Monetary policy and endogenous financial crises

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Impact of monetary policy on financial stability remains a controversial topic

- Loose monetary policy can help to stave off financial crises (e.g. 9/11 attacks, Covid–19),
- ... but low–for–long rates can also induce search–for–yield and be a cause of financial imbalances/instability (e.g. Great Financial Crisis, Silicon Valley Bank)

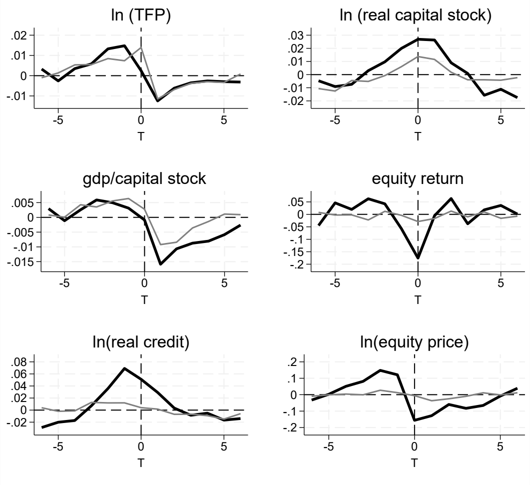
Research questions

1. What are the channels through which monetary policy (MP) affects financial stability (FS)?
2. Should MP deviate from price stability to promote FS?
3. To what extent may MP itself brew financial vulnerabilities?

$\rightarrow$ **Needed:** models where monetary policy affects the incidence and severity of crises, i.e.: models with micro-founded and endogenous crises

$\rightarrow$ Our model: rational exp., asymmetric information and moral hazard to micro-found financial fragility due to search for yield behaviours when capital return is low ("agency view")

Median dynamics around past crises: JST chronology



Normal recession — Financial crisis

- Most crises occur on the heels of a boom,

  ... when capital stock is high and

  ... marginal capital return starts receding

  ... due to a mix of capital overhang/declining TFP

- Low capital return incentivizes search for yield

  ... borrowers more likely to engage in below-the-radar activities

  ... that bring a higher personal return but harm the lender

  ... if large enough, these agency frictions may breakdown credit markets

Crisis dynamics

NK model with endogenous and micro–founded financial crises

- Textbook New Keynesian (NK) model, with capital accumulation and sticky prices
    + Idiosyncratic productivity shocks $\rightarrow$ capital reallocation among firms via a credit market
    + Financial frictions $\rightarrow$ credit market prone to endogenous collapse when capital return is low
    + Global solution $\rightarrow$ capture nonlinearities and dynamics far away from steady state
- MP is the "only game in town" (*e.g.* no macroprudential policy)

Contribution to the literature

Main findings

1. MP affects FS both in the *short run* via aggregate demand and in the *medium run* via capital accumulation

2. By deviating from strict inflation targeting (SIT), and reacting to output and financial fragility alongside inflation, the central bank can improve both FS and welfare

3. MP can lead to a crisis if the policy rate remains too low for too long and then increases abruptly

Roadmap

1. Extended New–Keynesian model
2. Anatomy of financial crises
3. "Divine Coincidence" revisited
4. Monetary policy discretion as a source of financial instability

Extended New–Keynesian model

Model– Agents

- **Central bank**: sets nominal interest rate Monetary Policy Rules
- **Household**: representative, works, consumes, saves (nominal bonds, firm equity) Optimisation problem
- **Retailers**: monopolistic, diversify intermediate goods, sticky prices Optimisation problem
- **Intermediate goods firms**: competitive, issue equity, invest, produce with labor and capital

  + Idiosyncratic productivity shocks $\rightarrow$ capital reallocation among firms via a credit market

Intermediate goods firms

- Continuum of 1-period firms indexed by $j \in [0, 1]$
- **End of** $t-1$: Firms are similar and <u>all</u> get start–up equity funding $P_{t-1}Q_{t-1}$ and purchase capital $K_t = Q_{t-1}$

◂ Firms' optimisation ◂ Credit market -reallocation role

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- **Beginning of** t: firm j has access to a production technology

$$Y_t(j) = A_t(\omega_t(j)K_t(j))^{\alpha}N_t(j)^{1-\alpha}, \quad \text{where } \omega_t(j) = \begin{cases} 0 & \text{with probability } \mu \rightarrow \text{Unproductive} \\ 1 & \text{with probability } 1-\mu \rightarrow \text{Productive} \end{cases}$$

Firms' optimisation
Credit market -reallocation role

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- Upon observing $\omega_t(j)$, firm j may adjust its capital from K_t to $K_t(j)$ via a credit market

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- Upon observing $\omega_t(j)$, firm j may adjust its capital from K_t to $K_t(j)$ via a credit market

<u>No credit frictions:</u> $\Rightarrow$ same equilibrium as in the textbook NK model with a representative firm

◂ Firms' optimisation
◂ Credit market -reallocation role

Credit market

- Asymmetric Information: $\omega_t(j)$ is private information
- Limited Commitment: firm j may borrow, purchase capital goods, and abscond with them in search for yield

$\Rightarrow$ Borrowing limit is the same for all firms, and credit market is fragile

Limited commitment only

Credit market

- **Incentive Compatibility Constraint:**

  An unproductive firm has two options:

  1. **Behave:** sell its capital to lend the proceeds at equilibrium loan rate $r_t^c \rightarrow (1 + r_t^c)K_t$
  2. **Misbehave:** borrow to buy more capital $K_t^p - K_t$ (*i.e.* mimic productive), abscond $\rightarrow$ $(1-\delta)K_t^p - \theta(K_t^p - K_t)$

Credit market

- **Incentive Compatibility Constraint:**

Unproductive firms lend *iff* the equilibrium loan rate r_t^c is high enough

$$\rightarrow \begin{cases} (1+r_t^c)K_t \geqslant (1-\delta)K_t^p - \theta(K_t^p - K_t) \\ \text{where } r_t^c \text{ satisfies } \mu K_t = (1-\mu)(K_t^p - K_t) \end{cases} \Leftrightarrow r_t^c \geqslant \bar{r}^k \equiv \frac{(1-\theta)\mu - \delta}{1-\mu}$$

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- **Participation Constraint:**

  Productive firms borrow iff r_t^c is lower than their return on capital r_t^k

$$r_t^c \leqslant r_t^k \equiv \frac{p_t}{P_t}\frac{\alpha Y_t^p}{K_t^p} - \delta = \frac{p_t}{P_t}\frac{\alpha Y_t}{K_t} - \delta$$

Credit market equilibrium

Credit market

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- Trade is possible iff the marginal return on capital $r_t^k \geq \bar{r}^k$

Normal versus crisis times

- **Normal times:** when $r_t^k \geq \bar{r}^k$ and firms trade on the credit market, $r_t^c = r_t^k \geq \bar{r}^k$, capital is fully reallocated, aggregate production function is as in the credit–frictionless economy

$$Y_t = A_t K_t^\alpha N_t^{1-\alpha}$$

- **Crisis times:** when $r_t^k < \bar{r}^k$ and firms don't trade on credit market, capital is not reallocated, unproductive firms keep capital idle and capital mis–allocation lowers TFP

$$Y_t = A_t \left((1-\mu) K_t\right)^\alpha N_t^{1-\alpha}$$

- **Condition for a crisis**

$$\frac{\alpha Y_t}{\mathcal{M}_t K_t} \leqslant (1-\tau)\left[\frac{(1-\theta)\mu-\delta}{1-\mu}+\delta\right]$$

◂ Two types of polar crises

MP affects financial fragility in the short and medium run

- **Condition for a crisis**

$$\frac{\alpha Y_t}{\mathcal{M}_t K_t} \leqslant (1-\tau)\left[\frac{(1-\theta)\mu-\delta}{1-\mu}+\delta\right]$$

- **Short-run:** through macro–economic stabilization → Y– and $\mathcal{M}$–channels

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- **Short-run:** through macro–economic stabilization → Y– and $\mathcal{M}$–channels
- **Medium-run:** through capital accumulation → K–channel

◂ Two types of polar crises

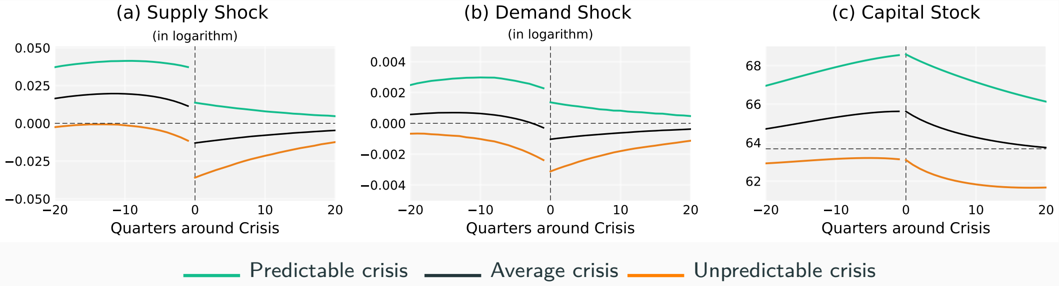
Anatomy of financial crises

Quantitative analysis

- **Quarterly parametrization**. Only two non–standard parameters
  1. μ: share of unproductive firms set to 5% to have a productivity fall by 1.8% due to financial frictions during a crisis
  2. θ: default cost set to 0.52 to have the economy spend 10% of the time in crisis (under TR93)
- **Global solution and simulation** of the (nonlinear) model over ten million periods
- **The analysis focuses on** the dynamics around financial crises and on crisis statistics

◂ Parametrization

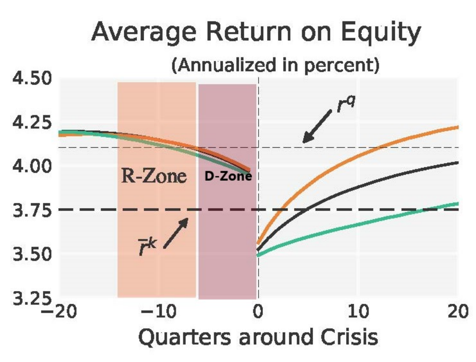
Average crisis dynamics and crisis variety under the Taylor Rule



→ Some crises break out on the back of an investment boom, others follow severe adverse non–financial shocks

Average crisis 1 | Average crisis 2 | Supply shocks only | Demand shocks only

The "yield gap" $(1+r^q_t)/(1+r^q)$ as index of financial fragility



Predictable crisis — Average crisis — Unpredictable crisis

“Divine Coincidence” revisited

The price–financial stability trade–off

- Under SIT, the economy spends 9.4% in a crisis and prices are fully stable.
- Reducing the incidence of crises below 9.4% necessarily entails deviating from price stability

	Rule parameters			Model with Financial Frictions				
	ϕ_π	ϕ_y	ϕ_r	Time in Crisis/Stress (in %)	Length (quarters)	Output Loss (in %)	Std(π_t) (in pp)	Welfare Loss (in %)
				SIT				
(6)	$+\infty$	–	–	9.4	5.1	8.1	0	0.23

Divine coincidence | Why? | Full table

The price–financial stability trade–off

- Under SIT, the economy spends 9.4% in a crisis and prices are fully stable.
- Reducing the incidence of crises below 9.4% necessarily entails deviating from price stability
- E.g.: when the central bank reacts to output, financial fragility and inflation, the incidence of crises can be lowered to 5.4%, but inflation volatility rises to 1.16 pp (in standard deviations)

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Augmented Taylor–type Rules								
(7)	1.5	0.125	5.0	5.4	3.9	5.5	1.16	0.65

Divine coincidence Why? Full table

Deviating from price stability can improve welfare

- E.g.: Reacting to output and financial fragility alongside inflation can improve welfare upon SIT

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(9)	5.0	0.125	25.0	6.9	4.7	6.6	0.19	0.18
(10)	10.0	0.125	75.0	6.3	4.6	6.4	0.09	0.16

Welfare gains can be even higher under "backstop rules"

- "Backstop policy rule": state–contingent rule whereby the central bank commits to deviate from its standard rule (e.g. SIT, Taylor rule) in the face of financial stress so as to avoid a crisis
- Under SIT–backstop, welfare gains relative to SIT are larger than under Augmented Taylor–type Rules

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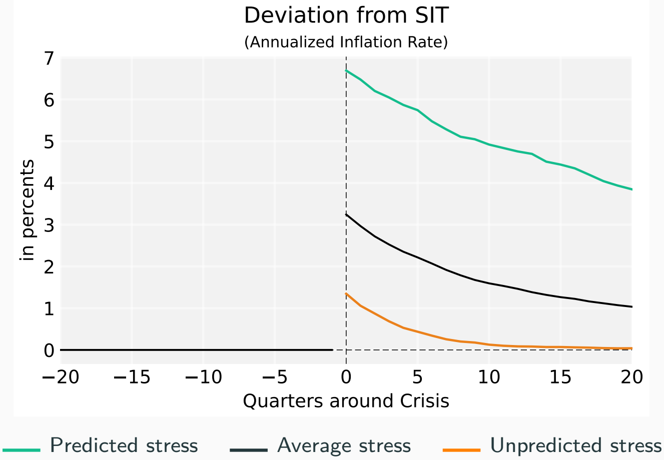
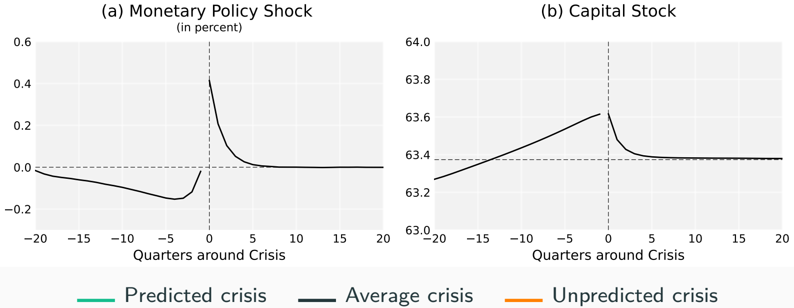
Crises are avoided under “backstop rules” with exceptionally loose policy



Monetary policy discretion as a source of financial instability

Discretionarily keeping rates too low for too long may lead to a crisis



- Discretionary deviations from TR93 → simulate the model with MP shocks only
- Crises occur after a “Great Deviation”...(Taylor (2011), Grimm et al (2023)) Deviations from Taylor rule
- ... when the central bank abruptly reverses policy stance (Schularick et al (2021), Jimenez et al (2023))

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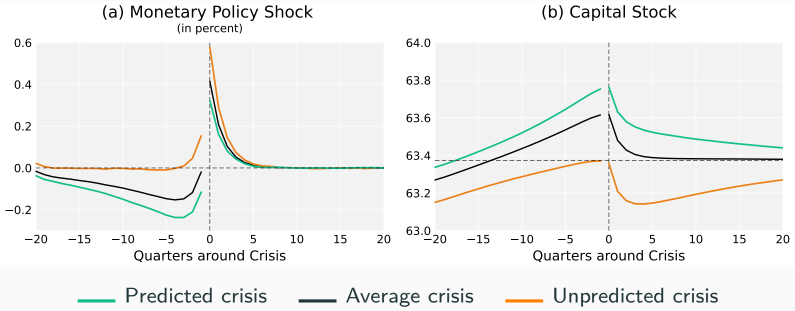

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Takeaways

Takeaways

- NK model with **micro–founded endogenous crises** where MP affects FS via **Y–M–K channels**
- Several **novel policy insights**:
  - → Systematic response to output and **yield gap** ($\neq$ SIT) improves both FS and welfare
  - → **Backstop policy** is effective and **normalisation path** depends on the nature of the stress
  - → **"Low–for–long"** policy followed by abrupt hike may lead to crisis

Instead of Epilogue...

"Monetary Tightening, Inflation Drivers and Financial Stress"

(Boissay, Collard, Manea and Shapiro (2023))

- Our theoretical paper suggests that tightening monetary policy to fight:
  - supply–driven inflation contracts aggregate demand when the economy is already financially fragile => higher crisis probability
  - demand–driven inflation offsets a possible unsustainable boom => lower crisis probability
- In a companion empirical paper, we explore the state-dependent effects of a MP tightening on financial stress, focusing on a novel dimension: the nature of supply *versus* demand inflation at the time of policy rate hikes.

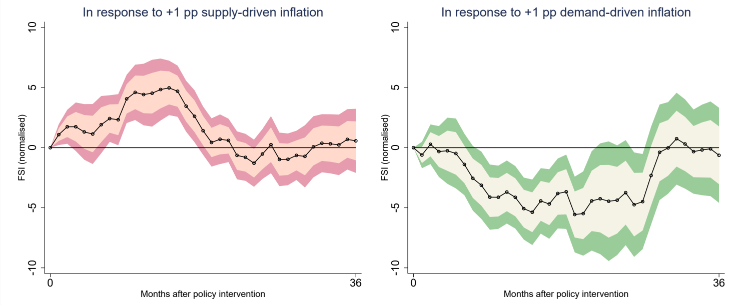
Econometric specification

- Country-level local projection:

$$y_{t+h} - y_{t-1} = \alpha_h + \beta_h^T \mathbb{1}\{mps_t > 0\} mps_t + \beta_h^{TS} \mathbb{1}\{mps_t > 0\} mps_t \pi_t^s + \beta_h^{TD} \mathbb{1}\{mps_t > 0\} mps_t \pi_t^d +$$
$$+ \beta_h^L \mathbb{1}\{mps_t < 0\} mps_t + \beta_h^{LS} \mathbb{1}\{mps_t < 0\} mps_t \pi_t^s + \beta_h^{LD} \mathbb{1}\{mps_t < 0\} mps_t \pi_t^d +$$
$$+ A_h \sum_{\tau=1}^{L} \mathcal{C}_{t-\tau} + e_{t+h}$$

- Dependent variable y: financial stress indices
- Independent variables: mps_t MP surprise, $\mathbb{1}\{mps_t > 0\}$ indicator variable for tightening, $\mathbb{1}\{mps_t > 0\}$ indicator variable for loosening, $\pi_t^{s/d}$ supply/demand–driven inflation (year on year), $\mathcal{C}_{t-\tau}$ control variables
- $\mathcal{C}_{t-\tau}$: 6 lags of the dependent variable, interaction variables, supply/demand–driven inflation (year on year), log of IP, unemployment rate, GZ excess bond premium (baseline); robust to adding commodity prices, FFR/Wu-Xia "shadow rate") as additional controls as in Bauer and Swanson (2023) and Ramey (2016).

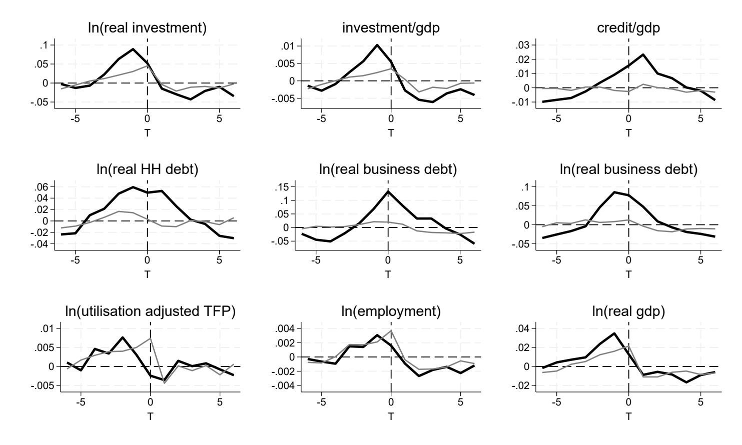
Additional effect of a MP tightening on financial stress



Notes: Dynamic responses to a 25 basis points positive monetary policy surprise. Shown are regression coefficients β_h^{TS} (left) and β_h^{TD} (right) for $h = 0, \ldots, 36$. Baseline specification with Fed Board Financial Stress Index. 90% confidence bands, Newey-West standard errors (statistically significant differences). US monthly data from January 1990 to December 2019.

APPENDIX

Dynamics around financial crises: JST database



Normal recession   Financial crisis

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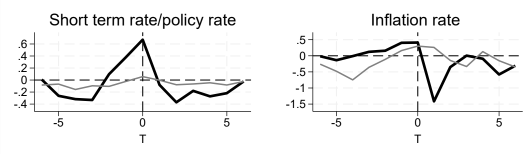
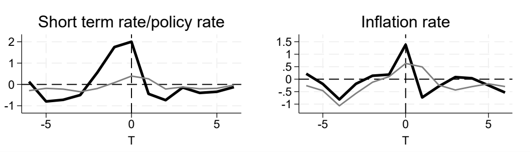
Dynamics around financial crises: JST database

(a) Full sample



(b) Post WW2



Normal recession — Financial crisis

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Contribution to the literature

- We study how MP affects FS in a NK model with endogenous microfounded crises
- Monetary policy and financial stability (reduced form models of endogenous crises)
  Woodford (2012), Filardo and Rungcharoentkitkul (2016), Svensson (2017), Gourio, Kashyap, Sim (2018), Ajello, Laubach, Lopez–Salido, Nakata (2019), Cairo and Sim (2018), Borio, Disyatat and Rungcharoentkitkul (2019)
- Micro–founded models of endogenous financial crises
  Boissay, Collard, Smets (2016), Benigno and Fornaro (2018), Gertler, Kiyotaki, Prestipino (2019), Paul (2020)
- Our approach: fragility of financial markets ($\neq$ institutions) and search–for–yield behaviours ($\neq$ collateral constraints)

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Central bank

- Sets nominal interest rate i_t on risk–free public bond B_t according to a Taylor-type policy rule:

$$1 + i_t = \frac{1}{\beta}(1 + \pi_t)^{\phi_\pi} \left(\frac{Y_t}{\bar{Y}} \right)^{\phi_y}$$

- We also experiment with alternative rules including financially–augmented Taylor rules and SIT

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Households

- The representative household consumes a basket of goods C_t, works N_t, invests in a private nominal bond B_t in zero net supply and in intermediate goods firm $j \in [0,1]$'s equity $Q_t(j)$

$$\max_{C_t, N_t, B_t, Q_t(j)} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \chi \frac{N_t^{1+\varphi}}{1+\varphi} \right]$$

$$\text{s.t.} \quad \int_0^1 P_t(i) C_t(i) \mathrm{d}i + B_t + P_t \int_0^1 Q_t(j) \mathrm{d}j \leq W_t N_t + (1 + i^b_{t-1}) B_{t-1} + P_t \int_0^1 (1 + r^q_t(j)) Q_{t-1}(j) \mathrm{d}j + \Upsilon_t$$

where

$$i^b_t \equiv \frac{1 + i_t}{Z_t} - 1$$

is the private bond yield, with Z_t the wedge between the private yield and the policy rate i_t

- Z_t acts as an aggregate demand shock

Back to main

Households' optimality conditions:

$$\frac{\chi N_t^{\varphi}}{C_t^{-\sigma}} = \frac{W_t}{P_t}$$

$$1 = \beta(1 + i_t^b)\mathbb{E}_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}\frac{1}{1+\pi_{t+1}}\right]$$

$$1 = \beta\mathbb{E}_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}\left(1 + r_{t+1}^q(j)\right)\right] \quad \forall j \in [0,1]$$

$$Q_t(j) = Q_t \quad \forall j \in [0,1]$$

Back to main

Retailers

- Monopolistic retailer $i \in [0,1]$ produces a differentiated final good using intermediate goods and sets its price subject to quadratic adjustment costs à la Rotemberg (1982):

$$\max_{P_t(i),Y_t(i)} \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t} \left[\frac{P_t(i)}{P_t} Y_t(i) - \frac{(1-\tau)p_t}{P_t} Y_t(i) - \frac{\varsigma}{2} \left(\frac{P_t(i)}{P_{t-1}(i)} - 1 \right)^2 Y_t \right]$$

$$\text{s.t. } \; Y_t(i) = \left(\frac{P_t(i)}{P_t} \right)^{-\epsilon} Y_t$$

where $Y_t = C_t + I_t + \frac{\varrho}{2} Y_t \pi_t^2$, with $I_t \equiv K_{t+1} - (1-\delta)K_t$

- Price setting behaviour:

$$(1+\pi_t)\pi_t = \mathbb{E}_t \left(\Lambda_{t,t+1} \frac{Y_{t+1}}{Y_t} (1+\pi_{t+1})\pi_{t+1} \right) - \frac{\epsilon - 1}{\varrho} \left(\frac{\mathcal{M}_t - \mathcal{M}}{\mathcal{M}_t} \right)$$

- Markup $\mathcal{M}_t \equiv \frac{P_t}{(1-\tau)p_t}$ will be important for the effect of MP on FS

Intermediate goods firms

$$\max_{N_t(j),K_t(j)} D_t(j) = \frac{p_t}{P_t} A_t(\omega_t(j) K_t(j))^{\alpha} N_t(j)^{1-\alpha} - \frac{W_t}{P_t} N_t(j) + (1-\delta) K_t(j) - (1+r_t^c)(K_t(j) - K_t)$$

Defining $r_t^k = \frac{p_t}{P_t} \frac{\alpha Y_t(j)}{K_t(j)} - \delta = \frac{p_t}{P_t} \frac{\alpha Y_t}{K_t} - \delta$ we obtain:

- Choices of an unproductive firm j with $\omega_t(j) = 0$:

$$\max_{K_t(j)} r_t^q(j) \equiv \frac{D_t(j)}{K_t} - 1 = r_t^c - (r_t^c + \delta) \frac{K_t(j)}{K_t}$$

- Choices of a productive firm j with $\omega_t(j) = 1$:

$$\max_{K_t(j)} r_t^q(j) \equiv \frac{D_t(j)}{K_t} - 1 = r_t^c + (r_t^k - r_t^c) \frac{K_t(j)}{K_t}$$

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Credit market – reallocation role:

- In the absence of credit frictions,

  (i) Unproductive firms sell their capital K_t and lend the proceeds on the credit market: $K_t^u = 0$

  (ii) Productive firms borrow and use the funds to buy $K_t^p - K_t > 0$ additional units of capital

  $\Rightarrow$ The credit market helps reallocate capital: $\mu K_t = (1-\mu)(K_t^p - K_t)$

  $\Rightarrow$ Equilibrium of the textbook NK model with a representative firm

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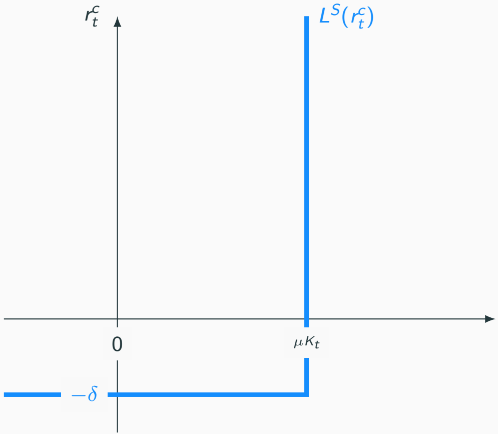
Credit market (given r_t^k)

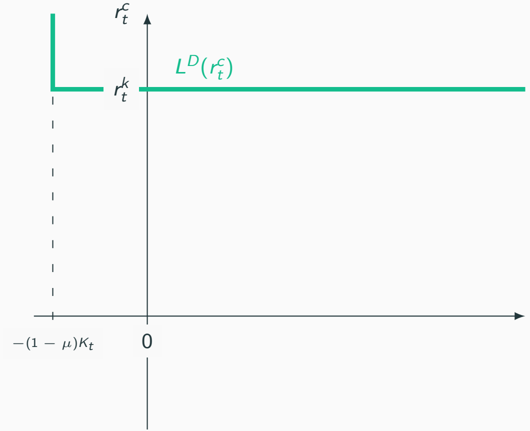


- Unproductive firms' net loan supply

$$L^S(r_t^c) = \begin{cases} \mu K_t & \text{for } r_t^c > -\delta \\ (-\infty, \mu K_t] & \text{for } r_t^c = -\delta \\ -\infty & \text{for } r_t^c < -\delta \end{cases}$$

Back to main

Credit market (given r_t^k)



- Productive firms' net loan demand

$$L^D(r_t^c) = \begin{cases} -(1-\mu)K_t & \text{for } r_t^c > r_t^k \\ [-(1-\mu)K_t, +\infty) & \text{for } r_t^c = r_t^k \\ +\infty & \text{for } r_t^c < r_t^k \end{cases}$$

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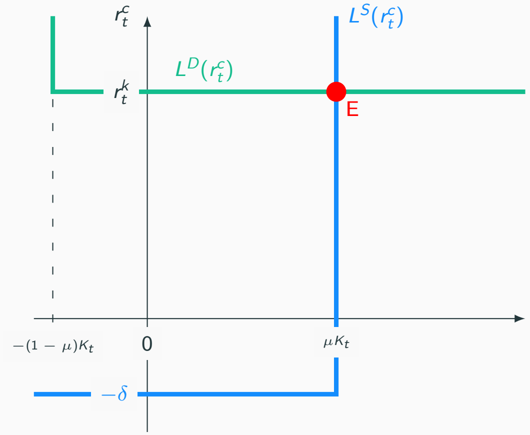
Credit market (given r_t^k)



- In E, $r_t^k = r_t^c$ and capital is perfectly reallocated to productive firms:

$$\mu K_t = (1-\mu)(K_t^p - K_t)$$

- Model boils down to the textbook NK model with one representative firm

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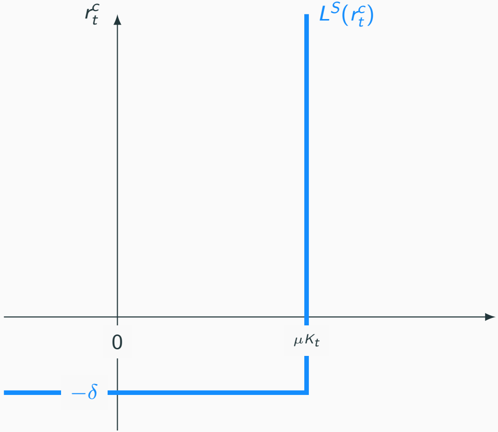
Credit market (given r_t^k)



- Unproductive firms' net loan supply...

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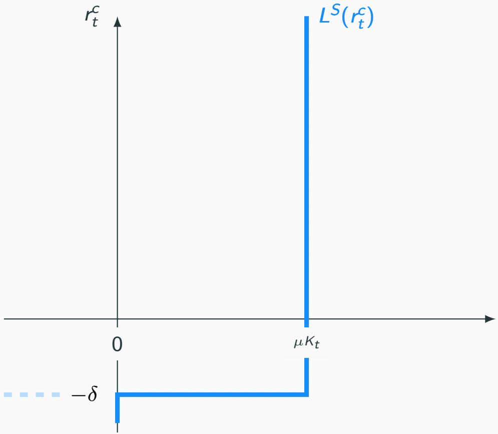
Credit market (given r_t^k)



- Unproductive firms' net loan supply...

  ... now with IC constraint

$$L^S(r_t^c) = \begin{cases} \mu K_t & \text{for } r_t^c > -\delta \\ [0, \mu K_t] & \text{for } r_t^c = -\delta \\ 0 & \text{for } r_t^c < -\delta \end{cases}$$

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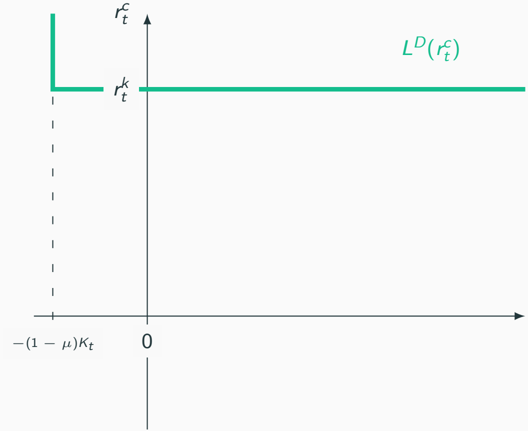
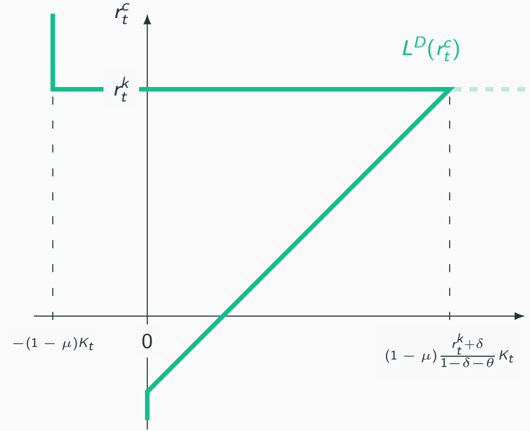
Credit market (given r_t^k)



- Productive firms' net loan demand...

Back to main

Credit market (given r_t^k)



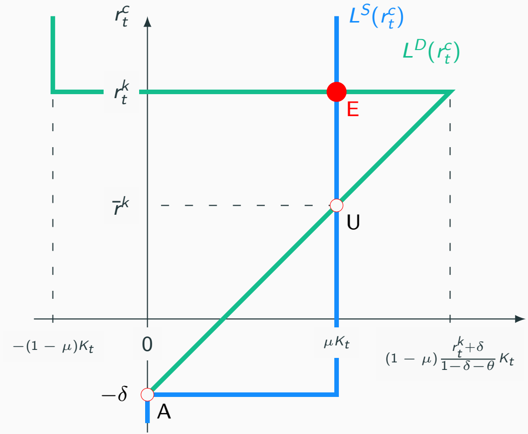
- Productive firms' net loan demand...

  ... now with IC constraint

$$L^D(r_t^c) = \begin{cases} -(1-\mu)K_t & \text{for } r_t^c > r_t^k \\ \left[-(1-\mu)K_t, (1-\mu)\frac{r_t^k+\delta}{1-\delta-\theta}K_t\right] & \text{for } r_t^c = r_t^k \\ (1-\mu)\max\{\frac{r_t^c+\delta}{1-\delta-\theta}, 0\}K_t & \text{for } r_t^c < r_t^k \end{cases}$$

Back to main

Credit market (given r_t^k)



- Equilibrium E is the same as in the frictionless case and textbook model:

$$\mu K_t = (1-\mu)(K_t^p - K_t)$$

- Aggregate outcome is the same in E and U
- Absence of coordination failure rules out equilibrium A

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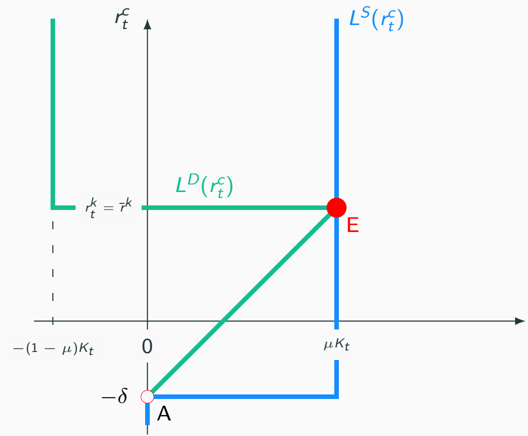
Credit market (given r_t^k)



- $\bar{r}^k$ is the minimum loan rate that ensures that all unproductive firms lend (i.e. there is no rationing)

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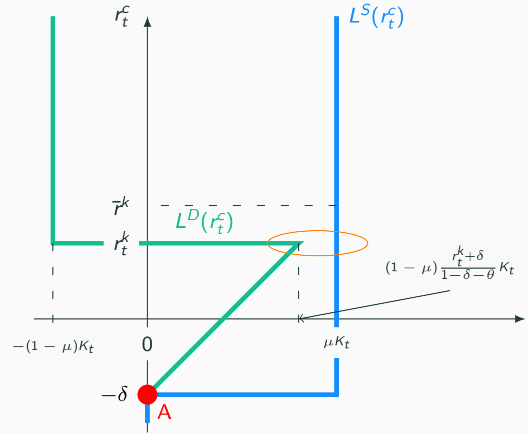
Credit market (given r_t^k)



- $\bar{r}^k$ is the minimum loan rate that ensures that all unproductive firms lend (i.e. there is no rationing)
- When $r_t^k < \bar{r}^k$, there is excess supply and every unproductive firm left out has an incentive to borrow and abscond
- In this case, A (autarky) is the unique equilibrium

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Perfect Information Case

- Unproductive firms do not get any loan
- Productive firm js' borrowing limit is given by the incentive compatibility constraint

$$(1-\delta)K_t(j) - \theta(K_t^p - K_t) \leq (1 + r_t^q(j))K_t = (1 + r_t^c)K_t + \left(r_t^k - r_t^c\right) K_t(j)$$

$$\Leftrightarrow K_t(j) - K_t \leq \frac{r_t^k + \delta}{1 - \delta - \theta + r_t^c - r_t^k} K_t$$

$$\Rightarrow L^D(r_t^c) \equiv (1-\mu)(K_t(j) - K_t) = (1-\mu)\frac{r_t^k + \delta}{1 - \delta - \theta + r_t^c - r_t^k} K_t \;\; \text{if } r_t^k \geq r_t^c$$

- Aggregate loan demand monotonically decreases with r_t^c

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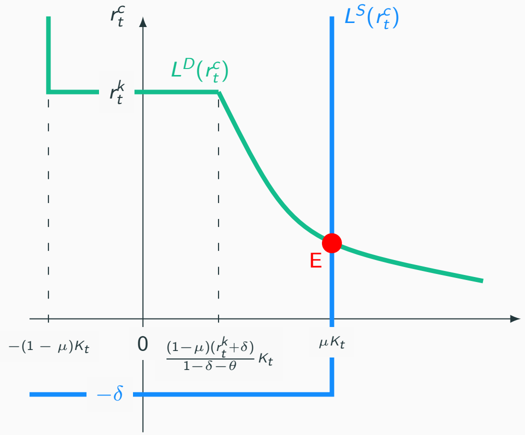
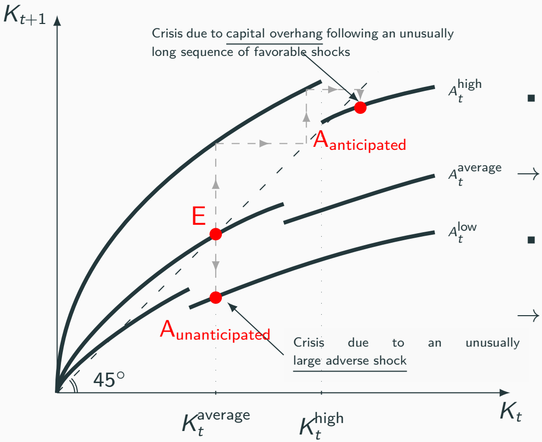
Perfect Information Case



Two polar types of crisis



Optimal decision rules $K_{t+1}(K_t, A_t)$

- Crises due to capital overhang following an unusually long sequence of favorable shocks

→ **MP may reduce their incidence via K–channel**

- Crises which break out in the face of an unusually large adverse shock

→ **MP may reduce their incidence via Y– and M–channels**

Equation Summary

1. $1 = \beta \mathbb{E}_t \left[\frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}} \frac{1+i_t}{1+\pi_{t+1}} \right]$

2. $1 = \beta \mathbb{E}_t \left[\frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}} (1 + r_{t+1}^q) \right]$

3. $\chi N_t^{\varphi} C_t^{\sigma} = \frac{\epsilon}{\epsilon-1} \frac{(1-\alpha)Y_t}{\mathcal{M}_t N_t}$

4. $r_t^q + \delta = \frac{\epsilon}{\epsilon-1} \frac{\alpha Y_t}{\mathcal{M}_t K_t}$

5. $Y_t = C_t + X_t - \frac{\varrho}{2} \pi_t^2$

6. $K_{t+1} = X_t + (1-\delta) K_t$

7. $Y_t = A_t (\omega_t K_t)^{\alpha} N_t^{1-\alpha}$

8. $\omega_t = \begin{cases} 1 & \text{if } r_t^q \geq \frac{\mu(1-\theta)-\delta}{1-\mu} \\ 1-\mu & \text{otherwise} \end{cases}$

9. $(1+\pi_t)\pi_t = \beta \mathbb{E}_t \left(\frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}} \frac{Y_{t+1}}{Y_t} (1+\pi_{t+1})\pi_{t+1} \right) - \frac{\epsilon-1}{\varrho} \left(1 - \frac{\epsilon}{\epsilon-1} \cdot \frac{1}{\mathcal{M}_t} \right)$

10. $1 + i_t = \frac{1}{\beta} (1+\pi_t)^{\phi_\pi} \left(\frac{Y_t}{Y} \right)^{\phi_y}$

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Parametrisation

Parameter	Target	Value
Preferences		
β	4% annual real interest rate	0.989
σ	Logarithmic utility on consumption	1
φ	Inverse Frish elasticity equals 2	0.5
χ	Steady state hours equal 1	0.81
Technology and price setting		
α	64% labor share	0.36
δ	6% annual capital depreciation rate	0.015
ϱ	Same slope of the Phillips curve as with Calvo price setting	58.22
ϵ	20% markup rate	6
Aggregate TFP (supply) shocks		
ρ_a	Standard persistence	0.95
σ_a	Volatility of inflation and output in normal times (in %)	0.81
Aggregate Demand shocks		
ρ_z	Standard persistence	0.95
σ_z	Volatility of inflation and output in normal times (in %)	0.16
Interest rate rule		
ϕ_π	Response to inflation under TR93	1.5
ϕ_y	Response to output under TR93	0.125
Financial Frictions		
μ	Productivity falls by 1.8% due to financial frictions during a crisis	0.05
θ	The economy spends 10% of the time in a crisis	0.52

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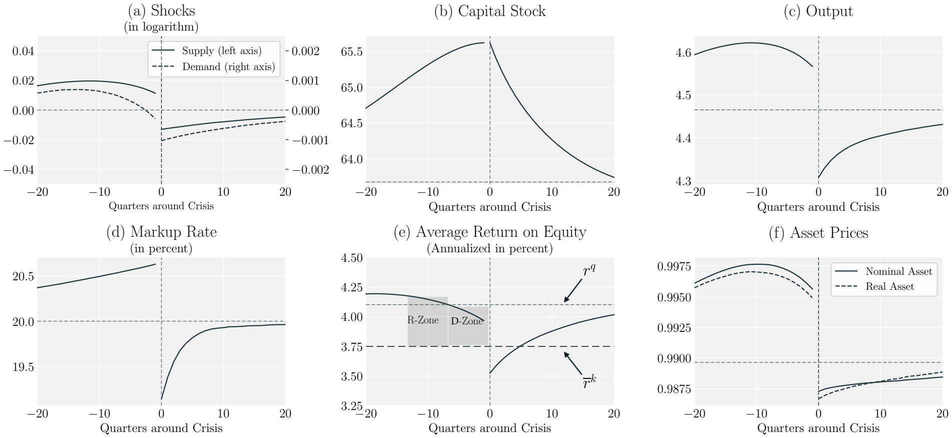
Anatomy of the average crisis



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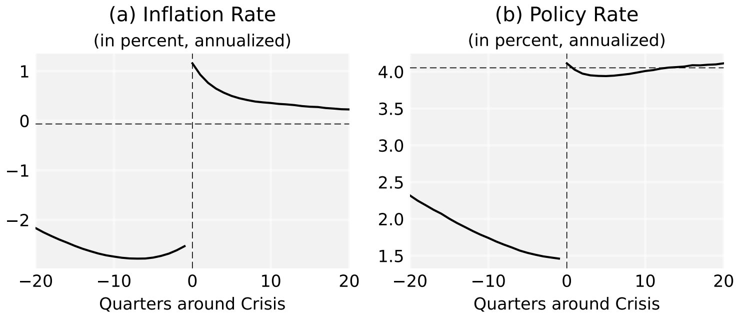
Anatomy of the average crisis: inflation and policy rate



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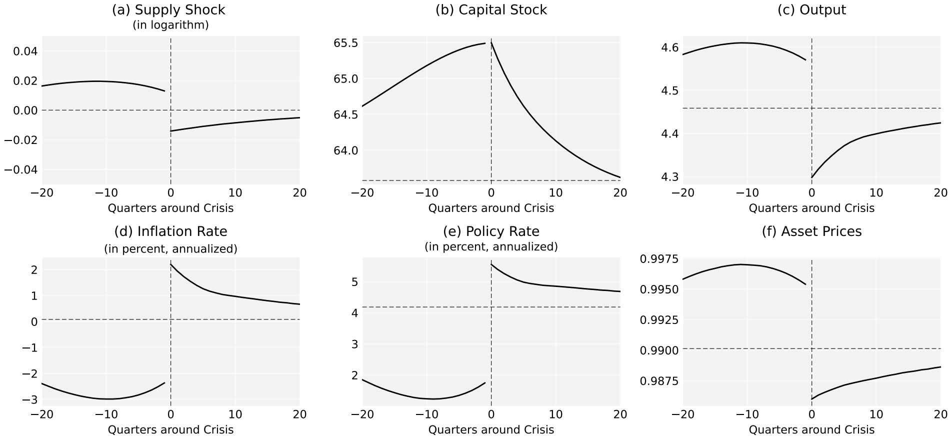
Anatomy of the average crisis: supply shocks only 1/2



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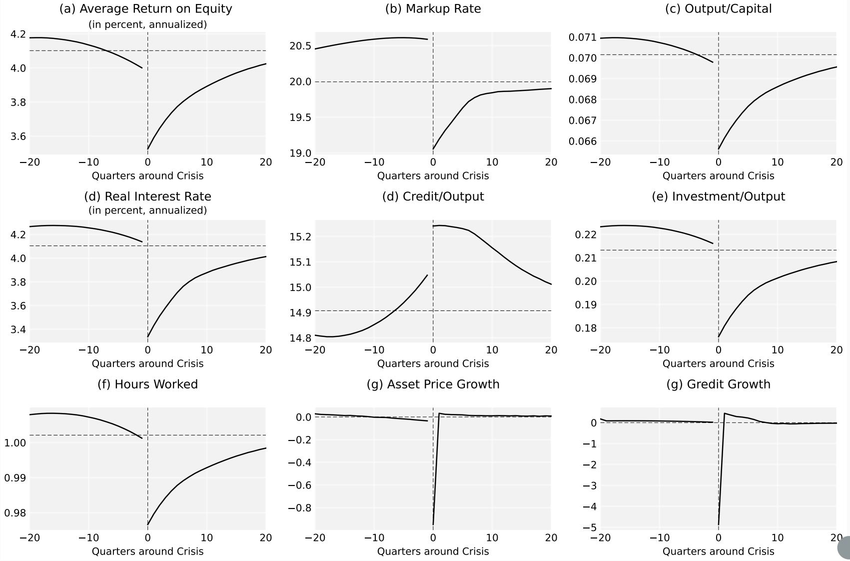
Anatomy of the average crisis: supply shocks only 2/2



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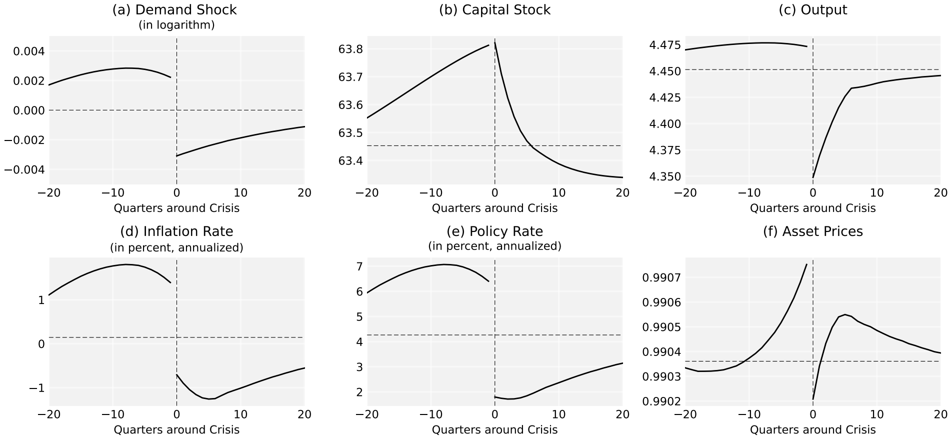
Anatomy of the average crisis: demand shocks only 1/2



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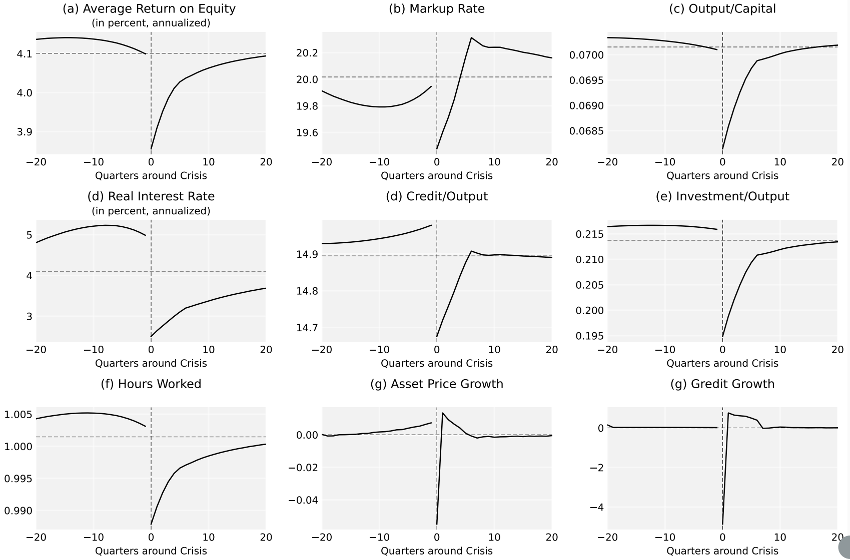
Anatomy of the average crisis: demand shocks only 2/2



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The "Divine Coincidence" revisited

- No credit frictions: SIT eliminates simultaneously inefficient fluctuations in prices and output gap and achieves the first best allocation – "divine coincidence" (Blanchard and Galí (2007))
- Credit frictions: SIT does not deliver the first best allocation $\Rightarrow$ may not be optimal anymore

- Should central banks deviate from price stability to promote financial stability?
- To answer this question, we study:
  - The trade-off between price and financial stability
  - Compare welfare under SIT with that under alternative policy rules: (i) Taylor-type rules, (ii) Taylor-type rules augmented with the yield gap, (iii) regime–contingent backstop rules

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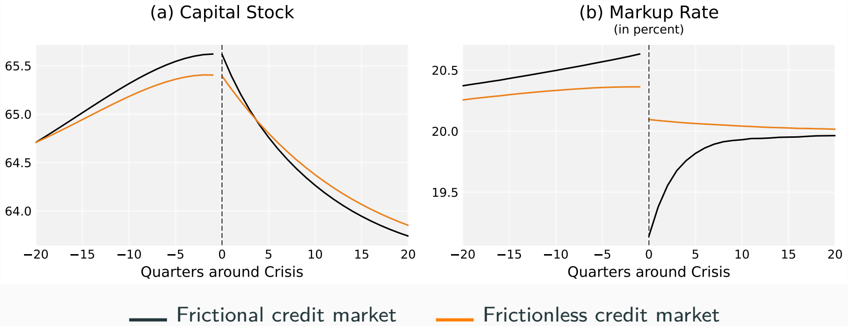
Welfare and crisis statistics under alternative monetary policy regimes

	Rule parameters			Model with Financial Frictions					Frictionless
	ϕ_π	ϕ_y	ϕ_r	Time in Crisis/Stress (in %)	Length (quarters)	Output Loss (in %)	Std(π_t) (in pp)	Welfare Loss (in %)	Welfare Loss (in %)
Standard Taylor–type Rules									
(1)	1.5	0.125	–	[10]	4.8	6.6	1.2	0.82	0.56
(2)	1.5	0.250	–	7.2	4.0	5.4	1.8	1.48	1.21
(3)	1.5	0.375	–	4.1	3.1	4.4	2.5	3.10	2.07
(4)	2.0	0.125	–	9.7	5.0	7.2	0.6	0.41	0.17
(5)	2.5	0.125	–	9.6	5.1	7.5	0.5	0.31	0.08
SIT									
(6)	$+\infty$	–	–	9.4	5.1	8.1	0	0.23	0.00
Augmented Taylor–type Rules									
(7)	1.5	0.125	5.0	5.4	3.9	5.5	1.16	0.65	–
(8)	5.0	0.125	5.0	8.8	5.0	7.4	0.18	0.22	–
(9)	5.0	0.125	25.0	6.9	4.7	6.6	0.19	0.18	–
(10)	10.0	0.125	75.0	6.3	4.6	6.4	0.09	0.16	–
Backstop Rules									
(11)	1.5	0.125	–	15.5	–	–	1.21	0.56	–
(12)	$+\infty$	–	–	17.1	–	–	0.50	0.10	–

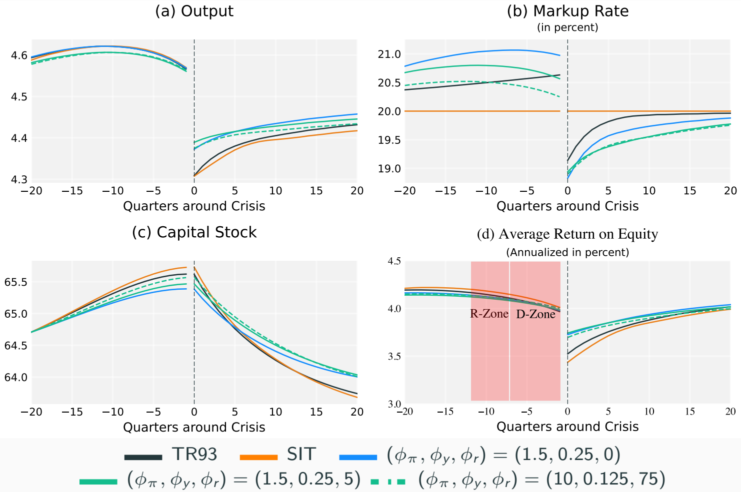
“Precautionary savings” and “markup” externalities



- The household accumulates precautionary savings in anticipation of revenue losses
- Retailers frontload price increases in anticipation of inflationary pressures

$\Rightarrow$ Individual “hedging” behaviors precipitate the crisis via K– and M–channels

Why do Taylor rules improve FS over SIT?



- **Short run:** The Taylor–type rules cushion better the fall in r_t^k in the face of adverse shocks

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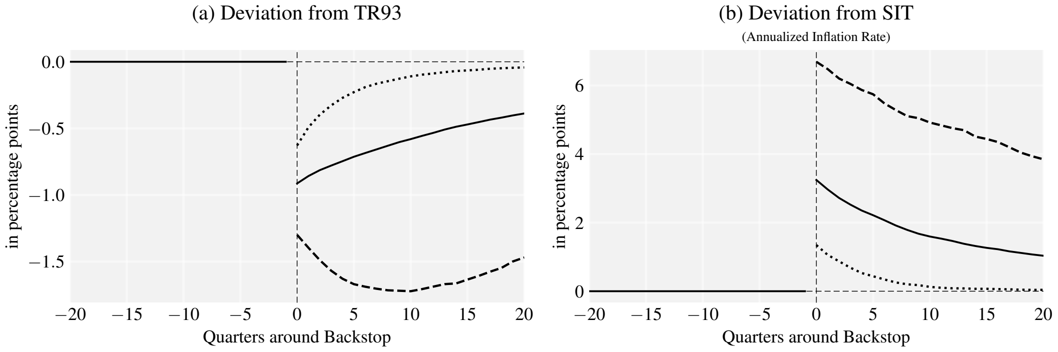
"Backstop rules" and normalisation paths



- - - Predicted stress — Average stress ..... Unpredicted stress

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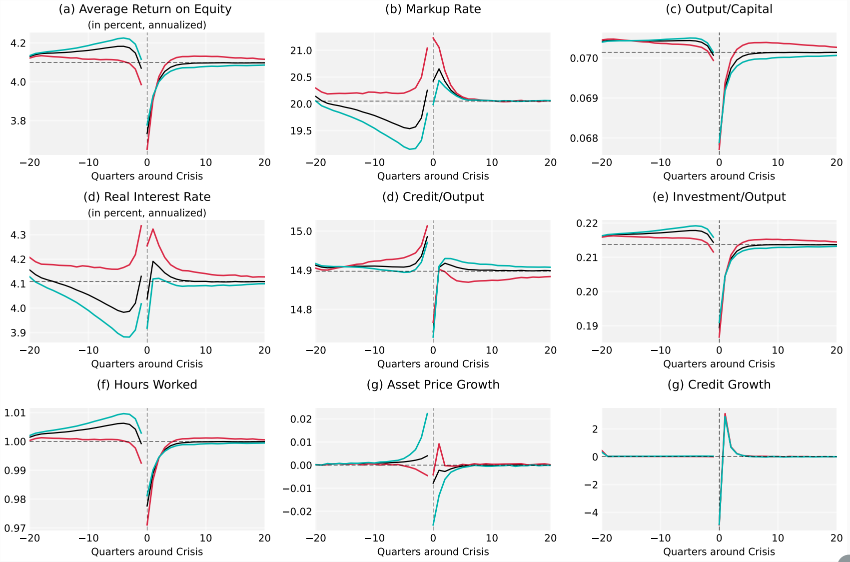
Anatomy of the average crisis: monetary shocks only



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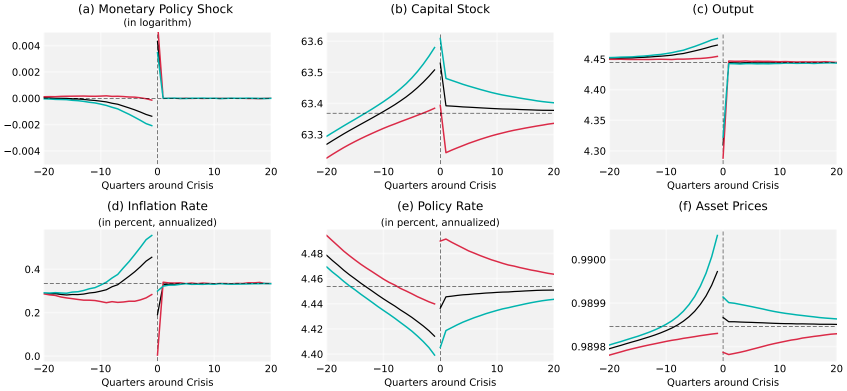
Anatomy of the average crisis: monetary shocks only (iid) 1/2



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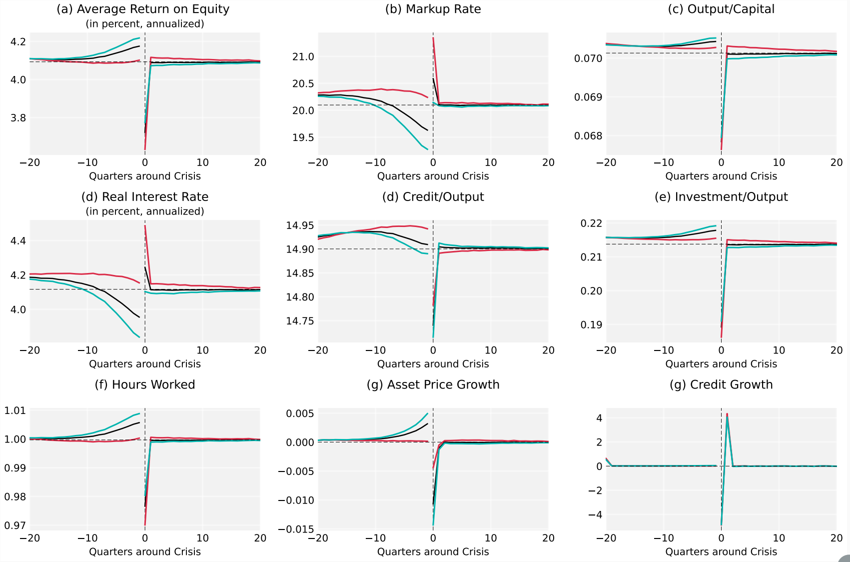
Anatomy of the average crisis: monetary shocks only (iid) 2/2



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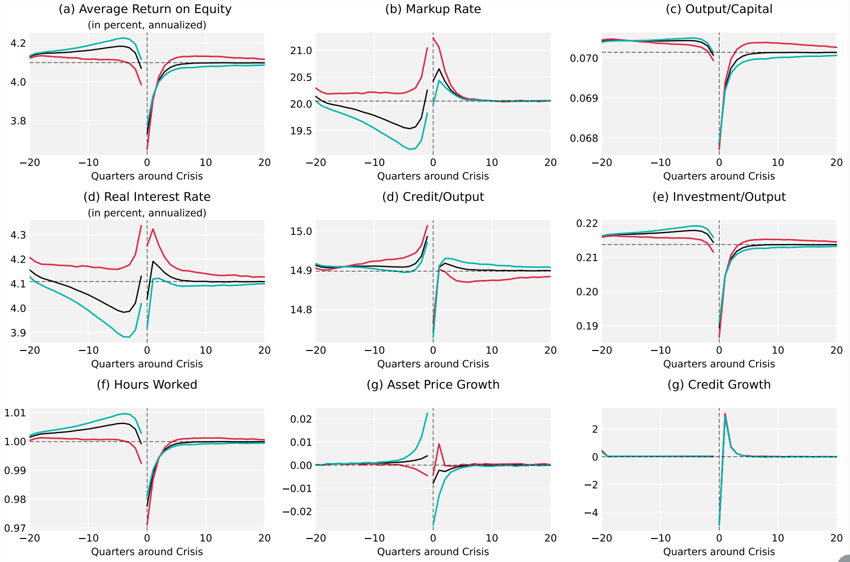
Anatomy of the average crisis: monetary shocks only



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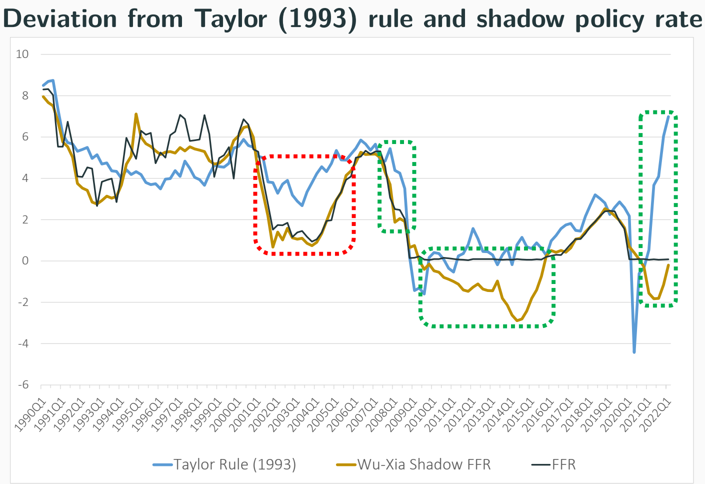
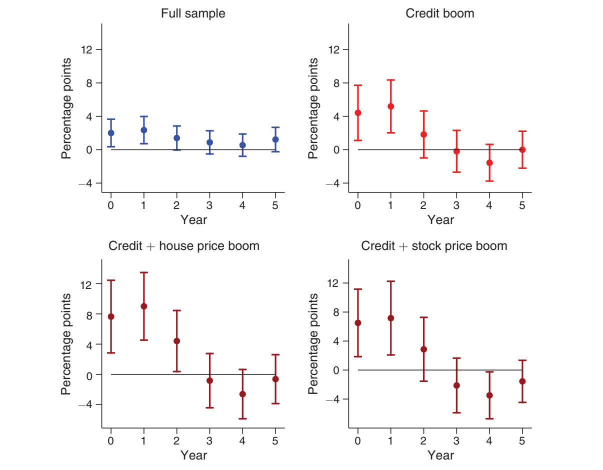
Deviation from Taylor (1993) rule and shadow policy rate



Source: Federal Reserve Bank of Atlanta

Schularick at al (2021)

Effect on annual crisis probability of an unexpected 1 pp policy rate hike



"Based on the near-universe of advanced economy financial cycles since the nineteenth century, we show that ***discretionary*** *leaning against the wind policies during credit and asset price booms are more likely to trigger crises than prevent them".*

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Greenwood at al (2022): Predictable versus Unpredictable Financial Crises

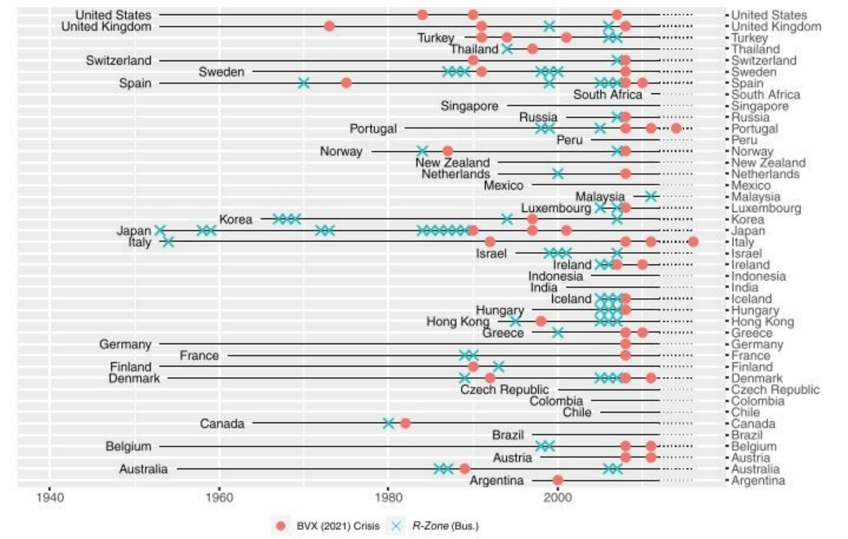
"Using historical data on postwar financial crises around the world, we show that the combination of ***rapid credit and asset price growth over the prior three years****, whether in the* ***nonfinancial business*** *or the household sector ["R-zone"], is associated with a 40% probability of entering a financial crisis within the next three years. This compares with a roughly 7% probability in normal times, when neither credit nor asset price grow this elevated."*

$$\textit{High-Debt-Growth}_{it} = 1\{\Delta_3 (\textit{Debt}/\textit{GDP})_{it} > 80^{\text{th}} \text{ percentile}\}, \tag{2a}$$

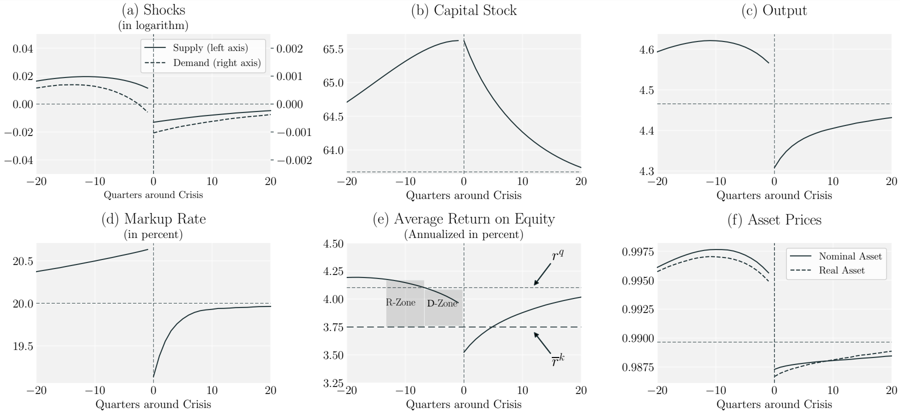
$$\textit{High-Price-Growth}_{it} = 1\{\Delta_3 \log(\textit{Price}_{it}) > 66.7^{\text{th}} \text{ percentile}\}, \tag{2b}$$

$$\textit{R-zone}_{it} = \textit{High-Debt-Growth}_{it} \cdot \textit{High-Price-Growth}_{it}, \tag{2c}$$

Greenwood at al (2022): Business R-Zones



Our Model: Business R-Zones



Greenwood et al (2022): False Positives/False Negatives

Panel A presents the percentage of red zones followed by a financial crisis within three years (PPV), the percentage of financial crises preceded red zones within three years (TPR), and the percentage of noncrisis years not preceeded by a red zone within three years (TNR) along with the numbers used for these metrics. We look at both of our red zone specifications: $R\text{-}Zone^{Bus.}$, which captures episodes of high growth in business debt and equity prices, and $R\text{-}Zone^{HH}$, which captures episodes of high growth in household debt and house prices. We also count the number of occurrences when we combine the indicators to either require both sectors to be in the red zone or either sector to be in the red zone:

$$\text{Both:} \quad R\text{-}Zone^{Both} \equiv R\text{-}Zone^{Bus.}_{it} \cdot R\text{-}Zone^{HH}_{it}$$

$$\text{Either:} \quad R\text{-}Zone^{Either} \equiv \max\{R\text{-}Zone^{Bus.}_{it}, R\text{-}Zone^{HH}_{it}\}.$$

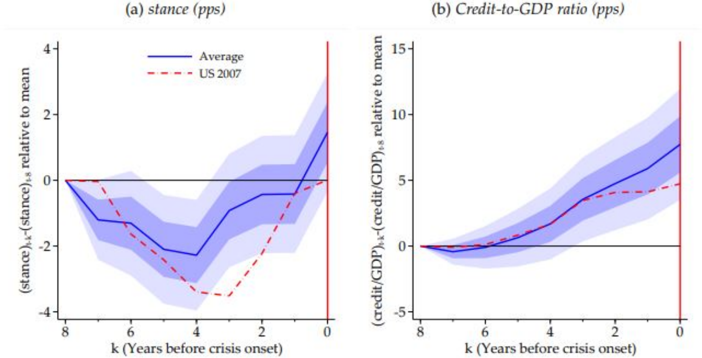
Panel B presents the results of an identical analysis with $Y\text{-}Zone \equiv 1\{\Delta_3(Debt/GDP)_{it} > 60^{th}\text{ percentile}\} \cdot 1\{\Delta_3 \log(Price_{it}) > 33.3^{rd}\text{ percentile}\}$.

Panel A: *R-Zone*

	Type			
	Business	Household	Either	Both
#*R-Zone* Events followed by a Crisis	34	42	61	15
#*R-Zone* Events	75	114	170	19
%*R-Zone* Events followed by a Crisis (PPV)	45.3	36.8	35.9	78.9
#Crises Preceded by *R-Zone*	20	21	32	7
#Crises	50	44	50	44
% of Crises preceded by *R-Zone* (TPR)	40.0	47.7	64.0	15.9
#Noncrises not Preceded by *R-Zone*	1077	897	969	1010
#Noncrises	1208	1063	1231	1040
% of Noncrises not preceded by *R-Zone* (TNR)	89.2	84.4	78.7	97.1
Time to Crisis (years)	2.9	3.7	3.6	3.0

Grimm et al (2023): Loose Monetary Policy and Financial Instability

Figure 1: *The stance of monetary policy and credit growth before financial crisis events.*



Notes: In this figure, the data, including crisis event definitions, are taken from the JST Macrohistory Database, as described later. The solid blue line shows estimates of β_k of $(y_{i,t-k} - y_{i,t-8}) = \alpha_k + \beta_k 1\{crisis_{i,t} = 1\} + e_{t-k}$. $crisis_{i,t}$ is a dummy that is equal to 1 if a financial crisis starts in country i in year t and 0 otherwise. y refers to $stance = r - r^*$ (left panel), as defined in the text; or credit-to-GDP ratio (right panel), based on the JST total loans series. The estimation of r^* is described below in section 2. Shaded areas indicate 95% (light) and 68% (dark) confidence intervals. The dashed red line shows demeaned changes in the two variables before the U.S. Great Recession.

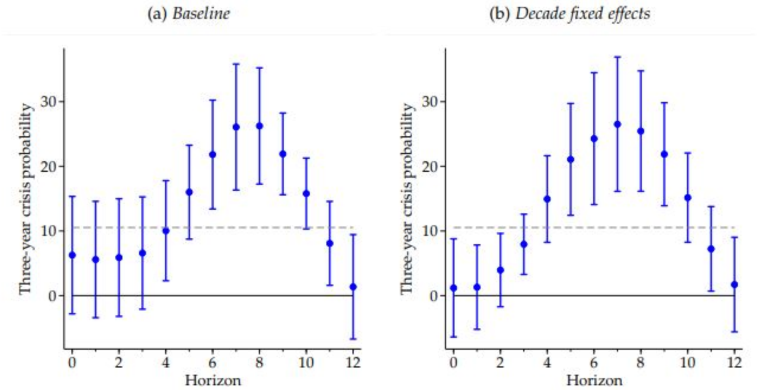
Grimm et al (2023): Loose Monetary Policy and Financial Instability

"We find that when the stance of monetary policy is accommodative over an extended period, the likelihood of financial turmoil down the road increases considerably. We investigate the causal pathways that lead to this result and argue that credit creation and asset price overheating are important intermediating channels."

"Using an instrumental variable approach, when stance is 1 percentage point (pp) lower on average in a 5-year window, then the probability of a financial crisis in the next 5 to 7 years increases by 5.5 pps, and by 15.5 pps in the following 7 to 9 years ahead".

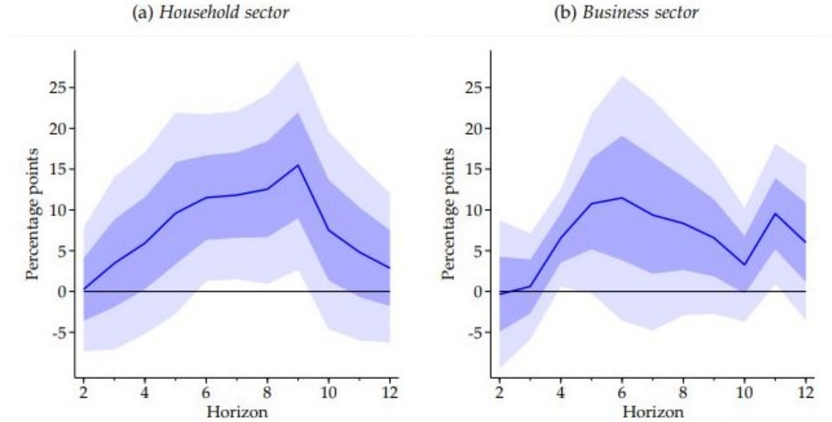
"We find that when interest rates remain below the natural rate for an extended period of time, there is a buildup in asset prices and in credit growth, both of which have been shown to be associated with greater financial fragility (see, e.g. Greenwood et al. (2022))".

Grimm et al (2023): Loose monetary policy and 3–year crisis probability (IV)



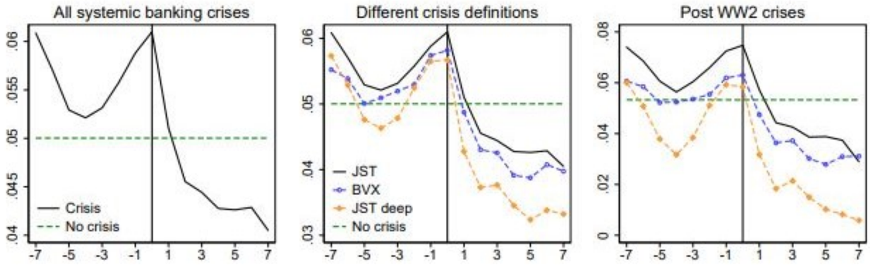
Notes: In panel (a), we re-estimate model (5) by 2SLS. In panel (b), we replace the global control variables by decade fixed effects. $\overline{stance}_{i,t}$ is instrumented with $\{z_{i,t-k}\}_{k=1}^{10}$ as defined in equation (7). The points show IV estimates of $\{10.5 - 100\beta^h\}_{h=0}^{12}$ with financial crises as the outcome variable, noting that the unconditional three-year crisis probability in our sample is 10.5%. The same controls as before are included. Bars indicate 95% confidence intervals of $\{-100\beta^h\}_{h=0}^{12}$ based on country-based cluster-robust standard errors.

Grimm et al (2023): Loose monetary policy and post-WWII R-zones



Notes: We re-estimate the same model as before but replace the continuous variable $\overline{stance}$ by the binary variable $\mathbb{1}\{\overline{stance} < 20^{th}\ percentile\}$ and show estimates of $\{100\beta^h\}_{h=2}^{12}$. Shaded areas indicate 95% (light) and 68% (dark) confidence intervals based on Driscoll-Kraay (1998) standard errors with h lags.

Jimenez et al (2023): U–shaped monetary policy and financial crises



Notes: Unweighted averages of the level of the short-term interest rate (monetary rate) in year t (start of the crisis at $t = 0$). Total of 72 crises (24 post-WW2). The left panel uses the narrative crisis definition from Jordà et al. (2016). The middle panel additionally considers the Baron et al. (2021) crisis chronology (BVX crises), and deep crises (JST deep crises) defined as Jordà et al. (2016) banking crises with -3% or less GDP growth in one year, or average -1% or less GDP growth over 3 years in the $t-1$ to $t+3$ crisis window. The right panel limits the sample to crises that started after 1945. Green dashed lines show the mean of the respective variable for non-crisis observations.

Jimenez et al (2023): The path of monetary policy and crisis risk

Table 2: *The path of monetary policy rates and crisis risk*

	Dependent variable: $\text{Crisis}_{t \text{ to } t+2}$					
	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_3\text{Rate}_t$	0.02***	0.02***	0.01*	0.03**	0.02*	0.00
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
$\text{Cut Rate}_{t-8,t-3}$		0.07**	0.07**		0.06***	0.06***
		(0.02)	(0.02)		(0.02)	(0.02)
$\Delta_3\text{Rate}_t \times \text{Cut Rate}_{t-8,t-3}$			0.03***			0.06**
			(0.01)			(0.03)
Country fixed effects	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
Kleibergen-Paap Weak ID				82.26	82.72	36.08
Observations	1624	1624	1624	1624	1624	1624

Notes: This table shows linear probability models for a systemic banking crisis occurring between years t and $t+2$. All specifications control for 8 lags of GDP growth, inflation, and the crisis dummy. Δ_3Rate is the 3-year change in the nominal monetary policy rate. Cut is a dummy which equals 1 if nominal rates were cut between $t-8$ and $t-3$. IV specifications instrument Δ_3Rate with the residualized Jordà et al. (2020) trilemma variable. IV interaction specifications include residualized JST trilemma variable and its interaction with the cut dummy as instruments. In this case the Kleibergen-Paap Weak ID is the joint test for both instruments. Country-clustered standard errors in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Jimenez et al (2023): U–shaped monetary policy and financial crises

"We show that a U-shaped monetary rate path increases banking crisis risk, via credit and asset price cycles, analyzing 17 countries over 150 years. Monetary rate hikes (raw or instrumented using the international finance's trilemma) materially increase crisis risk, but only if rates were previously cut (or low) for long."

"Regarding the mechanism, rate cuts in the first half of the U increase the likelihood of vulnerable "red zones" of high credit and asset prices, while subsequent rate hikes within "red zones" tend to trigger crises. U-shaped monetary rates are also associated with boom-bust dynamics in bank stock returns and profits (in long-run data), and with higher loan defaults, especially for ex-ante riskier borrowers and banks (in post-1995 administrative data for Spain)."