The International Spillovers of Synchronous Monetary Tightening

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Federal Reserve Board

April 29, 2023 - Carnegie-Rochester-NYU Conference

Motivation

- Central banks are tightening aggressively to reduce inflation.
- Risks (Obstfeld, 2022):
  - Larger spillovers due to synchronous actions.
  - Global policy coordination needed to avoid severe global slowdown.
- Consensus view in the literature downplays these risks
  Obstfeld and Rogoff (2002), Corsetti and Pesenti (2005), Taylor (2013)
  - Traditional open economy models: spillovers through trade linkages.
  - Small spillovers $\Rightarrow$ small gains from policy coordination.

Our Contribution

Synchronous tightening can cause large spillovers through financial channels, and worsen monetary policy trade-offs.

1. Data: look at contractionary monetary shocks:
   - Spillovers from one country to others.
   - Amplification during global tightening cycles
   - Larger amplification on output than inflation
     $\rightarrow$ higher sacrifice ratios: $\downarrow Y > \downarrow \pi$
2. Model analysis:
   - Leverage-constrained global financial intermediaries (GFIs).
   - Nonlinear effects of synchronous tightening through GFIs balance sheet.
   - Financial amplification worsens policy trade-offs.
3. Optimal policy analysis:
   - When financial channel active, large spillovers and strategic interaction.
   - State-dependent spillovers $\rightarrow$ state-dependent gains from coordination.

Empirical Analysis

Empirical Background

Data on interest rates, GDP, inflation, credit spreads, bank equity prices, unemployment for 21 advanced economies 1980q1-2019q4.

Look at aftermath of monetary shocks $\varepsilon_{i,t}^{MP}$

$$R_{i,t} = \alpha_i + \boldsymbol{\beta}_i \mathbf{Z}_{i,t} + \varepsilon_{i,t}^{MP},$$

$\mathbf{Z}_{i,t}$: two lags of of interest rates, inflation, unemployment, exchange rate.

Two questions :

1. What are the GDP effects of contractionary shocks —$\mathbb{1}\{\varepsilon_{i,t}^{MP} > 0\}$—, in isolation or combined?
2. Are the effects of a sizeable contractionary shock —$\mathbb{1}\{\varepsilon_{i,t}^{MP} > 0.25\}$— larger during a global tightening cycle?

Spillovers, in Isolation and Combined

1. Contractionary monetary shocks spill over from one country to others and combined GDP effects are "large"

$$\Delta GDP_{i,t+8} = \beta_D \mathbb{D}_{i,t} + \beta_F \mathbb{F}_{i,t} + \beta_H \mathbb{DF}_{i,t} \times \mathbb{YH}_{i,t} + \beta_L \mathbb{DF}_{i,t} \times \mathbb{YL}_{i,t} + u_{i,t}$$

	(1) $\Delta GDP(t+8)$	(2) $\Delta GDP(t+8)$	(3) $\Delta GDP(t+8)$
Dummy: Own Tightening	-1.09*** (-6.16)	-0.77*** (-3.61)	-0.80*** (-3.72)
Dummy: Foreign Tightening	-0.87*** (-3.39)	-0.55** (-2.23)	-0.56** (-2.18)
Dummy: Own × Foreign Tightening		-0.65* (-1.93)	
Dummy: Own × Foreign Tightening, Hi Growth			-0.07 (-0.24)
Dummy: Own × Foreign Tightening, Lo Growth			-1.53*** (-4.95)
Observations	2,986	2,986	2,958
Fixed Effects	yes	yes	yes

State-dependency of large contractionary shocks

2. Large contractionary monetary shocks are amplified during a global tightening cycle (synchronous)

A global tightening window lasts two years and starts in quarter t when global interest rate R^* satisfies:

$$R_t^* - R_{t-4}^* > 0.25 \text{ and } \; R_t^* > R_{t+6}^*$$

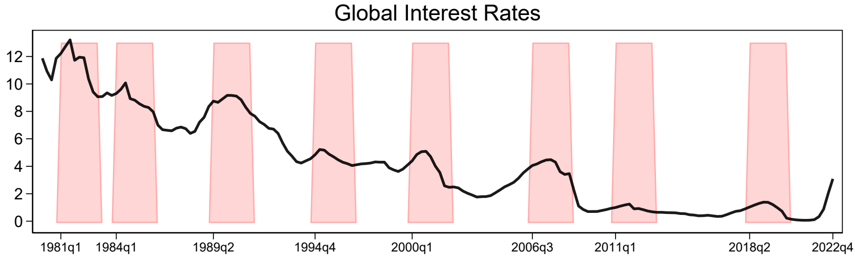
Define dummies for contractionary monetary shocks during and outside of global tightening windows:

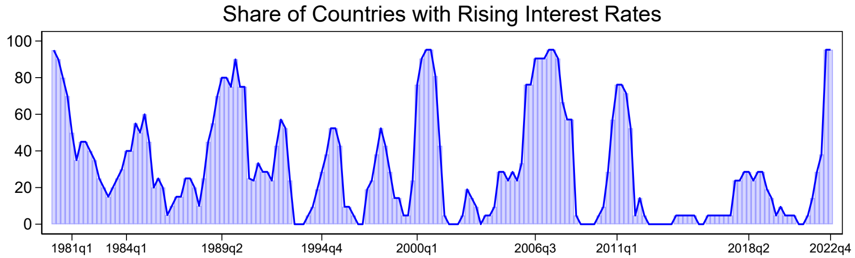
$$\text{Synchronous} : \mathbb{DS}_{i,t} = 1 \quad \text{if } \varepsilon_{i,t}^{MP} > 0.25 \text{ and } t \in \text{ global window}$$

$$\text{Asynchronous} : \mathbb{DA}_{i,t} = 1 \quad \text{if } \varepsilon_{i,t}^{MP} > 0.25 \text{ and } t \notin \text{ global window}$$

distributions

Global Tightening Windows

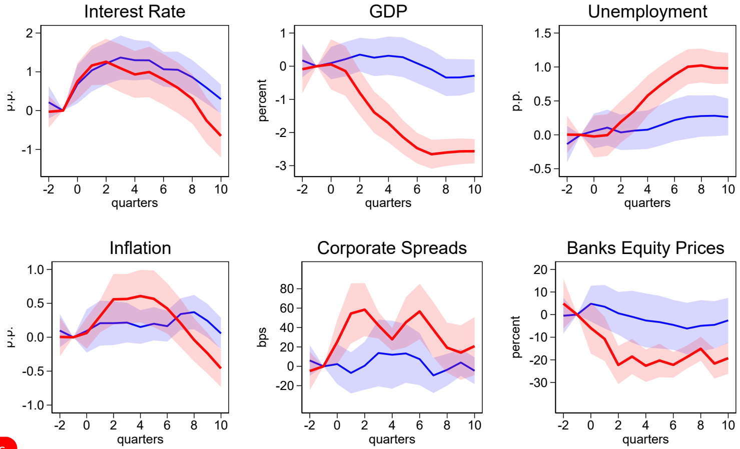




State-dependency of large contractionary shocks

Synchronous vs Asynchronous

$$y_{i,t} = \gamma_i + \sum_{\tau=-2}^{10} \sigma_\tau \mathbb{DS}_{i,t+\tau} + \sum_{\tau=-2}^{10} \alpha_\tau \mathbb{DA}_{i,t+\tau} + \varepsilon_{i,t},$$



Robustness

Empirical Background: Takeaways

- Contractionary monetary shocks spill over from one country to others
- Effects are “larger” than the sum of their parts

During a global tightening cycle:

- Contractionary monetary shocks have large effects on real and financial variables
- Contractionary monetary shocks affect activity relatively more than inflation

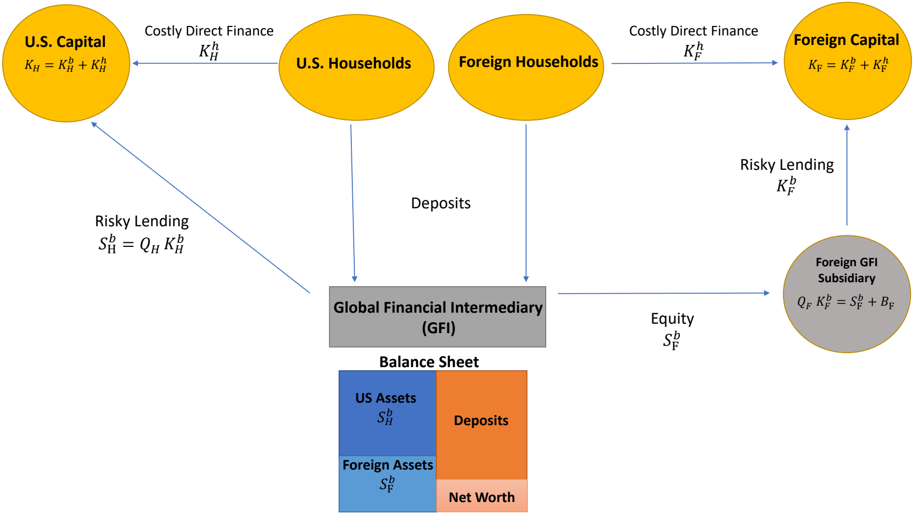
A Model of Global Spillovers

Model: Standard Parts of the

- Two-country new-Keynesian DSGE model: U.S. (H) and ROW (F).
- Consumption habits and investment adjustment costs
- Sticky prices for domestic and exported goods (LCP).
- Monetary policy follows Taylor rule reacting to domestic inflation.
- **Shocks**: Country specific monetary shocks $\varepsilon^{m}_{i,t}$; Global markup shock ϵ^{μ}_{t}.

Details

Model: International Financial Flows



Global Financial Spillovers

- Global financial intermediaries (GFI) facing occasionally binding leverage constraint.
- Spillovers of contractionary MP shock depend on GFIs' balance sheets:
  - Strong balance sheets $\Rightarrow$ Small spillovers:
    - Standard international transmission.
  - Weak balance sheets $\Rightarrow$ Large spillovers:
    - GFIs ability to increase borrowing is limited.
    - Credit spreads rise globally $\rightarrow$ financial amplification.
    - Decline in GDP $>$ decline in inflation $\rightarrow$ higher sacrifice ratios
- Key mechanism: **synchronous tightening weakens GFI balance sheet $\rightarrow$ activates financial amplification channel**.

GFI Problem

- GFI borrows at R^d_{Ht} and invest in home and foreign assets with returns:

$$R^s_{Ht+1} = R^k_{Ht+1} = \left(z_{Ht+1} + (1-\delta)Q_{Ht+1}\right)/\,Q_{Ht}$$

$$R^s_{Ft+1} = \frac{X_{t+1}}{X_t}\left(\lambda R^k_{Ft+1} - (\lambda - 1)R_{Ft}\right)$$

- If excess returns are positive GFI increases leverage until:

$$E_t\Lambda_{bt+1}\left(R^S_{ht+1} - R_t\right) = E_t\Lambda_{bt+1}\left(R^S_{ft+1} - R_t\right) = 0$$

- **Agency Problem**: GFI can divert fraction θ_H of home and θ_F of foreign assets

  $\Longrightarrow$ Leverage constraint which limits arbitrage.

Financial spillovers of Monetary Policy

- Joint tightening at home & abroad causes GFIs net worth losses:

$$\underbrace{N_t}_{\uparrow i_{ht}, i_{ft} \to N_t \downarrow} = \underbrace{R^s_{Ht} S_{Ht-1}}_{\uparrow i_{ht} \to R^s_{Ht} \downarrow} + \underbrace{R^s_{Ft} S_{Ft-1}}_{\uparrow i_{ft} \to R^s_{Ft} \downarrow} - R^D_{Ht-1} D_{t-1}$$

- Leverage constraint on GFIs:

$$\theta_h \frac{Q_{ht} S^b_{ht}}{N_t} + \theta_f \frac{Q_{ft} S^b_{ft}}{N_t} \leq 1$$

- If $N_t \downarrow$ small, GFIs leverage up, no change in spreads:

$$E_t \Lambda_{bt+1} \left(R^S_{ht+1} - R_t \right) = E_t \Lambda_{bt+1} \left(R^S_{ft+1} - R_t \right) = 0$$

- If $N_t \downarrow$ large, leverage constraint binds, credit spreads up globally:

$$E_t \Lambda_{bt+1} \left(R^B_{ht+1} - R_t \right) = \frac{\theta_h}{\theta_f} E_t \Lambda_{bt+1} \left(R^B_{ft+1} - R_t \right) > 0$$

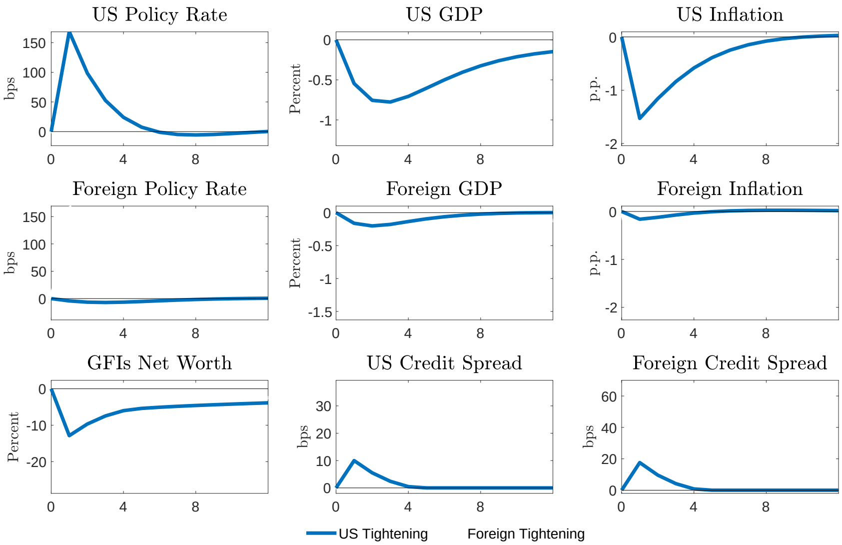
Calibration & Solution Method

- Key calibration targets:
  - Regions size: United States 1/4; Foreign 3/4.
  - GFI asset exposure: United States 3/4; Foreign 1/4. (BIS data)
  - Leverage of GFIs = 4.75. (Ottonello and Winberry (2018))
  - Global spreads rise 60bps with synchronous tightening. (Event Study Analysis)
- Leverage constraint not binding in steady state.
- Model solution: piece-wise linear with occasionally binding constraint (OccBin).

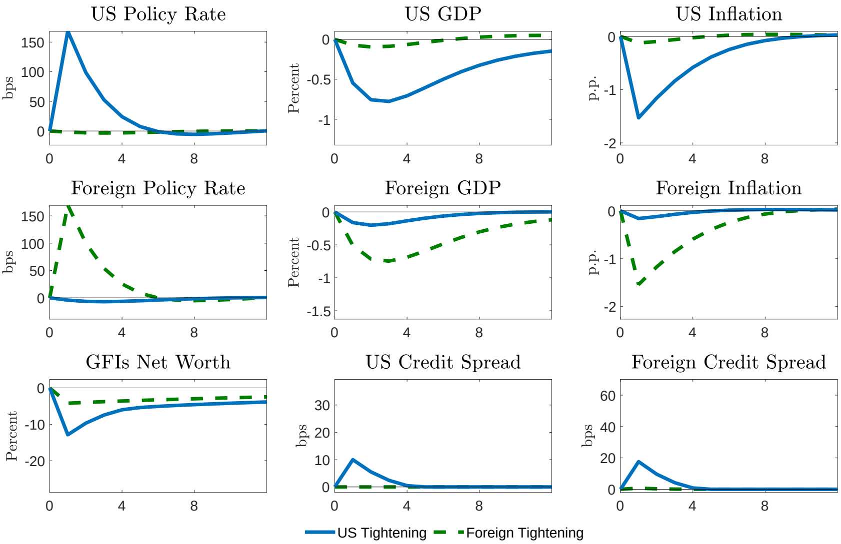
Details

Model Simulations

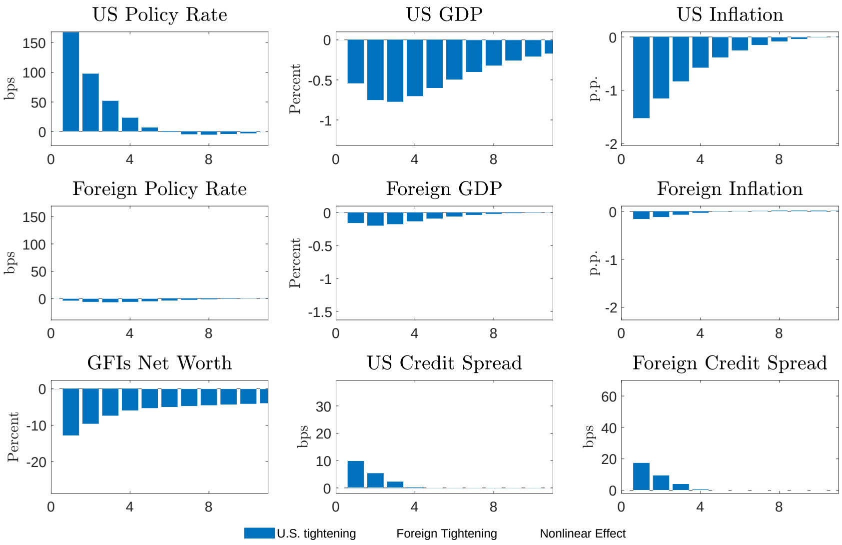
Simulations: Asynchronous Tightening



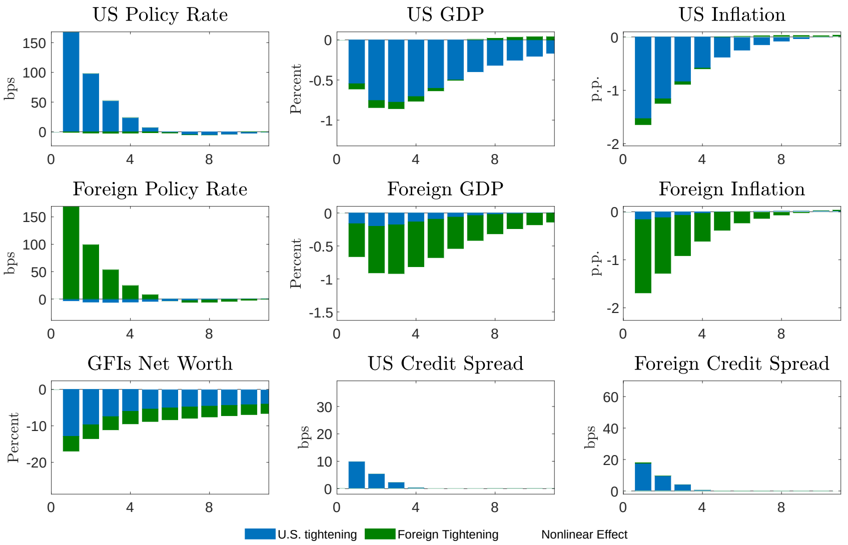
Simulations: Asynchronous Tightening



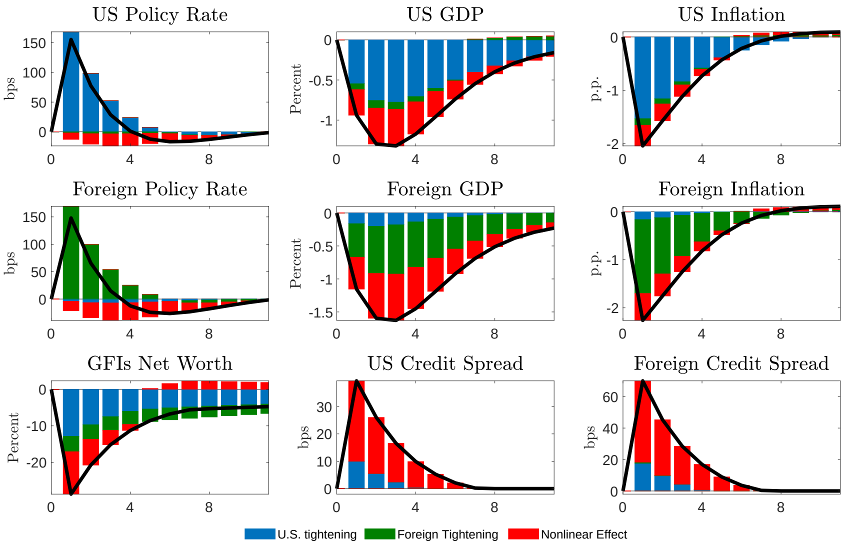
Synchronous vs Asynchronous Tightening



Synchronous vs Asynchronous Tightening



Synchronous vs Asynchronous Tightening



Policy Tradeoffs

- Financial amplification has larger effect on output than inflation (Christiano et al. (2015), Gilchrist et al. (2017))

- Intuition: Financial amplification works mainly on investment

$$\downarrow y_t = c_t + \downarrow\downarrow i_t + nx_t$$

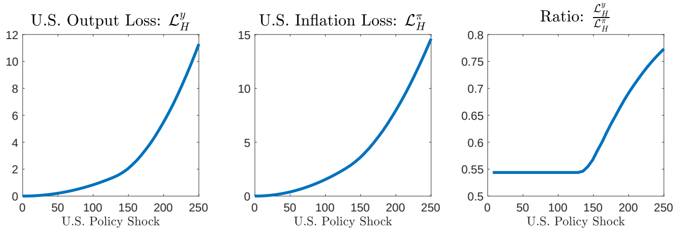
associated drop in inflation π is smaller

$$\pi_{it} = s\left(\left(1-\alpha\right)w_{it} + \alpha z_{it} - p_{iit}\right) + \beta E_t \pi_{it+1}$$

  - lower future capital dampens drop in z
  - smaller wealth effects on labor supply dampens drop in w

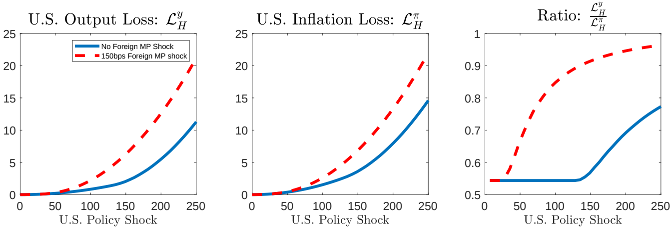
Policy Tradeoffs: Monetary and Markup shocks

Output Loss: $\mathcal{L}_i^y = \sum_0^T \beta^t y_{i,t}^2$ Inflation Loss: $\mathcal{L}_i^\pi = \sum_0^T \beta^t \pi_{i,t}^2$



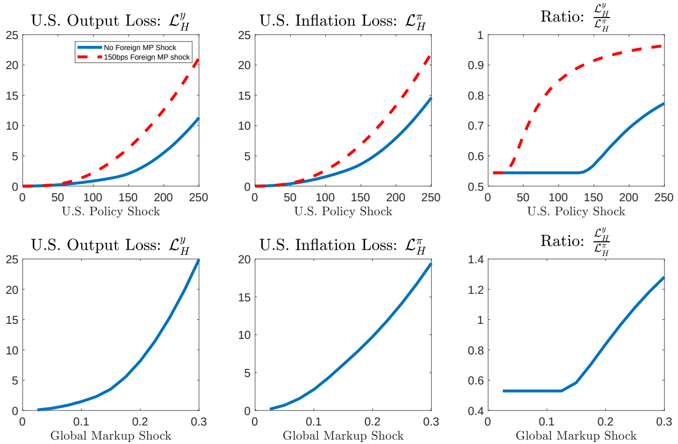
Policy Tradeoffs: Monetary and Markup shocks

$$\text{Output Loss: } \mathcal{L}_i^y = \sum_0^T \beta^t y_{i,t}^2 \qquad \text{Inflation Loss: } \mathcal{L}_i^\pi = \sum_0^T \beta^t \pi_{i,t}^2$$



Policy Tradeoffs: Monetary and Markup shocks

$$\text{Output Loss: } \mathcal{L}_i^y = \sum_0^T \beta^t y_{i,t}^2 \qquad \text{Inflation Loss: } \mathcal{L}_i^\pi = \sum_0^T \beta^t \pi_{i,t}^2$$



Markup Shock

Model Simulations: Key Takeaways

1. Effect of domestic tightening depends on:
   - GFIs balance sheet
   - Foreign policy response

2. Synchronous policy tightening can push the model into region with large financial spillovers.

3. Financial amplification worsens global monetary policy trade-offs.

Optimal Policy

Optimal Policy: Overview

- Question: how does interaction between GFIs balance sheet and MP trade-offs shape optimal policy?
- Consider optimal policy response to a global inflationary shock.
- Small shocks: no financial channel.
  1. *Strategic independence* of policy actions.
  2. Nash: aggressive on inflation.
  3. No gains from coordination.
- Large shocks: financial channel active.
  1. Relevant *strategic interaction* between policy actions.
  2. Nash: countries less aggressive on inflation.
  3. Gains and Pareto improvements from coordination.

Global policy game: strategies and objectives

- Central bank in country i observes a one-time markup shock ϵ^{μ} and chooses Taylor coefficient $\varphi_i \in [1.1, 10]$

- Loss associated with global markup shock ϵ^{μ} and strategies (φ_h, φ_f):

$$\mathcal{L}_j(\varphi_h, \varphi_f; \epsilon^{\mu}) = \sum_{t=0}^{T} \beta^t (\lambda_\pi \pi_{jt}^2 + y_{jt}^2)$$

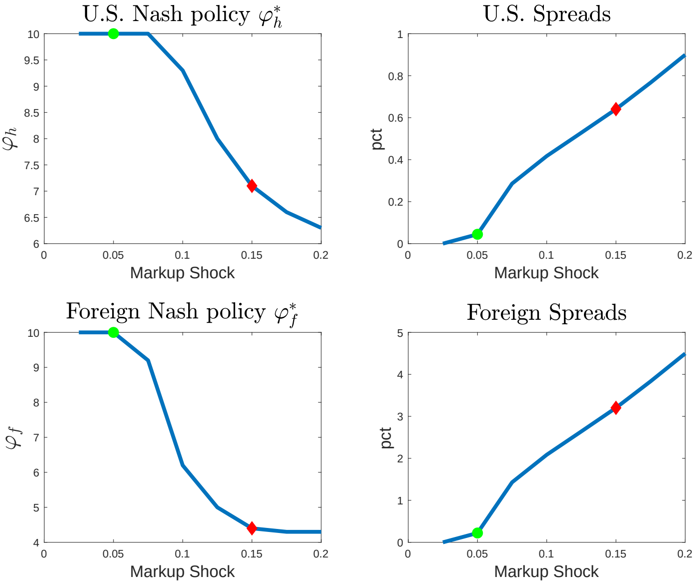
  with high weight on inflation $\lambda_\pi = 3$.

- To study strategic dependence we look at best response functions:

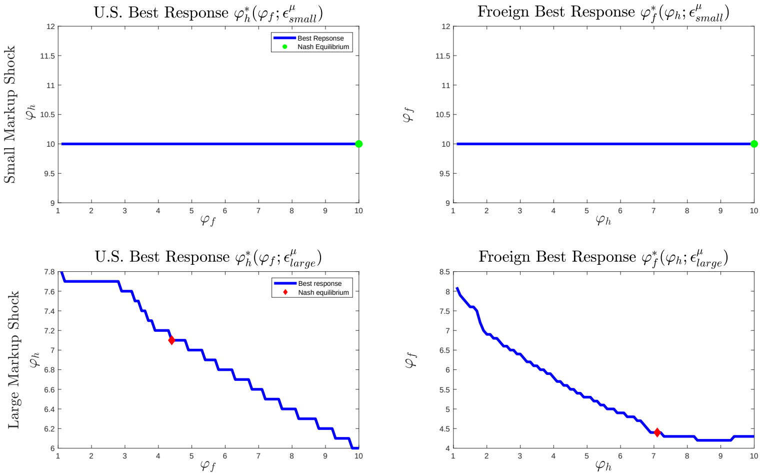
$$\varphi_i^{br}\left(\varphi_j; \epsilon^{\mu}\right) = \arg\min_{\varphi_i} \mathcal{L}_i\left(\varphi_i, \varphi_j; \epsilon^{\mu}\right),$$

- **Nash Eq.**: strategies are best responses to each other

International monetary policy and financial spillovers



Strategic dependence and financial spillovers



Gains from coordination

- Global Loss function:

$$\bar{\mathcal{L}}\left(\varphi_h,\varphi_f;\epsilon^{\mu}\right)=\sigma_h\mathcal{L}_h\left(\varphi_h,\varphi_f;\epsilon^{\mu}\right)+(1-\sigma_h)\mathcal{L}_f\left(\varphi_h,\varphi_f;\epsilon^{\mu}\right)$$

where U.S. weight $\sigma_h=\frac{\mathcal{N}_h}{\mathcal{N}_h+\mathcal{N}_f}=\frac{1}{4}$

- Two coordination solutions:

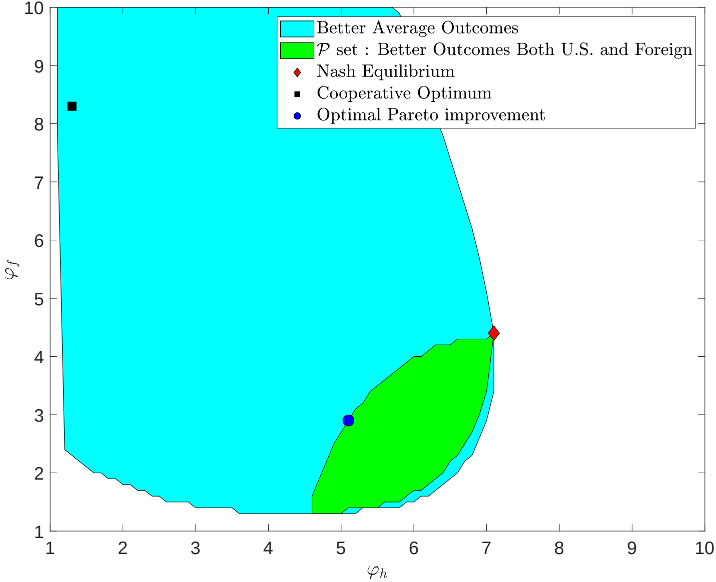
$$\left(\varphi_h^{coop}\left(\epsilon^{\mu}\right),\varphi_f^{coop}\left(\epsilon^{\mu}\right)\right)=\arg\min_{\varphi_h,\varphi_f}\bar{\mathcal{L}}\left(\varphi_h,\varphi_f;\epsilon^{\mu}\right)$$

$$\left(\varphi_h^{pi}\left(\epsilon^{\mu}\right),\varphi_f^{pi}\left(\epsilon^{\mu}\right)\right)=\arg\min_{(\varphi_h,\varphi_f)\in\mathcal{P}(\epsilon^{\mu})}\bar{\mathcal{L}}\left(\varphi_h,\varphi_f;\epsilon^{\mu}\right)$$

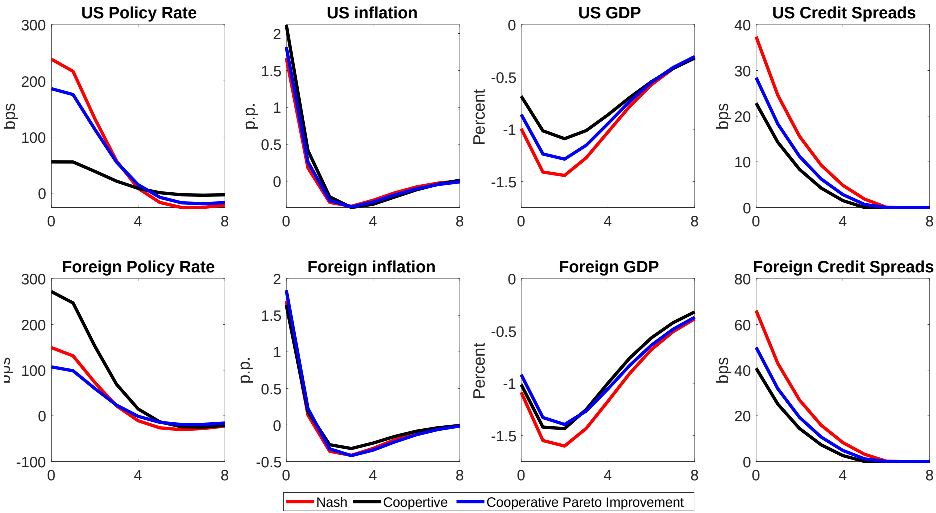
where

$$\mathcal{P}\left(\epsilon^{\mu}\right)=\left\{\left(\varphi_h,\varphi_f\right)\quad\middle|\quad\mathcal{L}_i\left(\varphi_h,\varphi_f;\epsilon^{\mu}\right)\leq\mathcal{L}_i^{NASH}\text{ for } i=h,f\right\}.$$

Coordination Policies



Outcomes Under Alternative Policies



Conclusions

Conclusions

- Monetary policy actions can have large effects on asset valuations & funding capacity of global intermediaries.
- With interconnected financial network, financial turbulence can spread across countries.
- We explore implications for global monetary policy.
- Next steps:
  - Liquidity tools.
  - Deposit pass-through.
  - Bank runs.

Appendix

Details on Data

- We use quarterly data since 1980 on interest rates, GDP, unemployment and inflation.
- Advanced economies: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, U.K., U.S.
- Emerging market countries: Chile, HK, Indonesia, Israel, Korea, Mexico, Philippines, South Africa, Taiwan.

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Details on Data (I)

- Corporate credit spreads available for:
  - Canada, France, Germany, Italy, Japan, Spain, Switzerland, United Kingdom, United States.
- Equity data of following global banks:
  - Canada: Royal Bank of Canada, Toronto Dominion.
  - France: BNP, SG.
  - Germany: Deutsche Bank.
  - Japan: Sumitomo Mitsui FG, Mitsubishi UFJ FG
  - Spain: Banco Santander, BBVA.
  - Switzerland: Credit Suisse.
  - United Kingdom: HSBC, Barclays, NatWest, Lloyd's.
  - United States: JPMorgan, Citi, WF, BofA, GS, MS.

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Related Literature

- Foreign spillovers of monetary policy shocks.
  Iacoviello and Navarro (2019), Dedola, Rivolta, and Stracca (2017), Degasperi, Hong, and Ricco (2020), di Giovanni and Shambaugh (2008).
  Our contribution: We study interaction between domestic and global monetary shocks and the nonlinear and state-dependent nature of their effects.
- Models with global financial intermediaries and international financial contagion.
  Gabaix and Maggiori (2015), Maggiori (2017), Morelli, Ottonello, and Perez (2022), Devereux and Yetman (2010), Cetorelli and Goldberg (2012), Bruno and Shin (2015)
  Our contribution: The stance of global monetary policy is key determinant of how financial intermediation matters for economic outcomes
- Literature on gains from policy coordination
  Obstfeld and Rogoff (2002), Corsetti and Pesenti (2005), Devereux and Engel (2003), Taylor (2013), Dedola, Karadi, and Lombardo (2013), Bodenstein, Corsetti, and Guerrieri (2020),
  Our contribution: Gains from cooperation are larger when adverse shocks are severe and financial intermediation is impaired

Empirical Specification

- Event study panel regression:

$$y_{i,t} = \gamma_i + \sum_{\tau=-4}^{10} \sigma_\tau DS_{i,t+\tau} + \sum_{\tau=-4}^{10} \alpha_\tau DA_{i,t+\tau} + \varepsilon_{i,t},$$

$DS_{i,t}$: synchronous tightening dummy;

$DA_{i,t}$: asynchronous tightening dummy.

- Dependent variables:
  - Interest rate, inflation.
  - Real GDP, unemployment.
  - Corporate credit spreads, bank equity.
- Normalize to 0 the response in $t-1$.
- Standard errors are clustered by country and quarter.

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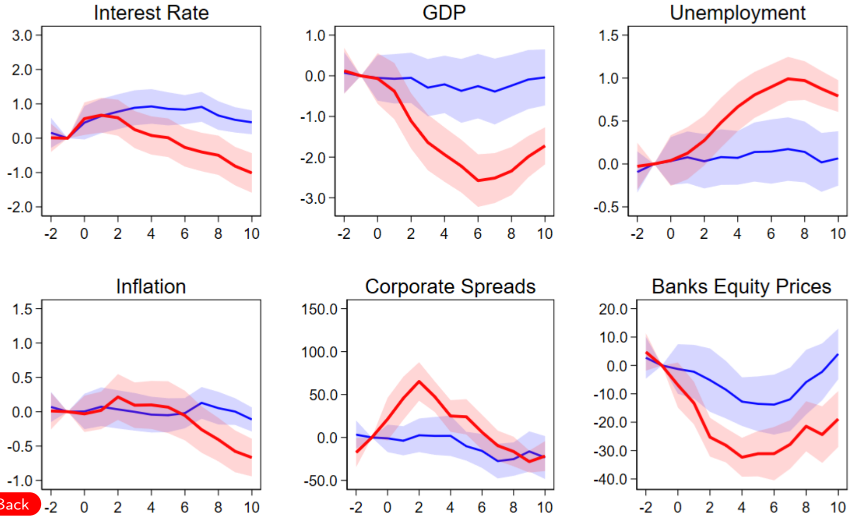
Responses to MP Tightening: Global Controls

Synchronous (red) vs Asynchronous (blue)



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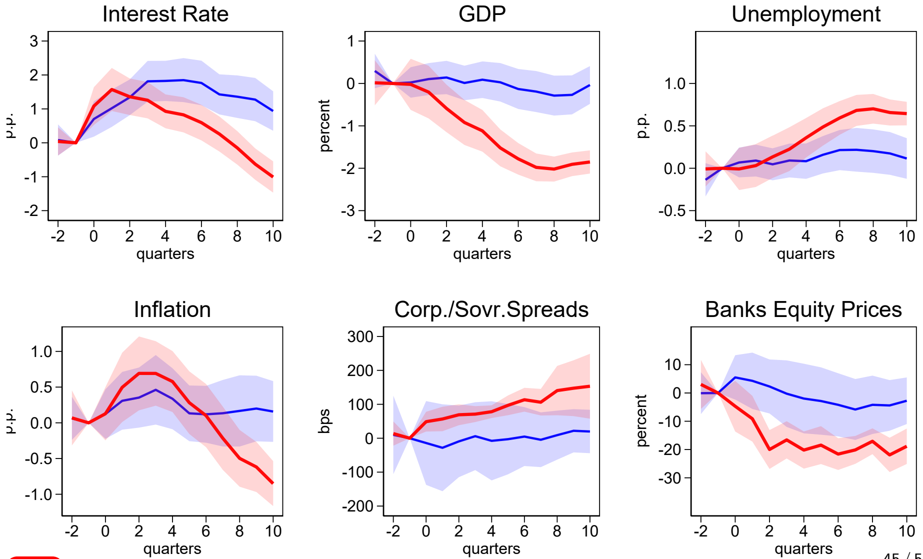
Responses to MP Tightening: Add EMs

Synchronous (red) vs Asynchronous (blue)



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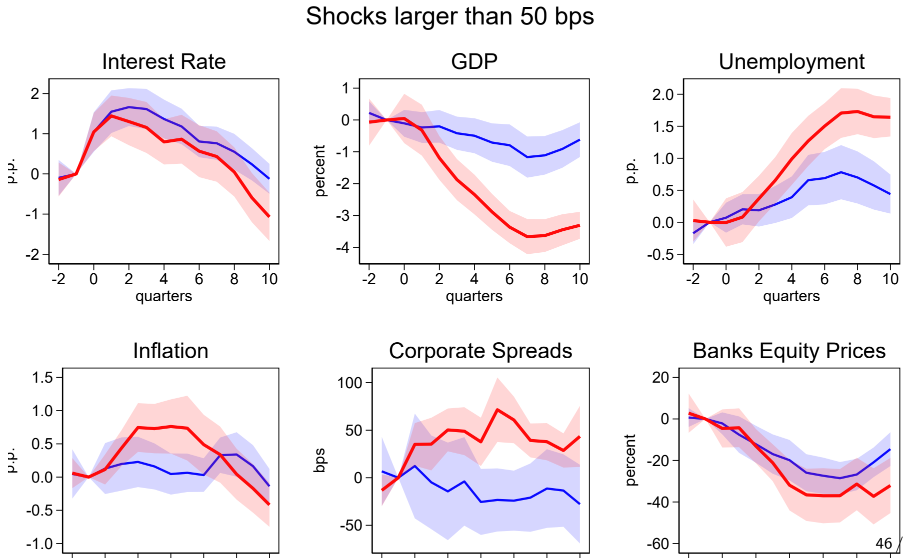
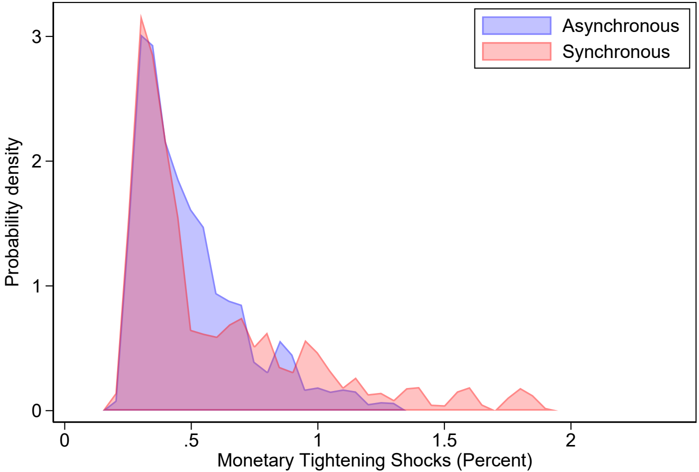
Responses to Tightening: Shocks more than 50bps

Synchronous (red) vs Asynchronous (blue)



Distribution of Shocks

Synchronous vs Asynchronous



Distribution trimmed at the 99th percentile

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Household Problem

Households in country $i = h, f$ solve

$$\max E_t \sum_{s \geq t} \beta^{s-t} \left[\frac{(C_{i,s} - \iota C_{i,s-1})^{1-\rho}}{1-\rho} - \psi \frac{L_{i,s}^{1+\varphi}}{1+\varphi} \right]$$

subject to

$$C_{i,t} + X_{Hi,t} D_{i,t} + g_{i,t} + Q_{i,t} K_{i,t}^h + \zeta_i \left(K_{i,t}^h, K_{i,t} \right) =$$

$$w_{i,t} L_{i,t} + X_{Hi,t} D_{i,t-1} R_{t-1}^d + g_{i,t-1} \frac{R_{t-1}^g}{\pi_t} + K_{i,t-1}^h (z_{i,t} + (1-\delta) Q_{i,t}) + T_{i,t}$$

where

$$\zeta_i \left(K_{i,t}^h, K_{i,t} \right) = \frac{\chi}{2} \left(\frac{K_{i,t}^h}{K_{i,t}} - \gamma_i \right)^2 K_{i,t}$$

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Household Problem (cont.)

Optimality conditions are given by

$$\psi L_{i,t}^{\varphi} = U_{ci,t} w_{i,t},$$

$$1 = \beta E_t \Lambda_{i,t+1} \frac{X_{Hi,t+1}}{X_{Hi,t}} R_t^d = \beta E_t \Lambda_{i,t+1} \frac{R_{t+1}^g}{\pi_{t+1}},$$

$$1 + \frac{\partial \zeta_i}{\partial K_{i,t}^h} \frac{1}{Q_{i,t}} = E_t \Lambda_{i,t+1} \frac{\left(z_{i,t+1} + (1-\delta) Q_{i,t+1}\right)}{Q_{i,t}} = E_t \Lambda_{i,t+1} R_{i,t+1}^k,$$

where $U_{ci,t} = \left(C_{i,t} - \iota C_{i,t-1}\right)^{-\rho} - \beta \iota E_t \left(C_{i,t+1} - \iota C_{i,t}\right)^{-\rho}$ and $\Lambda_{i,t+1} = \frac{U_{ci,t+1}}{U_{ci,t}}$.

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Nominal Rigidities

Local Currency Pricing: retailers set prices for domestic goods and for exports subject to Rotemberg adjustment costs.

Phillips curve for domestic goods:

$$\left(\pi_{ii,t}-1\right)\pi_{ii,t}=s_t\left[mc_{i,t}\mu_t-p_{ii,t}\right]+\beta E_t\Lambda_{H,t+1}\left(\pi_{iit+1}-1\right)\pi_{iit+1}\frac{Y_{iit+1}}{Y_{ii,t}}$$

Phillips curve for exported goods:

$$\left(\pi_{ij,t}-1\right)\pi_{ij,t}=s_t\left[mc_{i,t}\mu_t-X_{ji,t}p_{ij,t}\right]+\beta E_t\Lambda_{t,t+1}\left(\pi_{ijt+1}-1\right)\pi_{ijt+1}\frac{Y_{ijt+1}}{Y_{ij,t}}$$

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Capital Goods Production

Capital producers create new investment goods subject to adjustment costs

$$\max E_t \Lambda_{t+1} \left[Q^k_{i,t} I_{i,t} - I_{i,t} - \frac{\gamma_k}{2} (\frac{I_t}{I_{t-1}} - 1)^2 I_t \right]$$

which implies the following first order condition

$$Q^k_{i,t} = 1 + \frac{\gamma_k}{2} (\frac{I_{i,t}}{I_{it-1}} - 1)^2 + \gamma_k \frac{I_{i,t}}{I_{it-1}} (\frac{I_{i,t}}{I_{it-1}} - 1) - \beta \Lambda_{it+1} \gamma_k \left(\frac{I_{it+1}}{I_{i,t}} \right)^2 (\frac{I_{it+1}}{I_{i,t}} - 1)$$

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Foreign Subsidiaries

Foreign subsidiaries finance capital with risk free debt from households and with global banks' equity

$$Q^k_{Ft} K^b_{Ft} = B_{i,t} + S_{Ft} \tag{1}$$

subject to a (binding) leverage constraint

$$B_{Ft} \leq \lambda Q^k_{Ft} K^b_{Ft} \tag{2}$$

Market clearing implies

$$R^s_{Ft} = \frac{1}{(1-\lambda)} R^k_{Ft} - \frac{\lambda}{(1-\lambda)} R_{Ft-1} \tag{3}$$

$$S_{i,t} = (1-\lambda)\, Q_{Ft} K^b_{Ft} \frac{\mathcal{N}_F}{\mathcal{N}_H} \tag{4}$$

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Market Clearing

Market clearing in the goods market

$$\bar{Y}_{i,t} = C_{ii,t} + I_{ii,t} + \frac{\mathcal{N}_j}{\mathcal{N}_i} Y_{ij,t} \left(C_{ij,t} + I_{ij,t} \right) = Y_{ii,t} + \frac{\mathcal{N}_j}{\mathcal{N}_i} Y_{ij,t} \text{ for } \; i \in \{H, F\} \tag{5}$$

Market clearing for capital

$$K_{i,t} = K^h_{i,t} + K^b_{i,t} \text{ for } \; i \in \{h, f\} \tag{6}$$

Market clearing for bank deposits

$$D_t = D_{H,t} + D_{F,t} \tag{7}$$

Balance of payment equation

$$C_{H,t} + I_{H,t} = p_{HH,t} \bar{Y}_{H,t} + \left(D_{F,t} - D_{F,t-1} R^d_t \right) + \left(R^s_{F,t} S^b_{F,t-1} - S^b_{F,t} \right) \tag{8}$$

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Calibration

Parameter	Symbol	Value	Target/Source
Country Size	$\mathcal{N}_H, \mathcal{N}_F$	1,3	Relative GDP share of United States
Discount Factor	β	0.9975	World Interest Rate =1%
CRRA coefficient	ρ	1	Standard
Inverse Frisch Elasticity	φ	1	Standard
Habit parameter	ι	0.8	Justiniano et al. (2010)
Disutility of Labor	ψ	0.85	$L_h = L_f = 1$
Home Bias	$\omega_{H,}\omega_F$	0.85, 0.90	U.S. import share =15 % and $X_{hf} = 1$
Foreign deposits	D_F	9	Balanced trade in steady state
Trade Elasticity	θ	1	Standard
Capital Depreciation Rate	δ	0.025	Standard
Capital Share	α	0.33	Standard
Markup	μ	1.1	10% steady-state markup
Rotemberg costs	κ	300	Phillips Curve slope=0.03
Investment adjustment cost	γ_k	2	Justiniano et al. (2010)
Taylor rule coefficient on inflation	φ_π	1.5	Standard
Taylor rule inertia	ρ_r	0.8	Standard
Share of capital held by households	γ_H, γ_F	0.67, 0.90	GFIs hold 33% of US capital, GFIs foreign asset share=0.25
GFIs survival rate	σ_b	0.95	Gertler and Kiyotaki (2015)
GFIs Subsidiary Leverage Constraint	λ	0.66	Leverage of GFIs subsidiaries =3
Households capital holding costs	χ	100	Global spreads rise 60bps with synchronous tightening
Agency problem parameters	θ_H, θ_F	0.1, 0.5	Ratio of foreign to home spread=1.5; Steady-state leverage=4.75
GFIs endowment	ξ	0.013	Equity 5% above constraint

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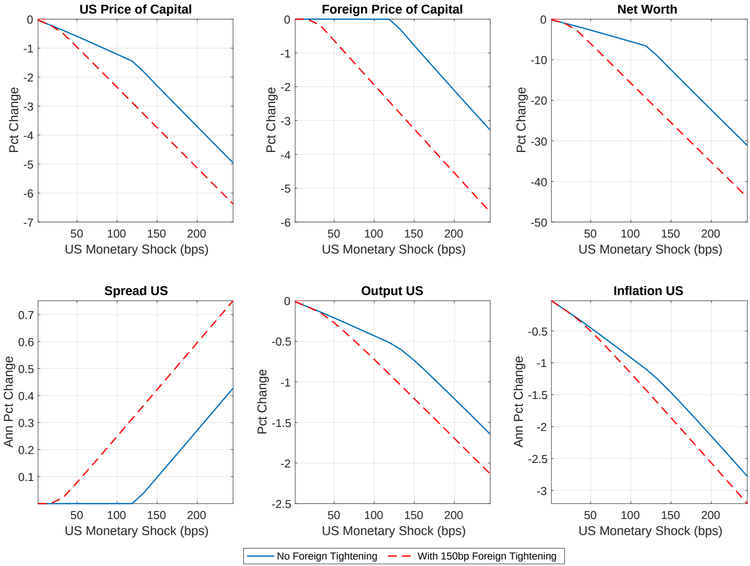
Nonlinear amplification of US monetary shocks



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Inflation and financial frictions

- Linearized Phillips curve in country i can be written

$$\pi_{iit} = LC_{it} + KC_{it}$$

where LC_{it} and KC_{it} are the present discounted values of wages and rental rates

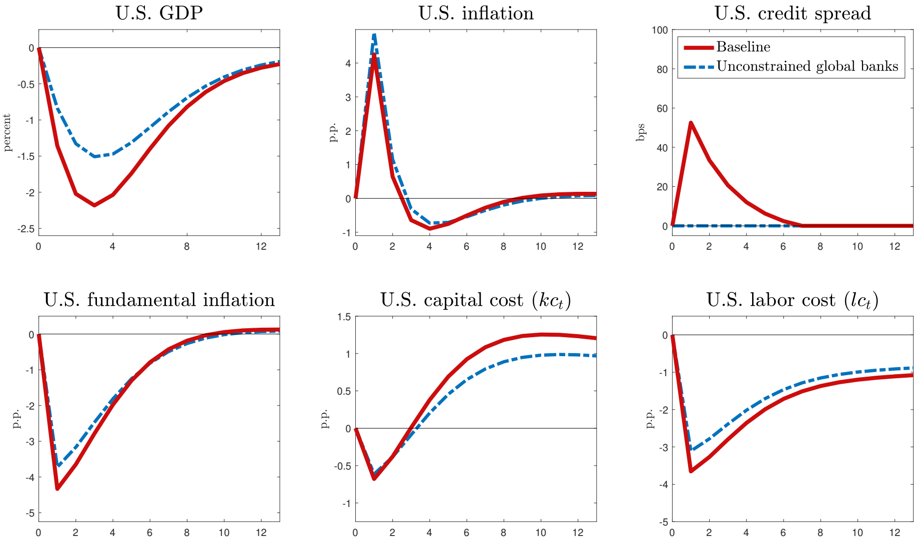
$$LC_{it} = \frac{\varepsilon}{\kappa}\left(\alpha w_{it} - \frac{p_{iit}}{(1+\mu)}\right) + \beta LC_{it+1}$$

$$KC_{it} = \frac{\varepsilon}{\kappa}(1-\alpha) z_{it} + \beta KC_{it+1}$$

- Financial frictions lower future capital pushing up KC_{it}

$$z_{it+i} = (1-\alpha)(l_{it+i} - k_{it+i})$$

Global Markup Shock



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