Welfare-enhancing properties of countercyclical bank capital requirements

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Motivation

- Macroprudential policy, systemic risk.
- Countercyclical capital buffer (Basel III).
- One role: improve financial stability (decrease systemic risk).
- Other roles?

What I do

- Take the model of Iacoviello (2015), modify. Key elements:
  - bank capital requirements,
  - collateral constraint (Kiyotaki and Moore, 1997).
- The model features financial amplification/accelerator, similar to Kiyotaki and Moore (1997), Bernanke, Gertler and Gilchrist (1999).
  - Entrepreneurs' net worth and consumption are very volatile.
  - Inefficiencies: nominal rigidities, monopolistic competition + *binding borrowing constraints*.
- Ramsey optimal bank capital requirements.
- Optimized (sub-optimal) policy rules.

Findings

- Countercyclical bank capital requirements are Ramsey optimal.
  - Capital adjustment costs and nominal rigidities are crucial.
- The optimal policy mitigates the inefficiency due to the binding collateral constraint.
  - Relax the constraint in recessions, tighten in expansions.
- The optimal policy is Pareto improving.
  - Entrepreneurs hugely gain, bankers and households—marginally.
- The optimized policy rules are *not* Pareto improving, but still countercyclical.
  - Entrepreneurs still benefit a lot.
  - The most successful rules respond to credit or asset prices.
  - The credit-to-GDP rule (similar to Basel III) performs poorly.

Literature

- Ramsey: Collard et al. (2017).
- Policy rules:
  - Martinez-Miera and Suarez (2014), Mendicino et al. (2018).
  - Angelini, Neri and Panetta (2014).
  - Angeloni and Faia (2013).

Model setup

- Measure one continua of identical bankers (b), entrepreneurs (e) and households (h).
- As in Blanchard (1985), each agent dies at the end of a period with a probability $\delta_i \in [0, 1)$, $i \in \{b, e, h\}$.
    - A measure δ_i dies, the same measure is born.
    - The effective discount factors are $\beta_i \equiv (1 - \delta_i)\beta$.

Bankers

They maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} {\beta_b}^t U_b \left(C_t^b \right)$$

subject to

$$C_t^b + L_t \leq NW_t^b + D_t, \quad (1)$$

$$L_t - D_t \geq k_t^m L_t, \quad (2)$$

where

$$NW_t^b \equiv \frac{R_t^l}{\Pi_t} L_{t-1} - \frac{R_{t-1}}{\Pi_t} D_{t-1},$$

where C_t^b is consumption, L_t are loans, D_t are deposits, R_t^l is the gross nominal loan rate, R_t is the gross nominal deposit rate, Π_t is the gross inflation rate, k_t^m denotes the regulatory capital requirement.

Bankers

$\Longrightarrow$

$$\frac{\gamma_t^b}{U_b'(C_t^b)} = 1 - \mathbb{E}_t \left\{ \beta_b \frac{U_b'(C_{t+1}^b)}{U_b'(C_t^b)} \frac{R_t}{\Pi_{t+1}} \right\}, \quad (3)$$

$$\frac{\gamma_t^b}{U_b'(C_t^b)}(1 - k_t^m) = 1 - \mathbb{E}_t \left\{ \beta_b \frac{U_b'(C_{t+1}^b)}{U_b'(C_t^b)} \frac{R_{t+1}^l}{\Pi_{t+1}} \right\}, \quad (4)$$

where $\gamma_t^b \geq 0$ is the Lagrange multiplier on the regulatory constraint.

Entrepreneurs

They maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} {\beta_e}^t U_e(C_t^e)$$

subject to

$$C_t^e + Q_t K_t \leq NW_t^e + L_t, \tag{5}$$

$$\mathbb{E}_t \left\{ R_{t+1}^l L_t \right\} \leq m_t \mathbb{E}_t \left\{ Q_{t+1}(\Pi_{t+1}) K_t \right\}, \tag{6}$$

where

$$NW_t^e \equiv \frac{Y_t^w}{X_t} - W_t N_t + Q_t(1-\delta)K_{t-1} - \frac{R_t^l}{\Pi_t} L_{t-1},$$

$$Y_t^w \equiv A_t {K_{t-1}}^{\alpha} {N_t}^{1-\alpha},$$

K_t is capital, Q_t its real price, W_t is the real wage, N_t is labor, A_t is the total factor productivity, m_t is the loan-to-value (LTV) ratio.

Entrepreneurs

$\Longrightarrow$

$$W_t = (1-\alpha)\frac{Y_t^w}{N_t X_t}, \tag{7}$$

$$Q_t = \mathbb{E}_t\left\{\beta_e \frac{U_e'(C_{t+1}^e)}{U_e'(C_t^e)}\left(\alpha\frac{Y_{t+1}^w}{K_t X_{t+1}} + (1-\delta)Q_{t+1}\right)\right\}$$
$$+\frac{\gamma_t^e}{U_e'(C_t^e)} m_t \mathbb{E}_t\left\{Q_{t+1}(\Pi_{t+1})\right\}, \tag{8}$$

$$\frac{\gamma_t^e}{U_e'(C_t^e)}\mathbb{E}_t\{R_{t+1}^l\} = 1 - \mathbb{E}_t\left\{\beta_e \frac{U_e'(C_{t+1}^e)}{U_e'(C_t^e)}\frac{R_{t+1}^l}{\Pi_{t+1}}\right\}, \tag{9}$$

where $\gamma_t^e \geq 0$ is the Lagrange multiplier on the collateral constraint.

The rest of the model

- Households consume, supply labor and save through bank deposits.
- Physical capital is produced subject to adjustment costs.
- Calvo (1983) nominal rigidities.
- Central bank sets $R_t = \bar{R} \left(\frac{\Pi_t}{\bar{\Pi}} \right)^{\phi_\pi}$.
- For a given macroprudential policy $\{\{k_t^m(s^t)\}_{s^t \in S^t}\}_{t=0}^{\infty}$, a competitive equilibrium can be defined.

Steady state equilibrium

Let $\bar{k}^m$ be the value of k_t^m in a steady state, and let

$$\tilde{\beta}_e \equiv \frac{\beta_h}{1 + \bar{k}^m \left(\frac{\beta_h}{\beta_b} - 1\right)}.$$

Proposition 1

There exists a steady state decentralized equilibrium with $k_t^m = \bar{k}^m \; \forall t \iff \left(\beta_b \leq \beta_h \wedge \beta_e \leq \tilde{\beta}_e\right)$.

Proposition 2

There exists a **unique** *steady state decentralized equilibrium with* $k_t^m = \bar{k}^m \; \forall t \iff (\beta_b < \beta_h \wedge \beta_e < \tilde{\beta}_e)$.

Decentralized equilibrium: bankers

Proposition 3

Suppose $U_b(\cdot) \equiv \ln(\cdot)$ *and* $\beta_b < \beta_h$*. Then in a "neighborhood" of the steady state,*

$$C_t^b = (1-\beta_b)NW_t^b, \tag{10}$$

$$D_t = \beta_b \frac{1-k_t^m}{k_t^m} NW_t^b, \tag{11}$$

$$L_t = \frac{\beta_b}{k_t^m} NW_t^b, \tag{12}$$

$$NW_t^b = \frac{\beta_b}{\Pi_t}\left(\frac{R_t^l - R_{t-1}}{k_{t-1}^m} + R_{t-1}\right) NW_{t-1}^b. \tag{13}$$

Decentralized equilibrium: entrepreneurs

Proposition 4

Suppose $U_e(\cdot) \equiv \ln(\cdot)$ *and* $\beta_e < \widetilde{\beta}_e$. *Then in a "neighborhood" of the steady state,*

$$C_t^e = (1-\beta_e) NW_t^e, \tag{14}$$

$$K_t = \eta_t NW_t^e, \tag{15}$$

$$L_t = (Q_t \eta_t - \beta_e) NW_t^e, \tag{16}$$

$$N_t = \left[\frac{(1-\alpha)A_t}{W_t X_t}\right]^{\frac{1}{\alpha}} \eta_{t-1} NW_{t-1}^e, \tag{17}$$

$$NW_t^e = \left\{\alpha \frac{A_t}{X_t}\left[\frac{(1-\alpha)A_t}{W_t X_t}\right]^{\frac{1-\alpha}{\alpha}} \eta_{t-1} + Q_t(1-\delta)\eta_{t-1} - \frac{R_t^l}{\Pi_t}(Q_{t-1}\eta_{t-1} - \beta_e)\right\} NW_{t-1}^e, \tag{18}$$

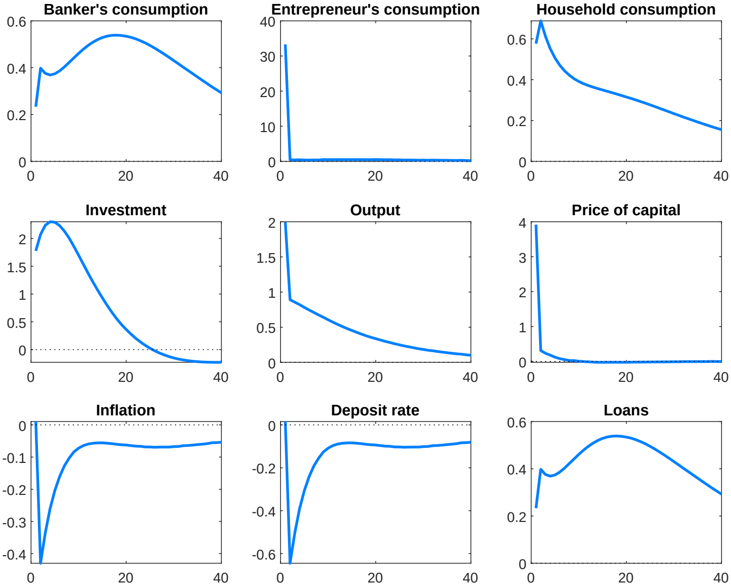
where

$$\eta_t \equiv \beta_e \left(Q_t - \frac{m_t \mathbb{E}_t\{Q_{t+1}\Pi_{t+1}\}}{\mathbb{E}_t\left\{R_{t+1}^l\right\}}\right)^{-1}.$$

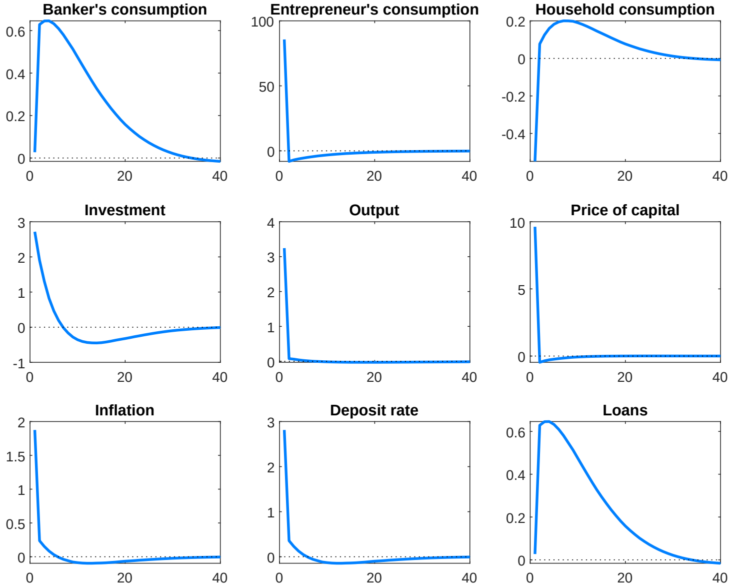
Parameters

Parameter	Value	Definition
α	1/3	Capital share in the wholesale good production
β	0.99	Discount factor
β_b	0.95	Bankers' adjusted discount factor
β_e	0.95	Entrepreneurs' adjusted discount factor
β_h	0.99	Household adjusted discount factor
δ	0.025	Capital depreciation rate
ϵ	6	Elasticity of substitution between retail good varieties
k^m	0.1	Steady state minimum bank capital requirement
m	0.9	Steady state LTV ratio
ϕ	1	Inverse Frisch elasticity of labor supply
ϕ_k	2.4	Capital good adjustment cost parameter
ϕ_π	1.5	Central bank's response to inflation parameter
π	0.005	Steady state inflation rate
ρ_a	0.9	TFP AR(1) autocorrelation coefficient
ρ_m	0.9	LTV ratio AR(1) autocorrelation coefficient
σ	1	Household RRA coefficient
τ_a	0.005	Standard deviation of the TFP shock
τ_m	0.005	Standard deviation of the LTV shock
θ	0.75	Retail price survival probability

1% shock to A_t (TFP)



1% shock to m_t (LTV)



Welfare criterion

- If a planner cares about living agents and agents born in the future, the aggregate welfare of agents of type $i \in \{b, e, h\}$ is

$$\mathcal{W}_t^i = U_i(t) + \beta \mathbb{E}_t \left\{ \mathcal{W}_{t+1}^i \right\}.$$

- The period t social welfare is

$$\mathcal{W}_t \equiv \sum_i \omega_i \mathcal{W}_t^i,$$

where ω_i are Pareto weights, $\omega_i \geq 0$, $\sum_i \omega_i = 1$.

- The expected welfare functions are $\mathcal{W}^i \equiv \mathbb{E}(\mathcal{W}_t^i)$ and $\mathcal{W} \equiv \mathbb{E}(\mathcal{W}_t)$.

Welfare gains

- Under log utility, welfare gains as a share of consumption are

$$\lambda_i = \exp\left[(1-\beta)\left(\widetilde{\mathcal{W}}^i - \mathcal{W}^i\right)\right] - 1,$$
$$\lambda = \exp\left[(1-\beta)\left(\widetilde{\mathcal{W}} - \mathcal{W}\right)\right] - 1,$$

where $\widetilde{\mathcal{W}}^i$ and $\widetilde{\mathcal{W}}$ are expected welfare functions under an alternative policy.

First-best problem

Assume w.l.o.g. that $\phi_k = 0$. The efficient allocation is the solution to the planner's problem:

$$\max \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\omega_b \ln C_t^b + \omega_e \ln C_t^e + \omega_h \left(\ln C_t^h - \frac{{N_t}^{1+\phi}}{1+\phi} \right) \right]$$

subject to

$$A_t {K_{t-1}}^{\alpha} {N_t}^{1-\alpha} = C_t^b + C_t^e + C_t^h + K_t - (1-\delta) K_{t-1}.$$

First-best allocation

$$\lambda_t = \frac{\omega_i}{C_t^i} \quad \forall i \in \{b, e, h\}, \tag{19}$$

$$\frac{C_t^i}{C_t^j} = \frac{\omega_i}{\omega_j} \quad \forall i, j \in \{b, e, h\}, \tag{20}$$

$$C_t^h {N_t}^{\phi} = (1-\alpha) A_t \left(\frac{K_{t-1}}{N_t} \right)^{\alpha}, \tag{21}$$

$$1 = \beta \mathbb{E}_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \left[\alpha A_{t+1} \left(\frac{K_t}{N_{t+1}} \right)^{\alpha-1} + 1 - \delta \right] \right\}, \tag{22}$$

where λ_t is the Lagrange multiplier corresponding to the resource constraint.

Flexible-price model without capital adjustment costs

- Borrowing constraints—the only friction.
  - Flexible prices.
  - Perfect competition in all markets.
  - No capital adjustment costs ($\phi_k = 0$).
- Entrepreneurs produce the final good, there are no retailers and no central bank.
- For illustrative purposes, $\omega_b = 0.1$, $\omega_e = 0.1$, $\omega_h = 0.8$.

Flexible-price model without capital adjustment costs: Ramsey optimal policy

- The steady state value of capital requirements is $\bar{k}^m = 0.1678$.
- Welfare gains relative to the decentralized equilibrium with $k_t^m = 0.1678\ \forall t$:

$\lambda_b, \%$	$\lambda_e, \%$	$\lambda_h, \%$	$\lambda, \%$
0.05	-0.01	0.00	0.00

- Almost no effect.
  - The price of capital is fixed—no financial amplification/accelerator.
  - First-best cannot be achieved.

Flexible-price model *with* capital adjustment costs: Ramsey optimal policy

- Now $\phi_k = 2.4$.
- Welfare gains:

$\lambda_b, \%$	$\lambda_e, \%$	$\lambda_h, \%$	$\lambda, \%$
0.14	0.39	-0.03	0.03

- λ changes from 0.00 to 0.05 when ϕ_k changes from 0 to 50 with a step 0.05.

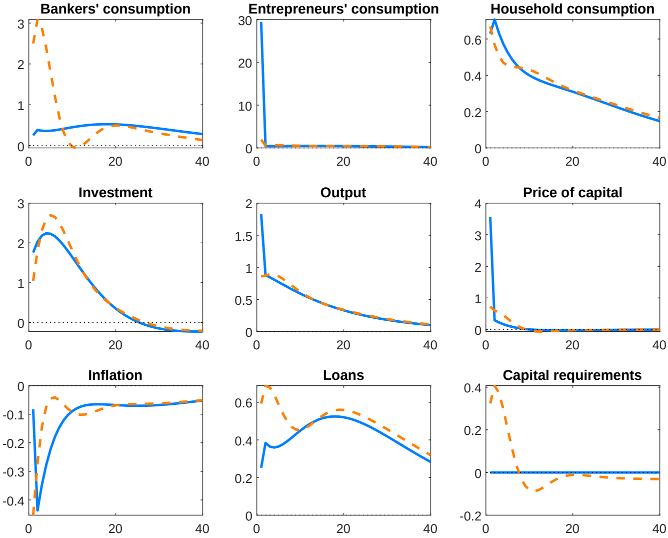
Sticky-price model with capital adjustment costs: Ramsey optimal policy

- Welfare gains:

$\lambda_b, \%$	$\lambda_e, \%$	$\lambda_h, \%$	$\lambda, \%$
0.32	8.69	0.02	0.88

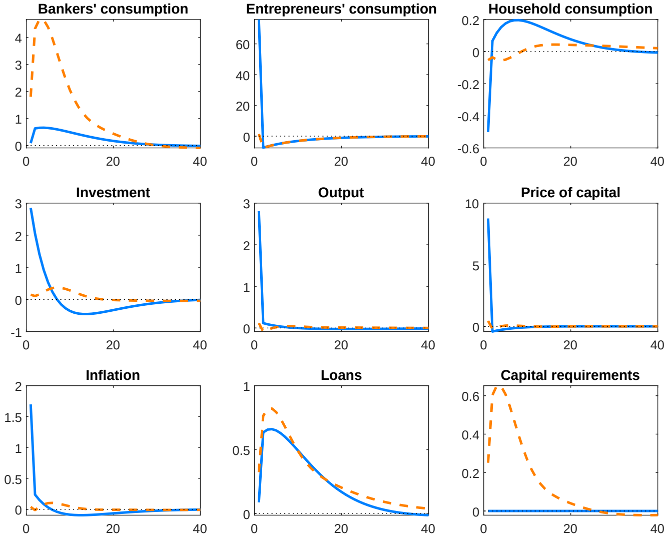
- Only with nominal rigidities the financial amplification is in full power.
- Pareto improving.

Optimal policy in the main model: 1% TFP shock



Solid: competitive equilibrium with $k_t^m = 0.17$ (steady state in the Ramsey equilibrium).
Dashed: Ramsey optimal equilibrium.

Optimal policy in the main model: 1% LTV shock



Solid: competitive equilibrium with $k_t^m = 0.17$ (steady state in the Ramsey equilibrium).
Dashed: Ramsey optimal equilibrium.

Optimal policy in the main model

- The optimal policy is countercyclical and has a striking impact.
- The financial amplification is dampened significantly, which alleviates the inefficiency of the binding collateral constraint.
- Bankers' net worth and consumption is necessarily more volatile under dynamic capital requirements.
- Household consumption is less volatile, but inflation *is* after TFP shocks.

Sub-optimal practical rules

- Consider policy rules of the form

$$k_t^m = k^m + \nu \left(\frac{x_t}{x} - 1 \right)$$

or

$$k_t^m = k^m + \nu \left(x_t - x \right),$$

where $\nu \in \mathbb{R}$ is a response parameter, x_t is a targeted indicator, and x is its steady state value.

- As x_t: loans, loans-to-output ratio, price of capital and output, both their current values and lags up to four.
- Choose $\nu \in [-5, 5]$ to maximize $\mathbb{E}(\mathcal{W})$.

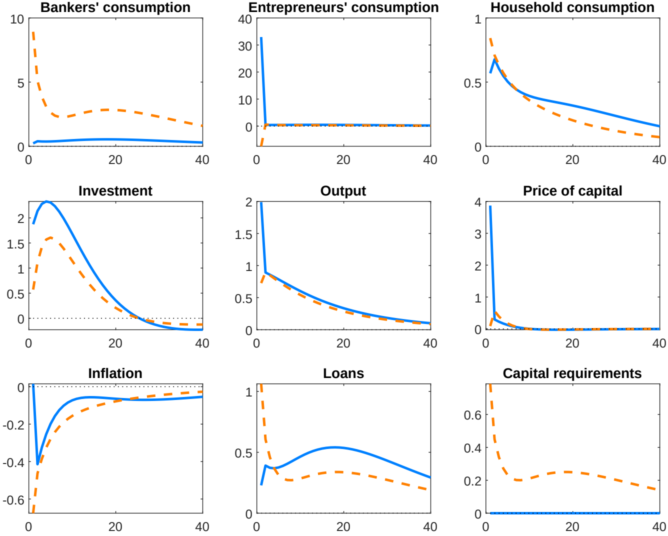
Optimized rule based on loans

Table: Welfare gains under the optimized rule based on loans

ω_h	ν	$\lambda_b, \%$	$\lambda_e, \%$	$\lambda_h, \%$	$\lambda, \%$	Lag
0.0	0.74	-0.16	8.32	0.05	4.21	0
0.1	0.74	-0.16	8.32	0.05	3.78	0
0.2	0.74	-0.16	8.32	0.05	3.35	0
0.3	0.74	-0.16	8.32	0.05	2.92	0
0.4	0.74	-0.16	8.32	0.05	2.49	0
0.5	0.74	-0.16	8.32	0.05	2.06	0
0.6	0.74	-0.16	8.32	0.05	1.68	0
0.7	0.74	-0.16	8.32	0.05	1.26	0
0.8	0.74	-0.16	8.32	0.05	0.82	0
0.9	0.74	-0.16	8.32	0.05	0.42	0
1.0	-1.32	-36.56	6.23	0.14	0.08	1

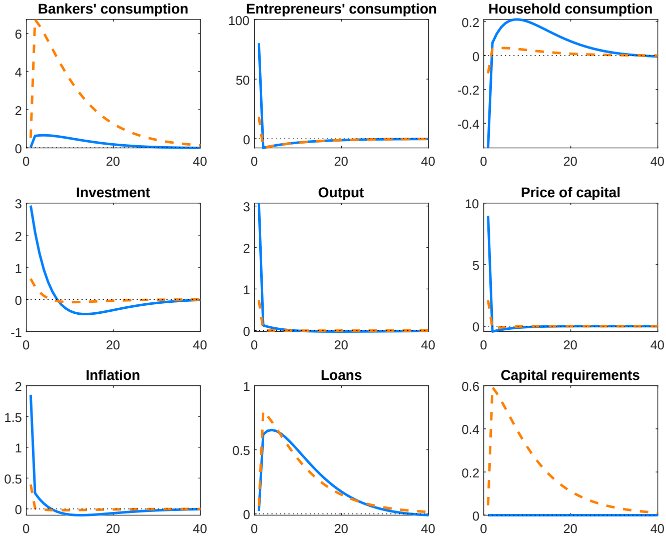
Note: ν maximizes $\mathbb{E}(\mathcal{W})$; $\omega_b = \omega_e = 0.5(1 - \omega_h)$.

Optimized rule based on loans: 1% TFP shock



Solid: competitive equilibrium with $k_t^m = 0.1$ (steady state).
Dashed: Optimized policy rule.

Optimized rule based on loans: 1% LTV shock



Solid: competitive equilibrium with $k_t^m = 0.1$ (steady state).
Dashed: Optimized policy rule.

Consumption volatilities under optimized rules

Table: Standard deviations of consumption under optimized rules

	$k_t^m = 0.1$	L	L/Y	Q	Y
Bankers	0.001	0.008	0.016	0.008	0.008
Entrepreneurs	0.036	0.011	0.013	0.007	0.022
Households	0.020	0.017	0.028	0.019	0.018

Note: $\omega_b = 0.1$, $\omega_e = 0.1$, $\omega_h = 0.8$.

Conclusion

- Countercyclical bank capital requirements are Ramsey optimal.
- The optimal policy is Pareto improving.
  - It mitigates the inefficiency due to the binding collateral constraint.
  - Entrepreneurs hugely gain, bankers and households—marginally.
- The optimized policy rules are *not* Pareto improving, but still countercyclical.
  - Entrepreneurs still benefit a lot.
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