Credit Booms, Financial Crises and Macroprudential Policy

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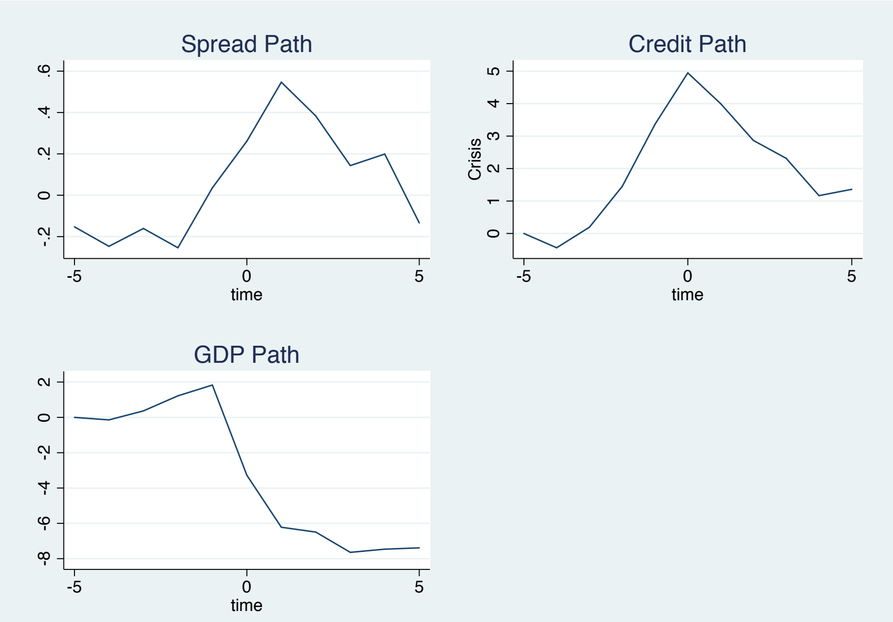
Why do banking crises usually follow credit booms?

Why don't all credit booms lead to crises?

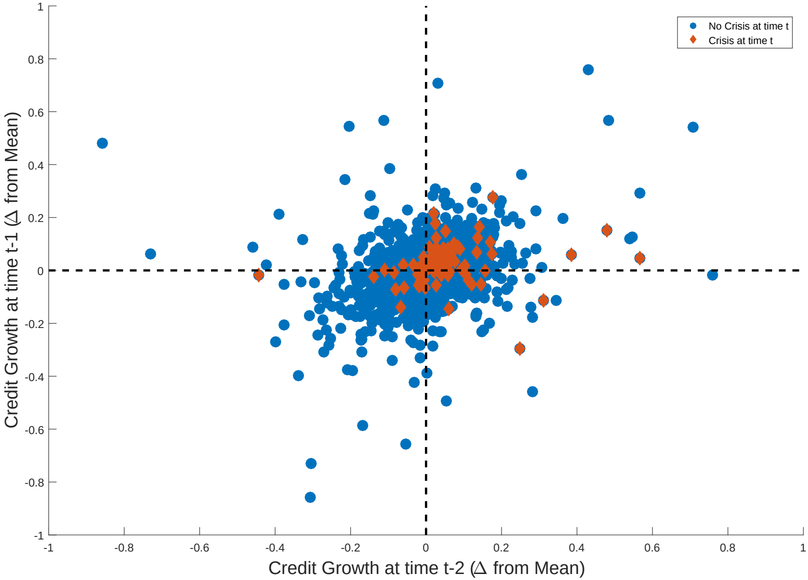
How to improve policy?

Develop a macro model with banks, credit booms, and banking panics

Banking Crises in the Data (Krishnamurthy and Muir)



Banking Crises in the Data (Schularick and Taylor)



Model

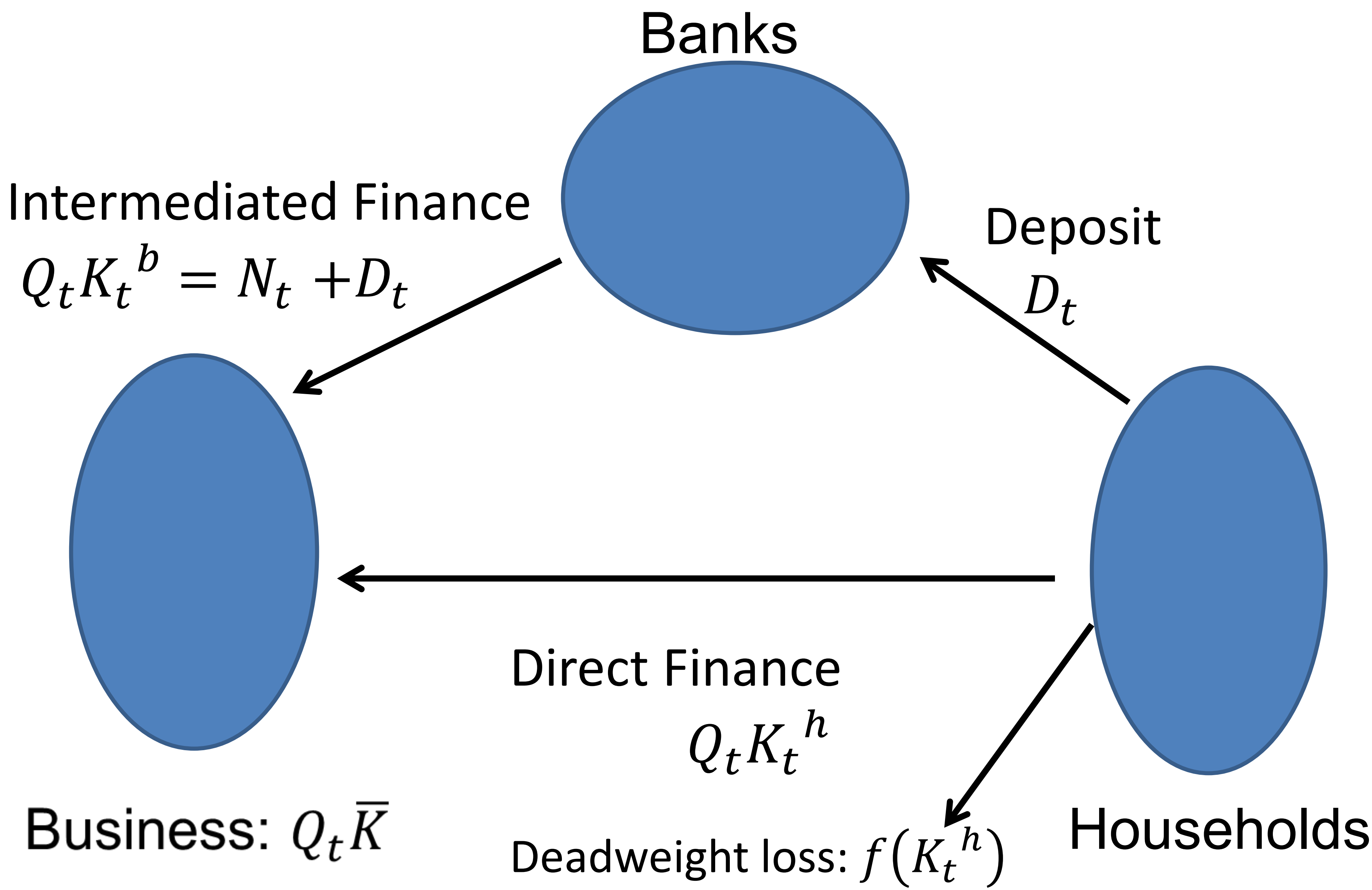
Capital is either intermediated by banks or directly held by households

$$K_t^b + K_t^h = \overline{K} = 1$$

$$\begin{array}{c} \textit{date } t \\ K_t^b \text{ capital} \end{array} \Big\} \rightarrow \begin{array}{c} \textit{date } t{+}1 \\ \left\{ \begin{array}{c} K_t^b \text{ capital} \\ Z_{t+1} K_t^b \text{ output} \end{array} \right. \end{array}$$

$$\begin{array}{c} \textit{date } t \\ \left. \begin{array}{c} K_t^h \text{ capital} \\ f(K_t^h) \text{ goods} \end{array} \right\} \end{array} \rightarrow \begin{array}{c} \textit{date } t{+}1 \\ \left\{ \begin{array}{c} K_t^h \text{ capital} \\ Z_{t+1} K_t^h \text{ output} \end{array} \right. \end{array}$$

$$f(K_t^h) = \frac{\alpha}{2}(K_t^h)^2 \text{: management cost } \alpha > 0$$



Banks
Intermediated Finance
$Q_t K_t{}^b = N_t + D_t$
Deposit
D_t
Direct Finance
$Q_t K_t{}^h$
Business: $Q_t \bar{K}$
Households
Deadweight loss: $f\left(K_t{}^h\right)$

Deposit contract

Short term

Promised rate of return $\overline{R}_t$ is non-contingent

$$\text{Realized returns } R_{t+1} = \begin{cases} \overline{R}_t, & \text{if no default w.p. } 1 - p_t \\ x_{t+1}\overline{R}_t, & \text{if default w.p. } p_t \end{cases}$$

Recovery rate x_{t+1} equals total realized bank assets per deposit obligation - depends upon both individual bank and aggregate conditions

Bank defaults because of rollover crisis

Each household consists of many members, $1-f$ workers and f bankers

Workers supply labor and bring wages back to the household

Each banker manages a bank, retains some earning and bring back the rest to the household

Perfect consumption insurance within the household

Each period, each banker becomes a worker and brings back the net worth with probability $1-\sigma$

$(1-\sigma)\,f$ workers become bankers with the start-up funds w^b

Households maximize

$$U_t = E_t\left(\sum_{i=0}^{\infty}\beta^i \ln C_{t+i}^h\right)$$

subject to:

$$C_t^h + D_t + Q_t K_t^h + f(K_t^h) = W^h + \Pi_t + R_t D_{t-1} + (Z_t + Q_t) K_{t-1}^h$$

$\longrightarrow$

$$1 = E_t\left(\Lambda_{t,t+1} R_{t+1}\right)$$

$$1 = E_t\left[\Lambda_{t,t+1}\frac{Z_{t+1} + Q_{t+1}}{Q_t + f'(K_t^h)}\right]$$

where

$$\Lambda_{t,t+1} = \beta\frac{C_t}{C_{t+1}}$$

Each banker pays dividend which equals net worth n_t upon exit

$$V_t = E_t \left\{ \Lambda_{t,t+1} \left[(1-\sigma) n_{t+i} + \sigma V_{t+1} \right] \right\}$$

Bank balance sheet

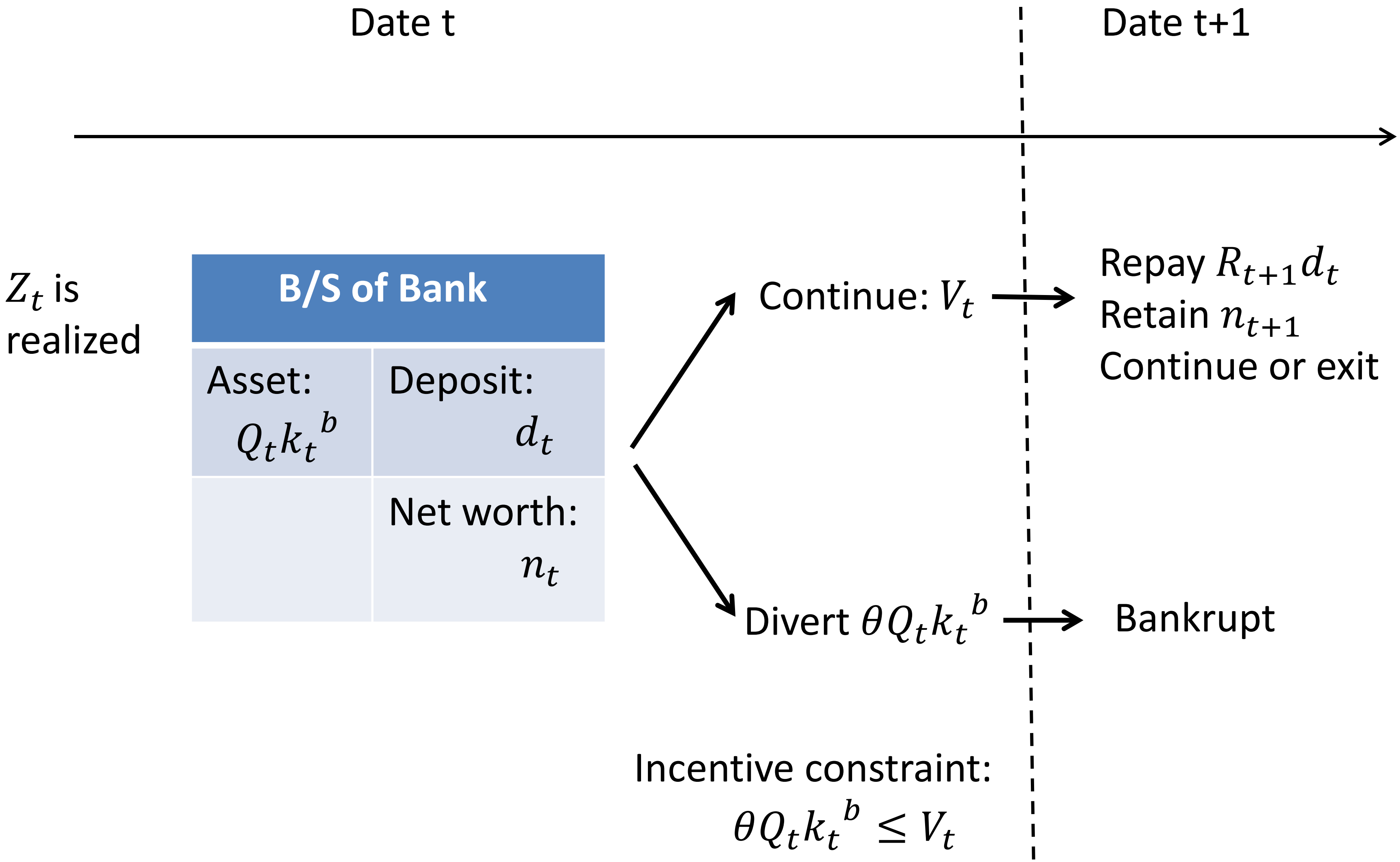
$$Q_t k_t^b = d_t + n_t$$

Net worth n_t of surviving bankers

$$\begin{aligned} n_t &= (Z_t + Q_t) k_{t-1}^b - R_t d_{t-1} \\ &= R_t^b Q_{t-1} k_{t-1}^b - R_t d_{t-1} \end{aligned}$$

where

$$R_t^b = \frac{Z_t + Q_t}{Q_{t-1}} : \text{ bank asset return}$$


Date t
Date t+1
Z_t is realized
B/S of Bank
Asset: $Q_t {k_t}^b$
Deposit: d_t
Net worth: n_t
Continue: V_t
Repay $R_{t+1} d_t$
Retain n_{t+1}
Continue or exit
Divert $\theta Q_t {k_t}^b$
Bankrupt
Incentive constraint: $\theta Q_t {k_t}^b \le V_t$

Bank chooses "leverage multiple" $\phi_t = \frac{Q_t k_t^b}{n_t}$ to maximize

$$\frac{V_t}{n_t} = \psi_t = E_t\left[\Lambda_{t,t+1}(1-\sigma+\sigma\psi_{t+1})\frac{n_{t+1}}{n_t}\right]$$

$$= E_t\left\{\Lambda_{t,t+1}(1-\sigma+\sigma\psi_{t+1})\left[\phi_t\left(R_{t+1}^b - R_{t+1}\right) + R_{t+1}\right]\right\}$$

subject to $\theta Q_t k_t^b \leq V_t$ and

$$\begin{aligned} 1 &= E_t\left\{\Lambda_{t,t+1}\cdot Min\left[\overline{R}_t, \frac{(Z_{t+1}+Q_{t+1})\,k_t^b}{d_t}\right]\right\} \\ &= E_t\left\{\Lambda_{t,t+1}\cdot Min\left[\overline{R}_t,\ R_{t+1}^b\frac{\phi_t}{\phi_t - 1}\right]\right\} \end{aligned}$$

Endogenous leverage constraint

$$\phi_t \leq \frac{\psi_t}{\theta}$$

Aggregate bank assets

$$Q_t K_t^b = \phi_t N_t$$

Aggregate net worth

$$N_t = \sigma \left[\left(Z_t + Q_t \right) K_{t-1}^b - R_t D_{t-1} \right] + (1 - \sigma) f w^b$$

Goods market

$$C_t = Z_t \overline{K} + W^h - f(K_t^h) = Y_t$$

Bank Runs: Self-fulfilling Rollover Crisis

At the beginning of period t, depositors decide whether to roll over their deposits or run

A bank run equilibrium exists if:

$$\left(Z_t + Q_t^*\right) K_{t-1}^b < \overline{R}_t D_{t-1}$$

Run occurs iff run equilibrium exists AND sunspot appears with probability $\varkappa$ to coordinate run

The time-t probability of run at t+1 is

$$p_t = \varkappa \cdot \mathsf{Pr}\left\{Z_{t+1} < Z_{t+1}^R\right\}$$

Z_{t+1}^R is threshold value below which a run equilibrium exists

$$[Q_{t+1}^*(Z_{t+1}^R) + Z_{t+1}^R]K_t^b = \overline{R}_t D_t$$

Q_t^* : Liquidation Price

After a bank run at t, household holds all capital and will gradually decrease their holdings as new bankers enters and grow. Household condition for direct capital holding $\longrightarrow$

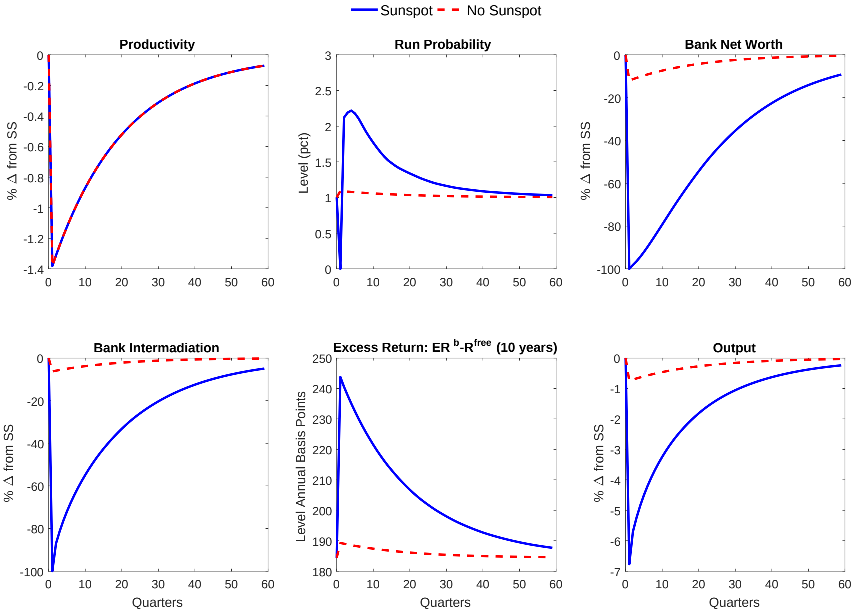
$$Q_t^* = E_t \left\{ \sum_{i=1}^{\infty} \Lambda_{t,t+i} [Z_{t+i} - f'(K_{t+i}^h)] \right\} - f'(1)$$

where $f'(K_t^h)$ is the marginal management cost which as at a maximum at $K_t^h = 1$

Calibration

Parameter	Description	Value	Target	Model
Calibrated Parameters				
θ	Share of Divertible Assets	.22	Leverage =10	$\phi = 9.9$
σ	Banker Survival Rate	.935	Quarterly Spread=50 bps	$ER^b - R = 45$ bps
W	New Banker Endowmnet	1 pct of SS Net Worth	HH Share of Interm.=.5	$K^h = .49$
α	Marginal HH Intermediation Costs	.006	Output Drop During Run=6 pct	$pct\Delta y$ during run =6 pct
ι	Sunspot Probability	10 pct	Run Probability= 1 pct quarterly	Run Prob=1.1 pct
$\sigma(\epsilon^Z)$	Standard Dev. of Innovation to Z	1 pct	Standard Dev. of Output= 1.9 pct	$\sigma(Y) = 1.7$ pct
Fixed Parameters				
β	Impatience	.99	-	-
ρ^Z	Serial Correlation of Z	.95	-	-
W_h	HH Endowment	$2 \cdot Z$	-	-

Run After a Large Negative Shock



Boom Leading to the Bust: News Driven Optimism

$$Z_{t+1} - 1 = \rho (Z_t - 1) + \epsilon_{t+1}. \text{ Normally } E_t (\epsilon_{t+1}) = 0$$

Occasionally bankers receive a news at t: They learn unusually large realization of ϵ_τ of size $B > 0$ will happen at $\tau \in \{t+1, ..., t+T\}$ with probability

$$\text{Pr}_0 \ (\epsilon_\tau = B) \ = \overline{P}^B \cdot \zeta_\tau, \text{ where } \overline{P}^B < 1 \text{ and}$$

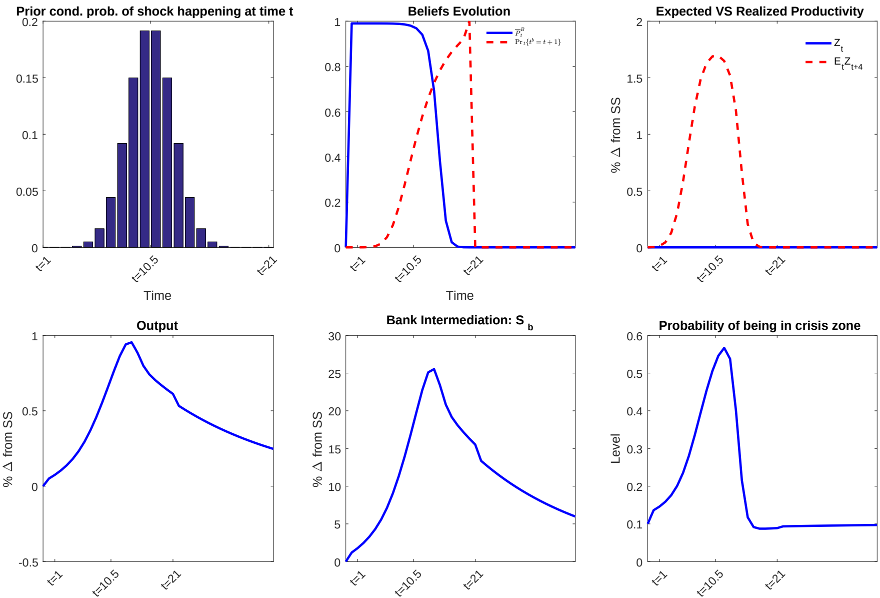
ζ_τ is a truncated Normal with discrete approximation $\sum_{\tau=t+1}^{t+T} \zeta_\tau = 1$
Households do not believe news

Conditional on the large shock not happening until $s < t + T$, the probability of happening in future is

$$\text{Pr}_s \ (\epsilon_\tau = B) \ = \frac{\overline{P}^B \cdot \zeta_\tau}{1 - \sum_{j=1}^{s-t} \overline{P}^B \cdot \zeta_j}, \text{ for } \tau = s+1, .., t+T$$

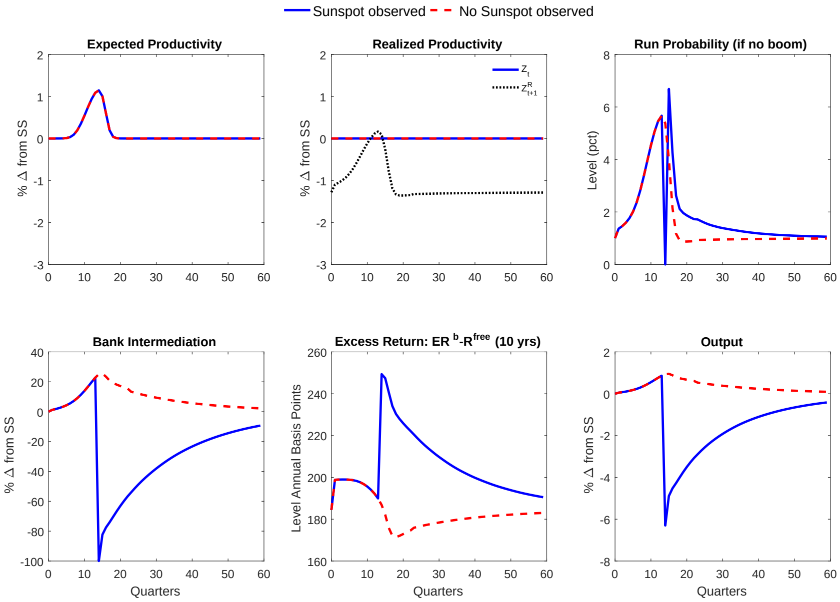
Beliefs Driven Credit Boom

▸ Calibration of News

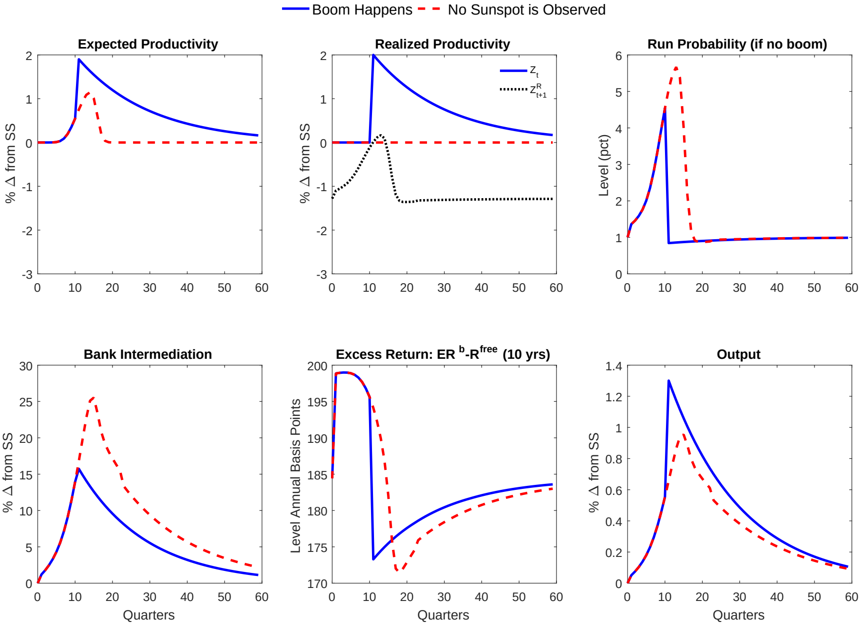


Boom Leading to a bust

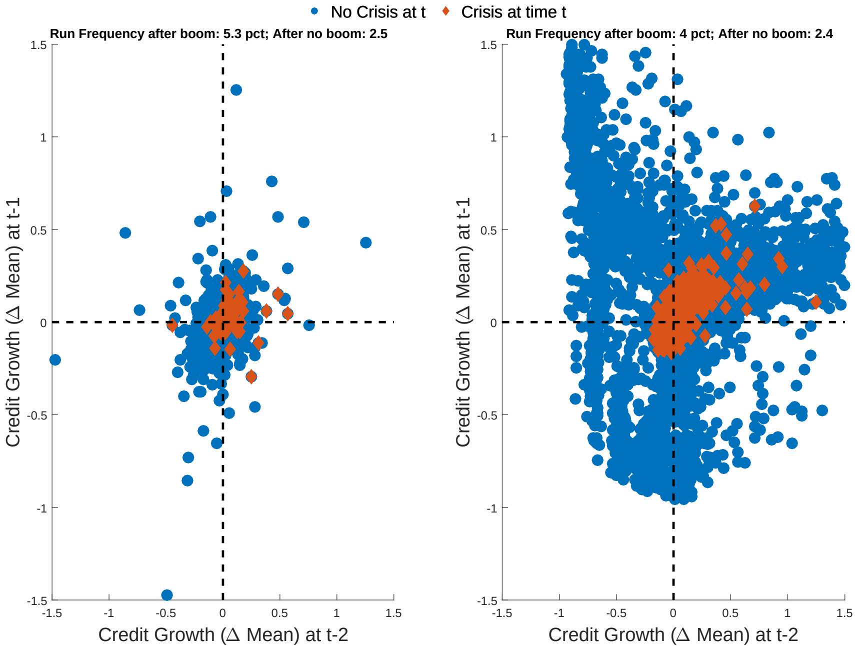
‣ Survey Evidence on Credit Spreads ‣ Survey Evidence on GDP



False Alarms



Unpredictability of Crises: Data and Model



Macro-prudential Policy

Regulator sets the time varying capital requirement $\underline{\kappa}_t$ for $\frac{N_t}{Q_t K_t^b}$

Equilibrium capital ratio is

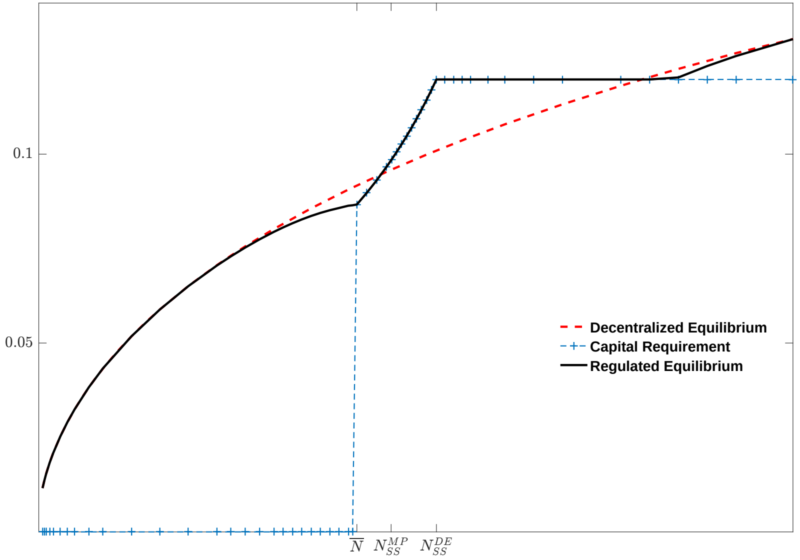
$$\kappa_t = Max\left(\underline{\kappa}_t, \frac{\theta}{\psi_t}\right)$$

We restrict policy to follow a simple rule

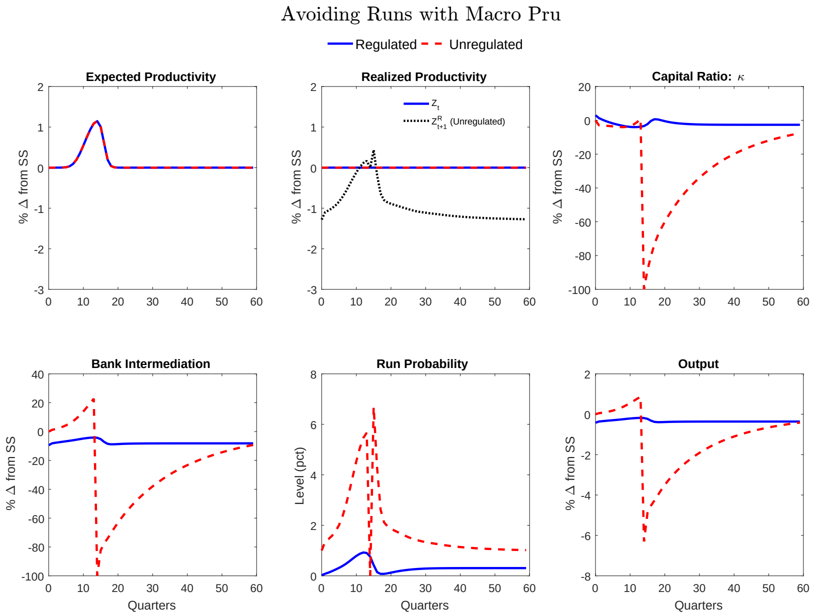
$$\underline{\kappa}_t = \begin{cases} \underline{\kappa}, \text{ if } N_t \geq \underline{N}, \\ 0, \text{ if } N_t < \underline{N} \end{cases}$$

We look for $(\underline{\kappa},\ \underline{N})$ that maximize the welfare

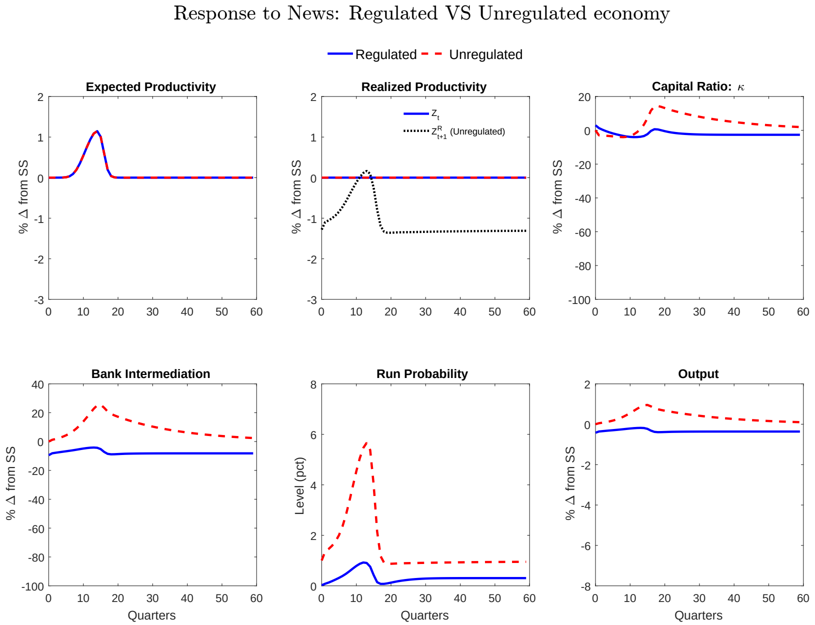
Regulation


0.1
0.05
$\overline{N}$
N_{SS}^{MP}
N_{SS}^{DE}
Decentralized Equilibrium
Capital Requirement
Regulated Equilibrium

Avoiding a Run with Regulation



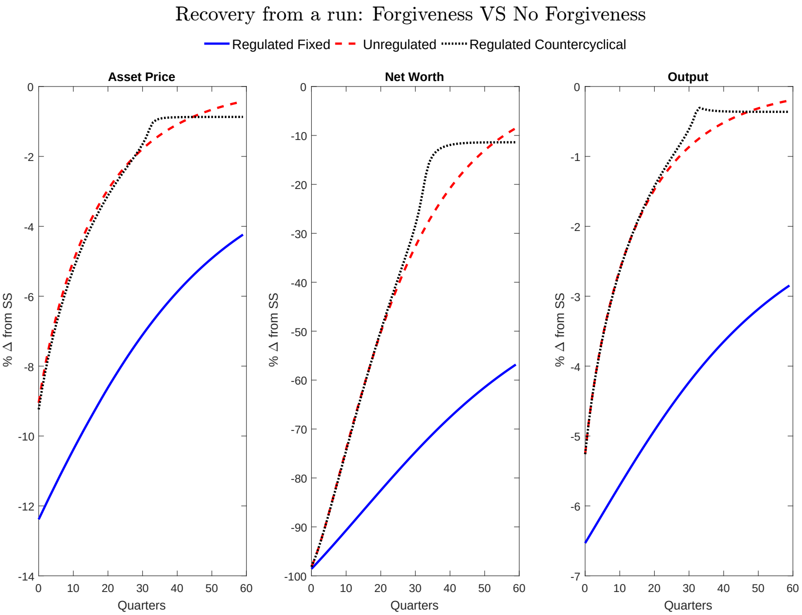
Responding to False Alarms: No Sunspot Observed



Effect of Regulation

	Unregulated Economy $(\bar{\kappa} = 0;\ \bar{N} = 0)$	**Optimal Regulation** $(\bar{\kappa} = .13;\ \bar{N} = .85 * N_{SS}^{DE})$	**Fixed Capital Requirements** $(\bar{\kappa} = .13;\ \bar{N} = 0)$
Run Frequency	.8 pct	.45 pct	.3 pct
AVG Output Cond. No Run (Δ *from Decentralized Economy*)	0	$-.4$ pct	-1.7 pct
AVG Output ($\boldsymbol{\Delta}$ *from Decentralized Economy*)	0	.1 pct	$-.9$ pct
Welfare Gain (Δ *Permanent Consumption*)	0	.16 pct	-1.16 pct

Recovery From a Run



Conclusion

Develop model of banking panics that captures boom-bust cycles and limited predictability of runs

Study macro-prudential policy

Future Work

- Ex-post interventions

- Equity injections

Calibration of News

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Parameter	Description	Value
π^n	Prob of Receiving News	.02
B	Size of Productivity Boom	$2 \cdot \sigma(\epsilon^Z)$
T	News Horizon	21 Quarters
$\mu(t^B)$	Expected time of Z boom	10.5 Quarters ahead
$\sigma(t^B)$	Std Dev. of prior	2 Quarters
$\overline{P}_0^B$	Banker Prob. that Shock will happen	.99
$\overline{P}_0^{TRUE}$	True Prob. that Shock will happen	.5

Forecast Errors for credit spreads from GKP (2019)

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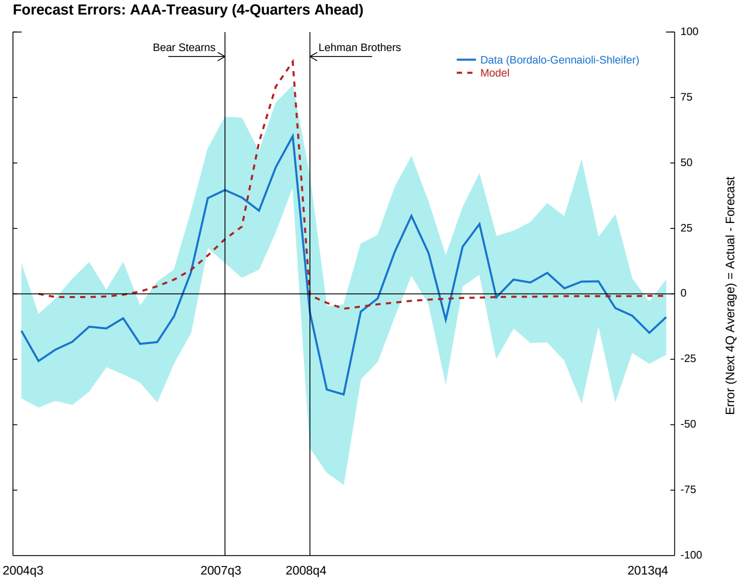

Forecast Errors for GDP

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