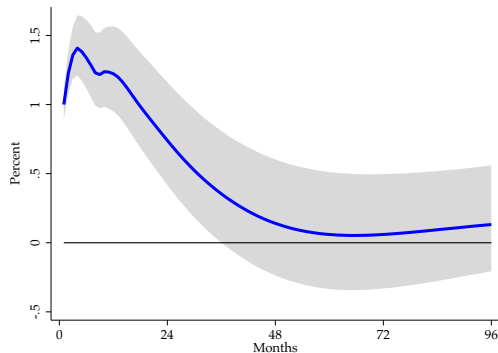
Brunnermeier, Palia, Sastry, and Sims (2021, AER)

Extend replication code of published studies to 8-year horizon

(a) Industrial Production



(b) Fed Funds Rate

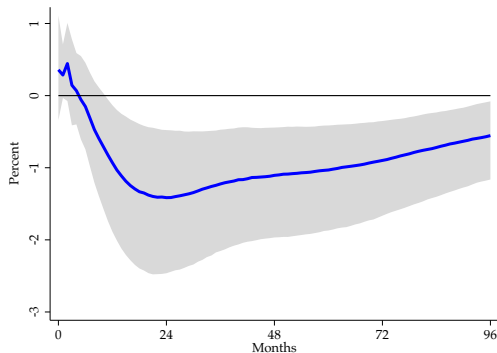


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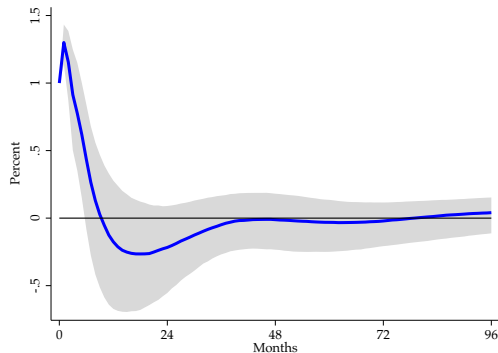
Cesa-Bianchi, Thwaites, and Vicondoa (2020, EER)

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 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