HBANK:
Monetary Policy with Heterogeneous Banks

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- Builds on our prior work (Jamilov and Monacelli, 2025) and the Gertler and Kiyotaki (2010); Gertler and Karadi (2011) class of models.
- Burgeoning literature on bank heterogeneity (Corbae and D'Erasmo, 2021; Bianchi and Bigio, 2022; Begenau and Landvoigt, 2022; Coimbra and Rey, 2023; Goldstein et al., 2024; Mendicino et al., 2024).

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- Automatic micro-pru policy that targets large banks mitigates the trade-off.
- Application to the 2021-2023 U.S. inflation and regional banking crisis episode.

Model

Overview

- Time is discrete and infinite.
- Unit-mass continuum of heterogeneous banks, indexed by j.
- Representative household.
- Representative capital good producer.
- New Keynesian block, Phillips curve.
- Monetary authority.
- Prudential authority.

HOUSEHOLD

Preferences:

$$\max \mathbb{E}_t \sum_{s=0}^{\infty} \beta^s \mathcal{U}\left(C_{t+s}, H_{t+s}\right)$$

Budget constraint:

$$C_t + \int_0^1 b_{j,t} dj \leq H_t W_t + \int_0^1 R^b_{j,t} b_{j,t-1} dj + Div_t + T_t$$

GHH period utility:

$$\mathcal{U}(C_t, H_t) = \log\left(C_t - \chi_1 \frac{H_t^{1+\chi_2}}{1+\chi_2}\right)$$

Capital Good Producer

The market for new capital, K_{t+1}, is intermediated by total bank credit, L_t:

$$K_{t+1} = L_t$$

Capital supply side:

$$K_{t+1} = \Phi(I_t), \quad \Phi' > 0 \quad \Phi'' < 0$$

Tobin's Q:

$$\max_{I_{z,t}} Q_t \Phi(I_{z,t}) - I_{z,t}\,, \quad Q_t = \left[\Phi'(I_t)\right]^{-1}$$

BANKS

Balance sheet constraint:

$$b_{j,t} + n_{j,t} = Q_t l_{j,t}$$

Idiosyncratic return risk:

$$R^T_{j,t} = \xi_{j,t} R^k_t\,, \quad \xi_{j,t} = \rho_\xi \bar{\xi} + (1-\rho_\xi)\xi_{j,t-1} + \varepsilon_{j,t}\,, \quad \varepsilon_{j,t} \overset{\text{i.i.d.}}{\sim} \mathcal{N}(0, \sigma^2_\xi)$$

Law of motion of net worth:

$$n_{j,t+1} = R^T_{j,t+1} Q_t l_{j,t} - R^b_{j,t+1} b_{j,t} - \zeta_1 l^{\zeta_2}_{j,t}$$

Scale variance property: $\zeta_2 > 1$.

Leverage constraint:

$$\lambda_{j,t} Q_t l_{j,t} \leq V_{j,t}$$

Bank-level insolvency probability:

$$\varphi_{j,t} = \mathbb{E}_t\Big(\Pr\left(n_{j,t+1} \leq 0\right)\Big)$$

Aggregate un-recovered bank assets conditional on insolvency:

$$S_t = \int s_{j,t} dj \equiv \int \omega_1 \varphi_{j,t} l_{j,t}^{\omega_2} dj\,, \quad \omega_1 = 28\%\,, \quad \omega_2 > 1$$

Aggregate resources lost due to insolvency: $\underline{Y}_t = \psi S_t$, $\psi > 0$ and $\tilde{S}_t \equiv \underline{Y}_t / Y_t$.

Realized return on capital net of default costs:

$$R^k_{t+1} = \frac{(1-\tilde{S}_t)\alpha A_{t+1} K^{\alpha-1}_{t+1} H^{1-\alpha}_{t+1}}{Q_t}$$

Uninsured deposit pricing:

$$1 = \Big[(1-\varphi_{j,t})\mathbb{E}_t(\Lambda_{t+1}|\textit{no default}) + \varphi_{j,t}\mathbb{E}_t(\Lambda_{t+1}\omega_1|\textit{default})\Big] \times R^b_{j,t+1}$$

Dynamic Banking Problem

$$V(n,\xi;\Gamma) = \max_{\{l,b,n'\}\geq 0} \left\{ \beta \mathbb{E}\left[\Big(1-\varphi(n,\xi)\Big)\Big((1-\sigma)n' + \sigma V(n',\xi';\Gamma'|\xi,\Gamma)\Big)\right] \right\}$$

subject to:

$$n' = \mathbb{E}\left[R^{k'}\left(\Gamma'|\Gamma\right)\xi'\right] Q(\Gamma)l - R^b(n,\xi)b - \zeta_1 l^{\zeta_2}$$

$$b + n = Q(\Gamma)l$$

$$\lambda Q(\Gamma)l \leq V(n,\xi;\Gamma)$$

$$1 = \left[(1-\varphi(n,\xi))\mathbb{E}(\Lambda') + \varphi(n,\xi)\mathbb{E}(\Lambda'\omega_1)\right] R^b(n,\xi)$$

$$\xi' = \rho_\xi \bar{\xi} + (1-\rho_\xi)\xi + \varepsilon'$$

$$\Gamma' = \mathcal{F}(\Gamma)$$

Retailers with Rotemberg adjustment costs:

$$Y_t = \left(\int_0^1 y_{i,t}^{\frac{\gamma-1}{\gamma}} di\right)^{\frac{\gamma}{\gamma-1}} \quad , \qquad y_{i,t} = A_t K_{i,t}^{\alpha} H_{i,t}^{1-\alpha}, \quad 0 < \alpha < 1$$

$$P_t = \left(\int_0^1 p_{i,t}^{1-\gamma} di\right)^{\frac{1}{1-\gamma}} \quad , \qquad y_{i,t} = \left(\frac{p_{i,t}}{P_t}\right)^{-\gamma} Y_t$$

NK Phillips curve:

$$\log \Pi_t = \frac{\gamma - 1}{\vartheta}(\log MC_t - \log MC_{ss}) + E_t\left[\Lambda_{t+1} \log \Pi_{t+1}\right]$$

Monetary policy via a Taylor rule:

$$i_t = \bar{r} + \varphi_\pi \pi_t + v_t$$

Automatic macro- or micro-prudential regulation:

$$\lambda_{j,t+1} = \lambda_j \left(\frac{s_{j,t+1}}{s_j} \right)^{\varphi}, \quad \varphi > 0$$

Micro-pru policy targets either the top 25% or the bottom 75% of banks by net worth.

Macro-pru policy targets the entire distribution.

Market Clearing

Credit market clearing:

$$\int_{\xi}\int_{n} n^{*}(n,\xi)\Gamma_{t-1} dn d\xi + \int_{\xi}\int_{n} b^{*}(n,\xi)\Gamma_{t} dn d\xi = Q_t \int_{\xi}\int_{n} l^{*}(n,\xi)\Gamma_{t} dn d\xi$$

Capital market clearing:

$$K_{t+1} = \int_{\xi}\int_{n} l^{*}(n,\xi)\Gamma_{t} dn d\xi$$

Goods market clearing:

$$Y_t = C_t + \underline{Y}_t + \Theta_t$$

The Distribution of Banks

Optimal lending choice:

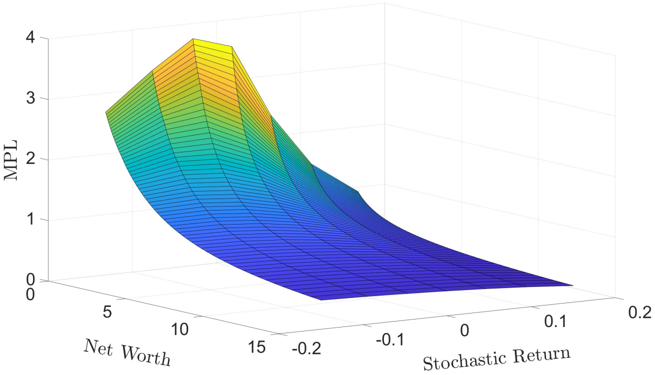
$$l^*(n,\xi;\Gamma) = \frac{\mathbb{E}\left\{\Omega\left(R^b(n,\xi)n - \zeta_1 l^{\zeta_2}\right)\right\}}{Q(\Gamma)\left(\lambda - \mathbb{E}\left\{\Omega\left(R^{k'}(\Gamma'|\Gamma)\xi' - R^b(n,\xi)\right)\right\}\right)}$$

where $\Omega \equiv \left(1-\varphi(n,\xi)\right)\beta\left(1-\sigma+\sigma\frac{V(n',\xi';\Gamma'|\xi,\Gamma)}{n'}\right)$

The marginal propensity to lend in HBANK:

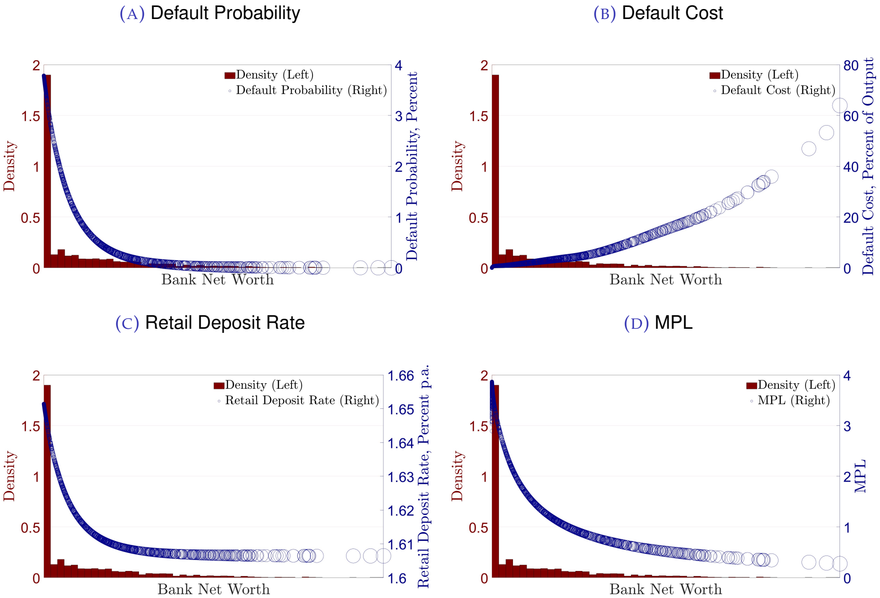
$$MPL(n,\xi) = \frac{\mathbb{E}\left\{\Omega R^b(n,\xi)\right\}}{Q(\Gamma)\left(\lambda - \mathbb{E}\left\{\Omega\left(R^{k'}(\Gamma'\Gamma)\xi' - R^b(n,\xi)\right) + \zeta_1\zeta_2 l^{\zeta_2-1}\right\}\right)}$$

MPL Heterogeneity in HBANK



Notes: Bank-specific marginal propensities to lend as a function of net worth and idiosyncratic returns.

Stationary Distributions



Notes: XXX.

Aggregate Transition Dynamics

Transitions with sequence-space methods (Boppart et al., 2018; Auclert et al., 2021).

Derive the intertemporal law of motion of bank net worth:

$$n_t(j) = \sum_{s=1}^{\infty} \left[\left(E_{j,t+s} - \mu_{j,t+s} Q_{t+1} l_{j,t+s} \right) \prod_{\ell=1}^{s} R^{b}_{j,t+\ell}{}^{-1} \right]$$

where $E_{j,t} \equiv \zeta_1 l_{j,t}^{\zeta_2}$ are non-interest expenses and $\mu_{j,t} \equiv R^k_t \xi - R^b_{j,t}$ are excess returns.

To solve for the lending sequence the only required input is the excess return μ:

$$\{r^k_s, r_s\}_{s=0}^{\infty}$$

Sufficient statistics approach (Auclert, 2019).

Bank Lending Block

1. Aggregate lending function:

$$K_{t+1} = \mathcal{L}_t\left(\left\{ r^k_s(K_s, Q_s, S_s, H_s), r_s, \lambda_s \right\}_{s=0}^{\infty} \right) = \int_\xi \int_n l^*(n, \xi)\Gamma_t dn d\xi$$

General-equilibrium impulse response:

$$d\mathbf{K} = \Big(\underbrace{\mathbf{I} - \mathbf{F}_K}_{\text{GE Multiplier}} \Big)^{-1} \Big(\underbrace{\mathbf{F}_r d\mathbf{r}}_{\text{Monetary Policy}} + \underbrace{\mathbf{F}_\lambda d\lambda}_{\text{Prudential Reaction}} \Big)$$

where entries of $\mathbf{F}_K$ are: $[\mathbf{F}_K]_{t,s} = \frac{\partial \mathcal{L}_t}{\partial r^k_{s+1}} \left(\frac{\partial r^k_{s+1}}{\partial K_s} + \frac{\partial r^k_{s+1}}{\partial Q_s}\frac{\partial Q_s}{\partial K_s} + \frac{\partial r^k_{s+1}}{\partial S_s}\frac{\partial S_s}{\partial K_s} + \frac{\partial r^k_{s+1}}{\partial H_s}\frac{\partial H_s}{\partial K_s} \right)$, of $\mathbf{F}_r$ are: $[\mathbf{F}_r]_{t,s} = \frac{\partial \mathcal{L}_t}{\partial r_{s+1}}$, of $\mathbf{F}_\lambda$ are $[\mathbf{F}_\lambda]_{t,s} = \frac{\partial \mathcal{L}_t}{\partial \lambda_s}$, and $\mathbf{L}$ is a lag operator.

Compute numerically: derivatives $\frac{\partial \mathcal{L}_t}{\partial r^k_{s+1}}, \frac{\partial \mathcal{L}_t}{\partial r_{s+1}}, \frac{\partial \mathcal{L}_t}{\partial \lambda_s}, \frac{\partial S_s}{\partial K_s}$. Compute the remaining derivatives analytically.

2. Aggregate default cost function:

$$S_t = \mathcal{S}_t\left(\left\{ r^k_s(K_s, Q_s, S_s, H_s), r_s, \lambda_s \right\}_{s=0}^{\infty} \right) = \int_\xi \int_n s^*(n, \xi)\Gamma_t dn d\xi$$

General-equilibrium impulse response:

$$d\mathbf{S} = \underbrace{\mathbf{X}_K d\mathbf{K}}_{\text{Equilibrium Capital}} + \underbrace{\mathbf{X}_r d\mathbf{r}}_{\text{Monetary Policy}} + \underbrace{\mathbf{X}_\lambda d\lambda}_{\text{Prudential Reaction}}$$

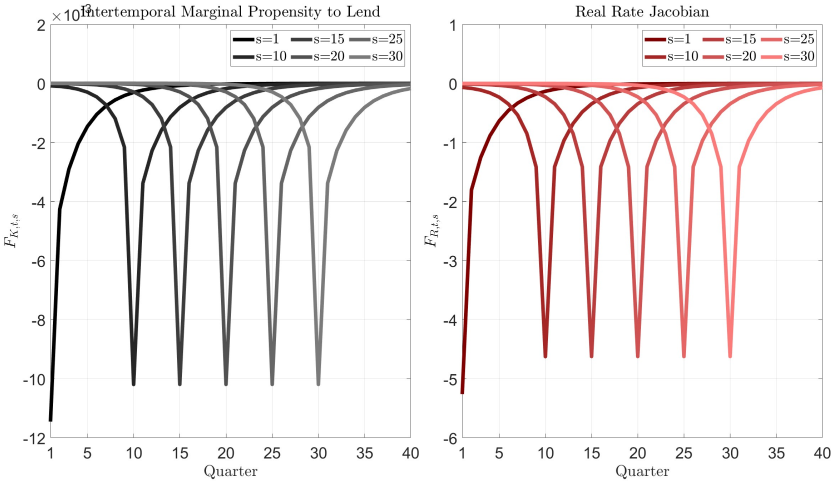
where entries of $\mathbf{X}_K$ are: $[\mathbf{X}_K]_{t,s} = \frac{\partial \mathcal{S}_t}{\partial r^k_{s+1}}\left(\frac{\partial r^k_{s+1}}{\partial K_s} + \frac{\partial r^k_{s+1}}{\partial Q_s}\frac{\partial Q_s}{\partial K_s} + \frac{\partial r^k_{s+1}}{\partial S_s}\frac{\partial S_s}{\partial K_s} + \frac{\partial r^k_{s+1}}{\partial H_s}\frac{\partial H_s}{\partial K_s}\right)$, of $\mathbf{X}_R$ are: $[\mathbf{X}_R]_{t,s} = \frac{\partial \mathcal{S}_t}{\partial r_{s+1}}$, and of $\mathbf{X}_\lambda$ are $[\mathbf{X}_\lambda]_{t,s} = \frac{\partial \mathcal{S}_t}{\partial \lambda_s}$.

Compute numerically: derivatives $\frac{\partial \mathcal{S}_t}{\partial r^k_{s+1}}$, $\frac{\partial \mathcal{S}_t}{\partial r_{s+1}}$, and $\frac{\partial \mathcal{S}_t}{\partial \lambda_s}$. The path d**K** and all the other derivatives are unchanged.

EQUILIBRIUM CONSTRUCTION

1. Compute the Jacobians $\mathbf{F}_K$, $\mathbf{F}_R$, $\mathbf{F}_\lambda$ and $\mathbf{X}_K$, $\mathbf{X}_R$, $\mathbf{X}_\lambda$.
2. Compute the general-equilibrium sequence of capital $d\mathbf{K}$.
3. The real rate ($d\mathbf{R}$) and prudential policy ($d\lambda$) sequences are fixed points.
4. Given $d\mathbf{K}$, compute the equilibrium sequence $d\mathbf{S}$. Given $d\mathbf{K}$ and $d\mathbf{S}$, recover every other object of interest:
   - 4.1 Given equilibrium $d\mathbf{K}$, compute the price of capital $d\mathbf{Q}$.
   - 4.2 Recover labor supply $d\mathbf{H}$ from GHH utility.
   - 4.3 Compute aggregate output $d\mathbf{Y}$ using $d\mathbf{H}$ and $d\mathbf{K}$.
   - 4.4 Compute the marginal cost, inflation, and the real wage.
   - 4.5 Compute consumption $d\mathbf{C}$ net of default costs and price adjustment costs.

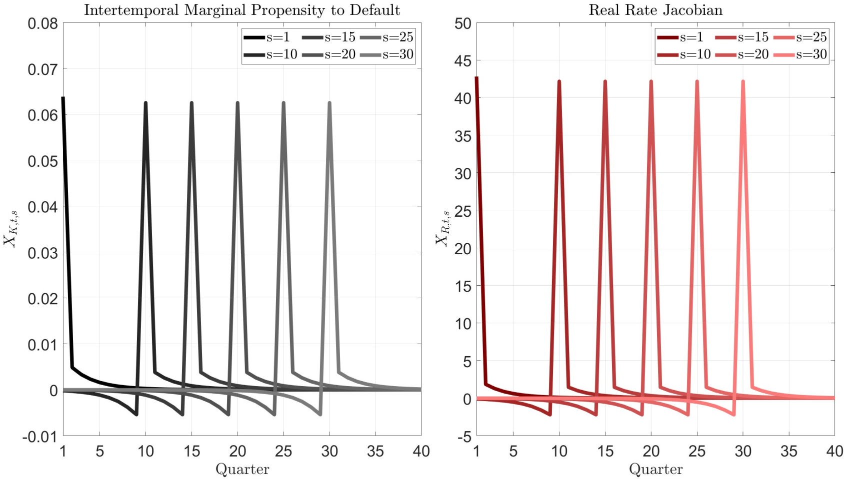
Capital Jacobians, F



Notes: Jacobians of aggregate capital with respect to capital (left panel) and the real interest rate (right panel).

Micropru Policy Jacobians

DEFAULT COST JACOBIANS, X



Notes: Jacobians of bank default costs with respect to aggregate capital (left panel) and the real interest rate (right panel).

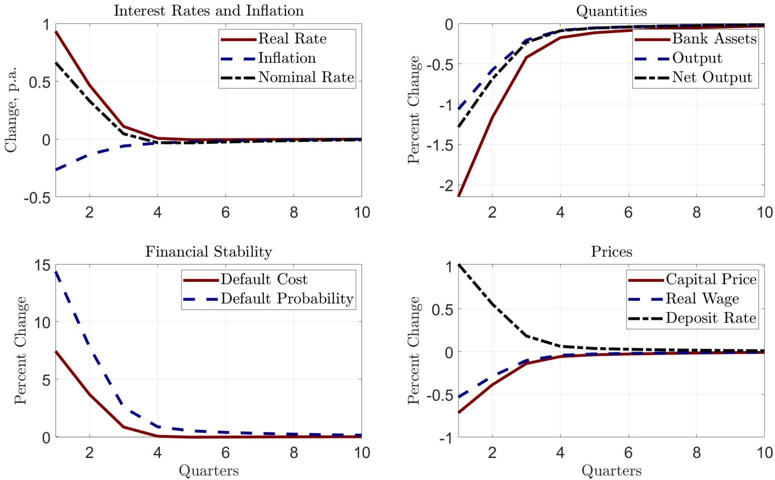
▸ Micropru Policy Jacobians

Non-Systematic Monetary Policy

Calibration

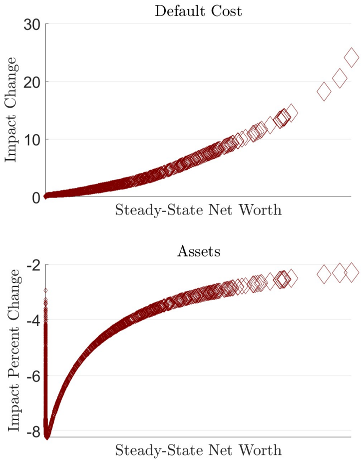
Parameter	Description	Value	Target/Source
		Households	
β	Discount factor	0.996	Internally calibrated
χ_1	Labor disutility	1.82	Labor supply = 1
χ_2	Labor supply elasticity	1	Kaplan et al. (2018)
		Banks	
σ	Bank survival rate	0.973	Gertler and Kiyotaki (2010)
ζ_1	Non-interest expense, linear	0.0024	Non-interest cost to assets ratio = 0.05
ζ_2	Non-interest expense, quadratic	2	Normalization
ρ_ξ	Idiosyncratic risk, persistence	0.553	Call Reports
σ_ξ	Idiosyncratic risk, volatility	0.04	Average default probability = 2%
ω_1	Default cost, linear	0.28	Granja et al. (2017)
ω_2	Default cost, quadratic	2	Normalization
ψ	Resource cost of default	0.0086	Default cost to output ratio = 2.5%
		Firms	
α	Capital share	0.36	Standard
a	Production technology	2.65	Steady-state capital price = 1
b	Production technology	0.25	Price elasticity of lending = 0.25
Υ	Demand elasticity	10	Standard
ϑ	Price adjustment cost	90	Slope of the Phillips curve = 0.1
		Monetary and Prudential Policy	
φ_π	Taylor rule coefficient	1.25	Standard
$\bar{r}$	Steady-state real rate target	1.6% p.a.	Standard
φ	Prudential policy rule	10	Internally calibrated
λ	Steady-state leverage policy	0.02	Average bank leverage ratio = 10

Aggregate Response to Monetary Policy



Notes: impulse responses to a monetary shock that increases the nominal interest rate by 0.25 percent on impact, with quarterly persistence of 0.5.

HETEROGENEOUS RESPONSES TO MONETARY POLICY



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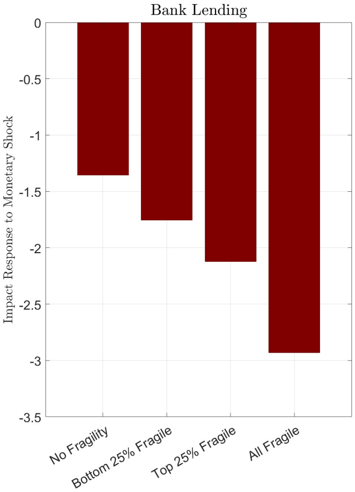
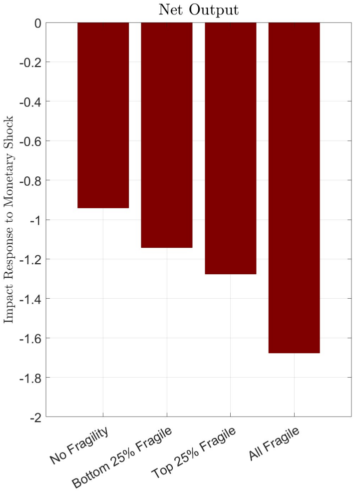
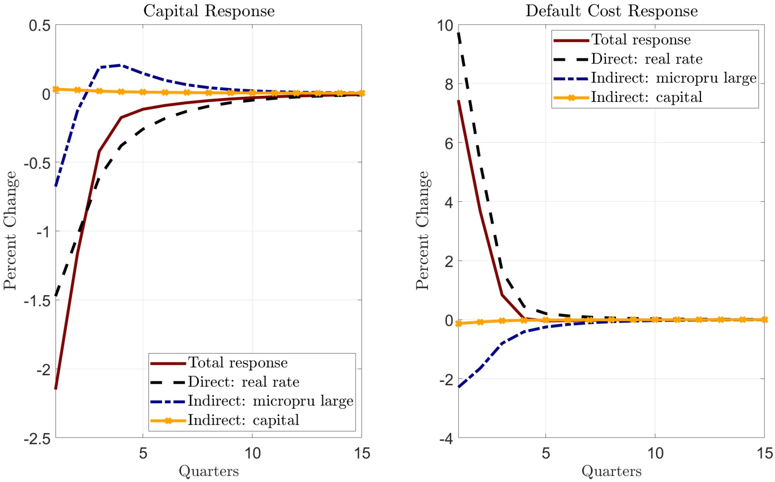
Distributional State-Dependency





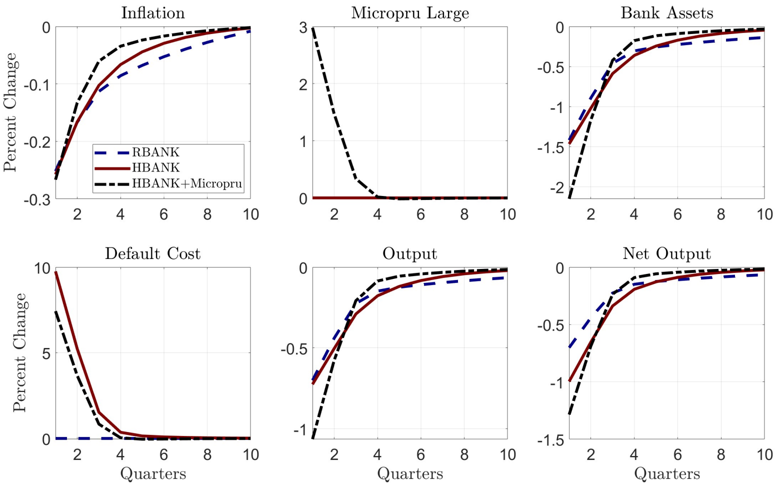
Notes: impact responses to a contractionary monetary shock for different levels of the underlying distribution of banks.

Direct-Indirect Effects Decomposition



Notes: Decomposition of the total response to a contractionary monetary shock into direct and indirect effects.

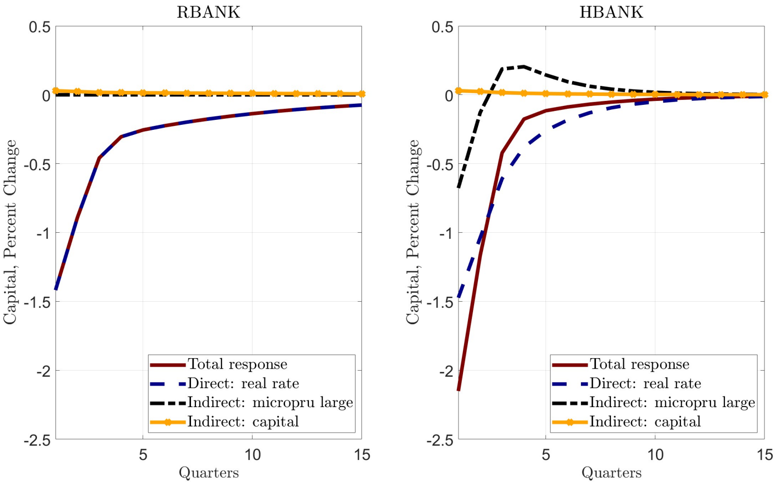
Monetary Policy in HBANK vs RBANK



Notes: Responses to a contractionary monetary shock in HBANK and RBANK.

Cumulative Impulse Responses

PE vs GE Decomposition in HBANK and RBANK



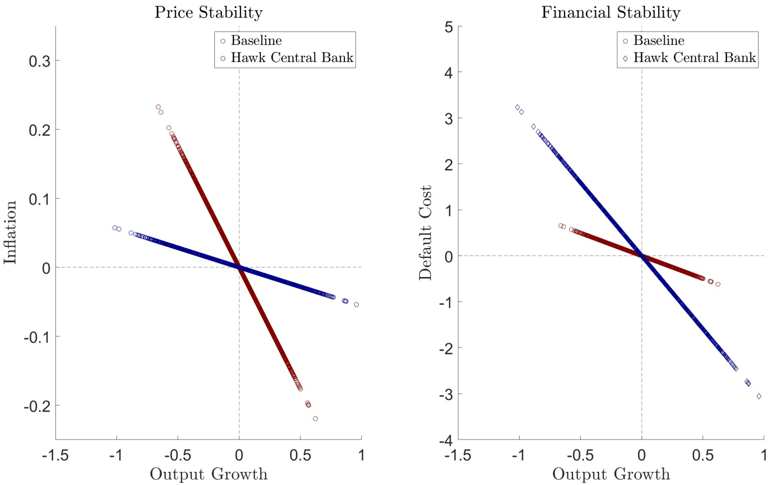
Notes: Decomposition of the total response to a contractionary monetary shock into direct and indirect effects, in HBANK and RBANK.

Taking Stock

- The distributions of bank size and financial fragility matter for monetary policy transmission.
- Monetary policy is amplified in HBANK — stronger direct effect (response to the real rate impulse) due to endogenous insolvency risk.
- Automatic micro-prudential reaction — powerful (indirect) amplifying channel of monetary policy.
- No need for automatic regulation of the whole sector; target only the largest banks.

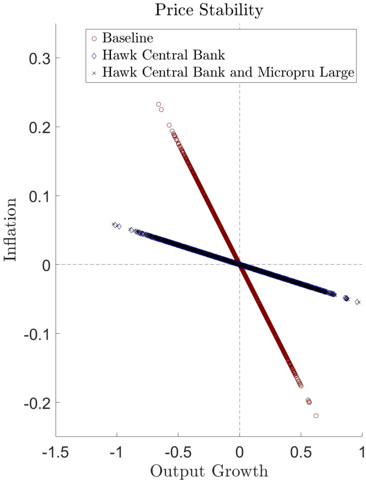
Systematic Monetary Policy

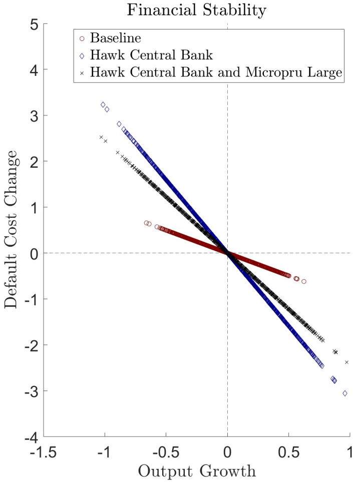
MACROECONOMIC-FINANCIAL STABILIZATION TRADE-OFF



Notes: Long simulations with TFP shocks (persistence 0.9 and volatility 0.01) as the only aggregate disturbance.

Systematic Micro-Pru Policy for Large Banks





Notes: Micro-pru large targets only the largest 25% of banks by net worth.

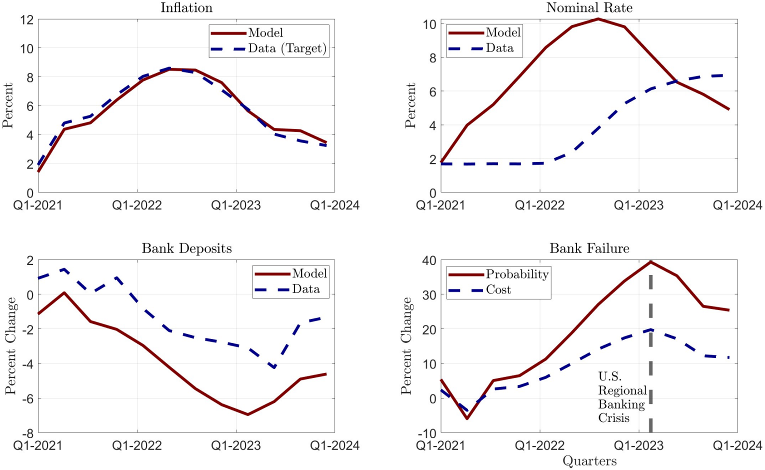
▸ Impulse Responses to TFP Shocks
▸ Micro-Pru Policy for Small Banks
▸ Simulation with Demand Shocks

Taking Stock

- There is a trade-off between macroeconomic stabilization and financial stability for the central bank.
- Inflation targeting stabilizies prices but worsens financial fragility.
- Systematic micro-pru policy targeting large banks tames the trade-off with minimal effects on price stability.
- Micro-pru potentially less costly, more efficient in practice than macro-pru.
- The Tinbergen principle in action: monetary policy for price stability, micro-prudential policy for financial stability when the distribution of banks is concentrated.

The 2021-2023 U.S. Inflation and Banking Crisis

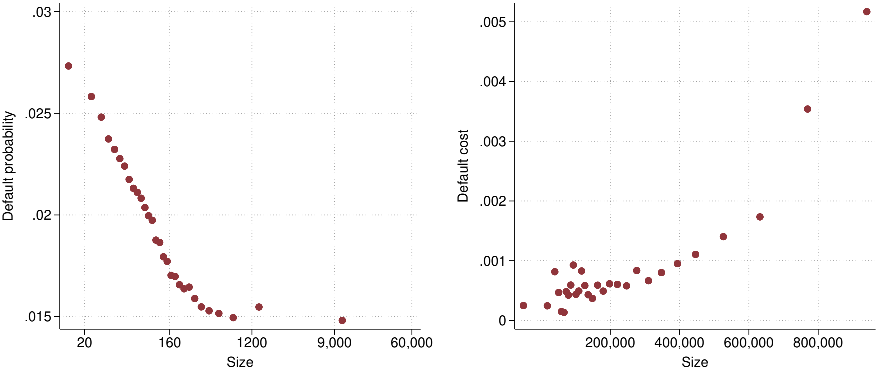
2021-2023 Event Study Analysis



Model-generated inflation surge, followed by delayed financial fragility and deposit withdrawals.

Empirical Support

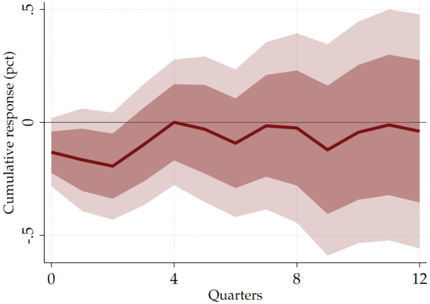
Bank Default Risk and Default Cost in the Distribution



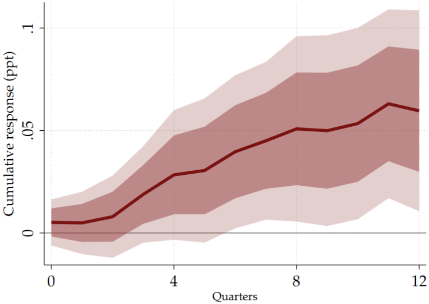
(A) Default probability (B) Default cost

Notes: binned scatter plots of default probability (panel (a)) and default cost (panel (b)) against bank size. We proxy default probability with the inverse z-score (Laeven and Levine, 2009) and default cost with the 95% dollar CoVaR from Adrian and Brunnermeier (2016). Both axes are residualized from time fixed effects.

Aggregate Response to Monetary Shocks

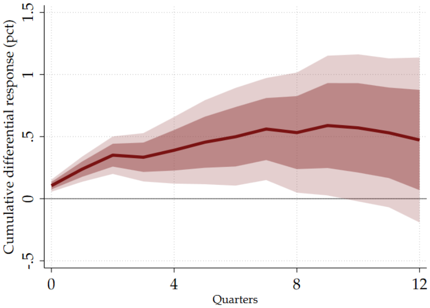


(A) Assets

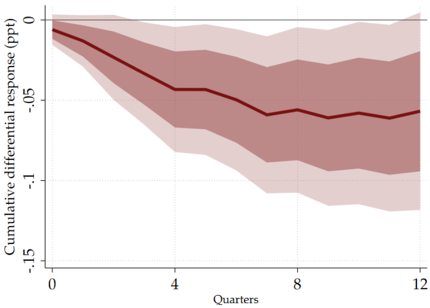


(B) Default Risk

Notes: estimated ψ_h from: $\Delta Y_{it+h} = \alpha_{ih} + \psi_h \varepsilon_t + \sum_{\ell=1}^{4} \gamma_{h\ell} \Delta Y_{it-\ell} + \sum_{\ell=1}^{4} \varphi_{h\ell} X_{t-\ell} + u_{iht}$. Responses to a one-standard-deviation contractionary monetary shock. The y-axis represents the cumulative percentage change in total real assets in panel (a) and the cumulative level change in default probability — as proxied by the inverse z-score — in panel (b). Standard errors are two-way clustered at the time and bank level. Shaded areas represent 90% and 68% confidence bands.



(A) Assets



(B) Default Risk

Notes: estimated β_h from: $\Delta Y_{it+h} = \underbrace{\alpha_{ih} + \delta_{th}}_{\text{Fixed effects}} + \underbrace{\beta_h \times D_{it} \times \varepsilon_t}_{\text{Size interaction}} + \underbrace{\varphi_h D_{it}}_{\text{Interaction controls}} + \underbrace{\sum_{\ell=1}^{4} \gamma_{h\ell} \Delta Y_{it-\ell}}_{\text{Lagged controls}} + u_{iht}$. Responses to a one-standard-deviation contractionary monetary shock. The y-axis represents the cumulative percentage change in total real assets in panel (a) and the cumulative level change in default probability — as proxied by the inverse z-score — in panel (b) for banks in the top 10% of the asset distribution, relative to those in the bottom 90%. Standard errors are two-way clustered at the time and bank level. Shaded areas represent 90% and 68% confidence bands.

Taking Stock

- In the data, default likelihood (cost) is systematically falling (increasing) with bank size.
- The aggregate empirical response to monetary shocks masks rich cross-sectional heterogeneity.
- Small banks are more responsive to monetary shocks both in terms of size and insolvency risk.
- Empirical findings are consistent with HBANK's predictions and with the literature (Kashyap and Stein, 1995, 2000; Kishan and Opiela, 2000).

CONCLUSION

HBANK: a tractable, quantitative New-Keynesian framework for monetary and prudential policy analysis with heterogeneous banks.

Endogenous and costly bank default risk — a force of amplification of non-systematic monetary shocks.

Automatic micro-prudential policy — a novel indirect channel of the systematic conduct of monetary policy.

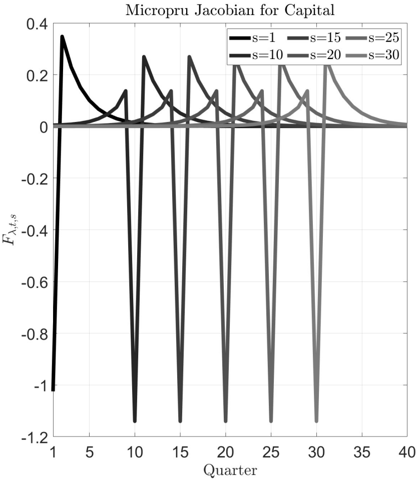
Avenues for future research:

- Open-economy extension.
- Measurement of iMPLs in the data.

Appendix

MICROPRU JACOBIANS, $\mathbf{F}_\lambda$ AND $\mathbf{X}_\lambda$

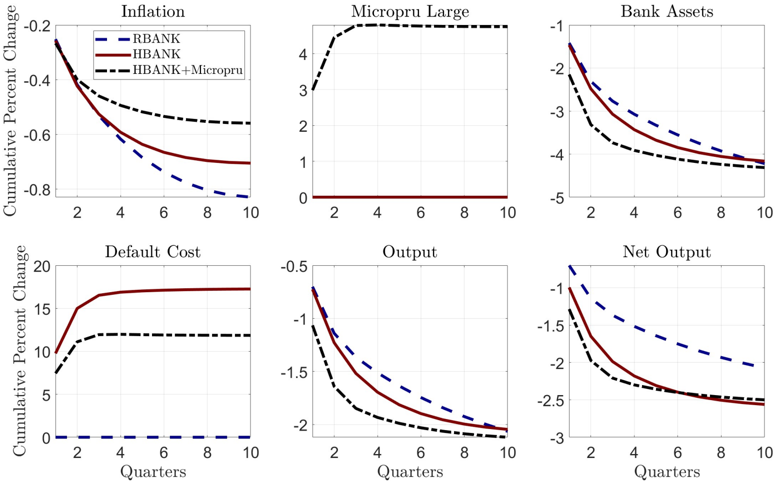
▸ BACK TO CAPITAL JACOBIANS



Notes: Jacobians of aggregate capital (left) and default costs (right) with respect to micropru large.

Cumulative Responses to Monetary Policy in HBANK and RBANK

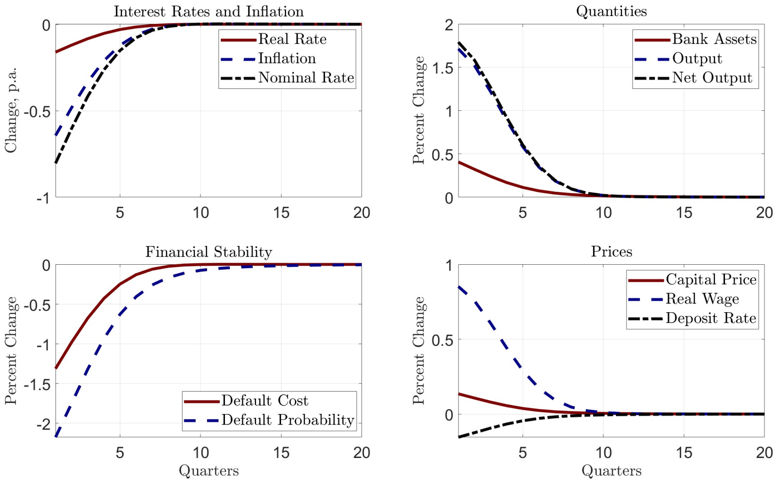
Back to Monetary Policy IRFs



Notes: cumulative impulse response functions to a monetary policy contraction

Impulse Response to TFP Shocks

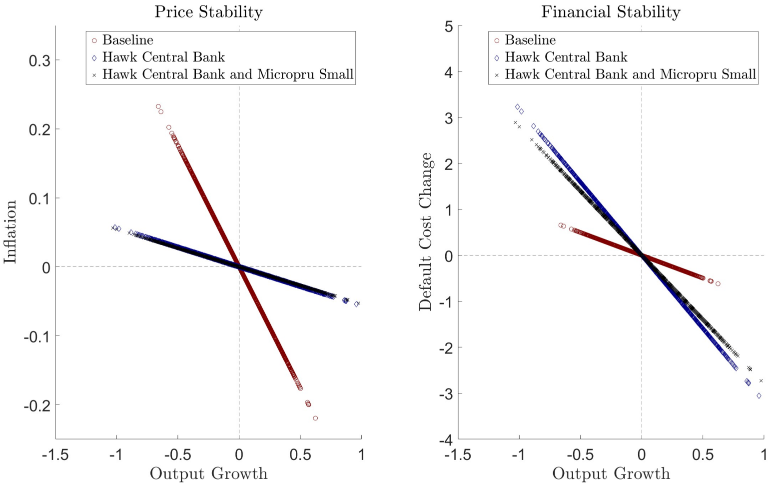
▸ Back to Trade-off



Notes: impulse response functions to an aggregate TFP shock with volatility 0.01 and persistence 0.9.

Macroeconomic-Financial Stabilization Trade-Off with Micro-Pru Policy for Small Banks

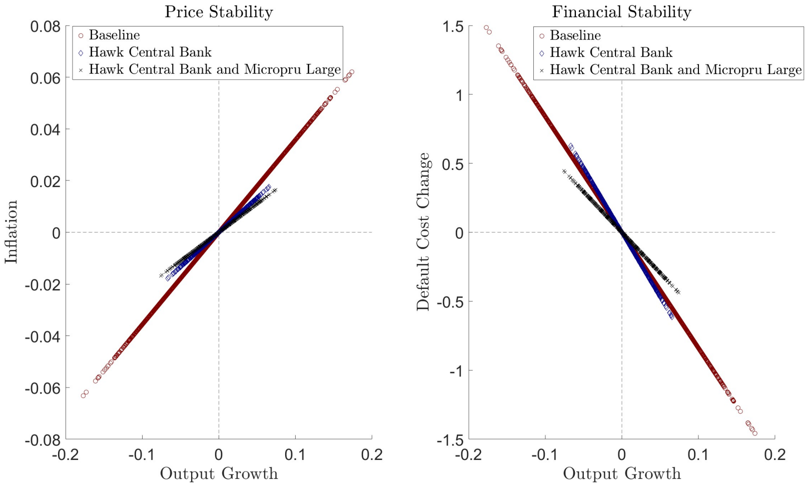
Back to Trade-off



Notes: macroeconomic-financial stabilization trade-off with automatic micro-prudential policy that targets only the smallest 75% of banks by net worth.

Macroeconomic-Financial Stabilization Trade-Off with Demand Shocks

Back to Trade-off



Notes: macroeconomic-financial stabilization trade-off with shocks to the interest rate rule as the only aggregate disturbance.

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