Money, Credit and Imperfect Competition Among Banks

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Vienna Macro Workshop, 10 September 2022

Questions

1. Why do banks charge different lending-rate markups for an identical loan product (even after conditioning for location, market and other factors)?

2. How does bank-lending market power distort the liquidity-risk insurance role of banks?

3. Market power and the *Aldrich-Vreeland Act*: What is an optimal stabilization/redistributive-liquidity policy?

Motivation I

New empirical facts. Using bank-branch level data (RateWatch, United States), we find:

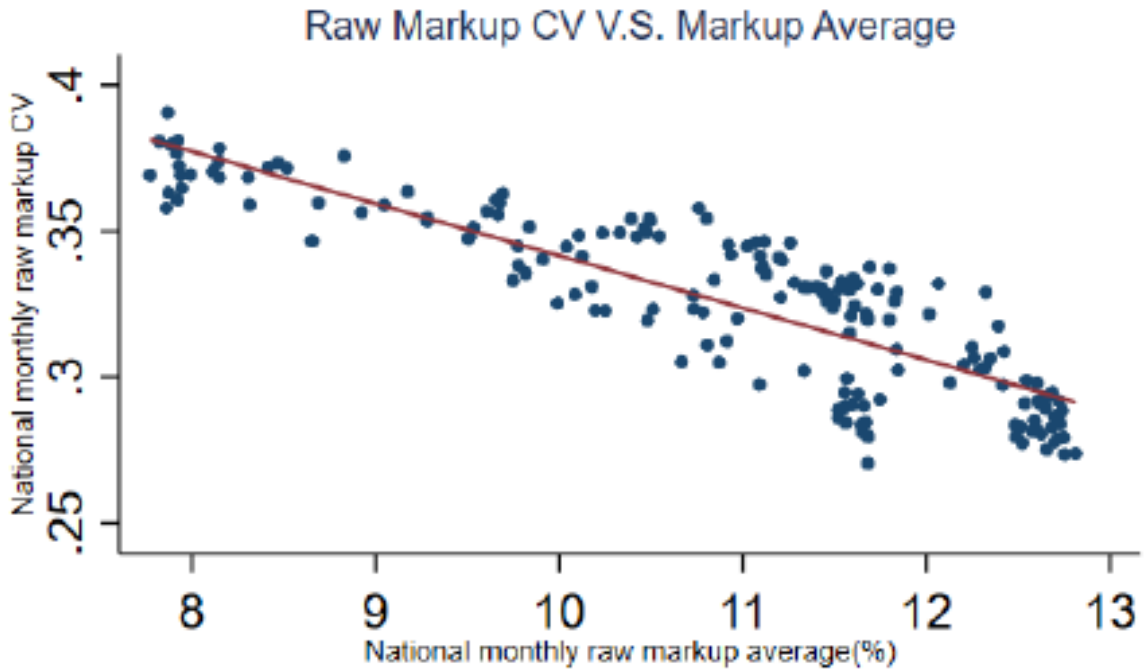
- Dispersion in bank lending-rate markups even with controls for geography and other characteristics.

Policy interests. Concerns about imperfect competition in banking among policy makers. ▸ More Evidence.

Motivation II

Markups and Dispersion

- We focus on consumers lending within a particular class of loans.
- Negative correlation between the coefficient of variation and the average level of markups in consumer loan rates. ▸ raw markup
- Pattern also holds for residual markup (after controlling for *local* confounding factors). ▸ residual markup



Our approach

- Banks reallocate liquidity among agents as in Berentsen, Camera and Waller (2007).

- One departure from Berentsen et al. (2007):
  - Bank competition in lending features a noisy search process of Burdett and Judd (1983).

  How it works:
  - Borrowers obtain a random number of loan-rate quotes (0,1,2) from banks.
  - Banks randomly match with borrowers and make loans at posted lending rates.
  - Banks face a trade-off between:
    - raising their loan rate to increase profit per customer,

      — and —

    - lowering their loan rate to increase the number of borrowers served.

- We then study (1) welfare effects of banking and (2) optimal stabilization policy.

▸ Related literature

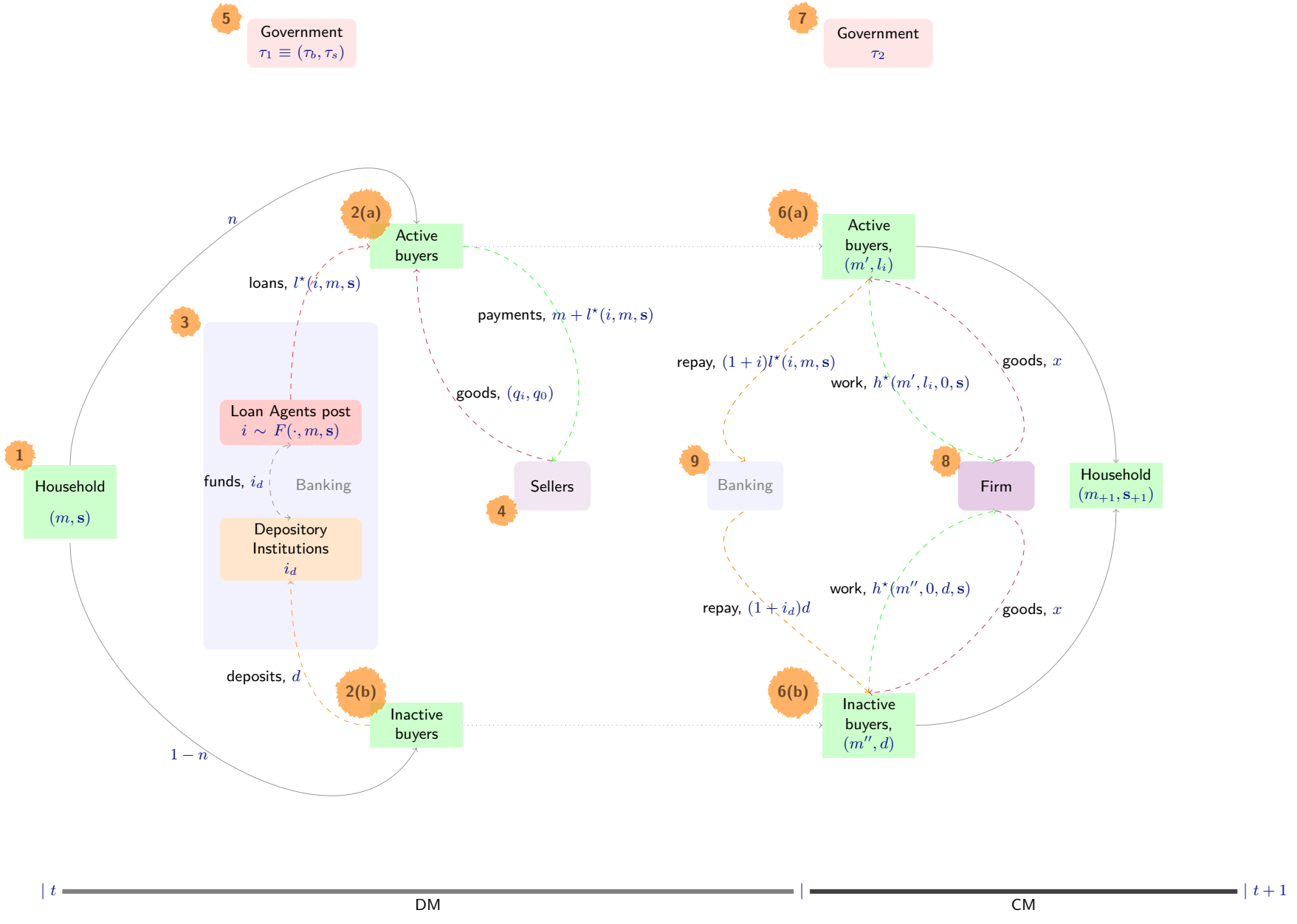
Main insight

1. A distribution of lending interest rates and associated markups in equilibrium.

2. Model prediction consistent with empirically observed relationships between dispersion and the average of loan-rate markups.

3. Optimal stabilization policy implements what is done in practice: Maintain an "elastic currency" as practiced by Central Banks, including the U.S. Fed.
   - Although historically, banking market power may not have been a motivation for such policies,
   - Here we show that the elastic-currency policy can be fine tuned to temper banking market power!

Model: overview



Model: lending banks I

- There is a common marginal cost of loanable funds, $i_d = \frac{1+\tau}{\beta} - 1$.

- Ex-ante profit from posting loan interest rate i:

$$\Pi(i) = \underbrace{n\left[\alpha_1 + 2\alpha_2 - 2\alpha_2 F(i)\right]}_{\text{extensive}} \underbrace{R(i)}_{\text{intensive}}$$

  where $R(i) = \underbrace{l^\star(m; i, p, M, \gamma)}_{\text{loan demand}} \underbrace{[i - i_d]}_{\text{interest spread}}$ is bank profit per customer served and $F(i)$ is the posted-loan-rate distribution (specified in next slide).

- Each bank (pricing at some $i \sim F$) trades off
  - intensive-margin ("gain"): $R(i)$

    — against —
  - extensive-margin ("loss"): $n[\alpha_1 + 2\alpha_2 - 2\alpha_2 F(i)]$

Model: lending banks II

Previewing equilibrium

1. All banks earn the same expected profit equal to monopolist's profit.

2. If probability of obtaining one loan-rate quote, $\alpha_1 \in (0,1)$, there is a unique non-degenerate, posted-loan-rate distribution F:

$$F(i) = 1 - \frac{\alpha_1}{2\alpha_2}\left[\frac{R\left(\bar{i}\right)}{R\left(i\right)} - 1\right],$$

   where $\text{supp}\left(F\right) = \left[\underline{i}, \bar{i}\right]$, $R(\underline{i}) = \frac{\alpha_1}{\alpha_1 + 2\alpha_2} R(\bar{i})$ and, $\bar{i} := \min\{\hat{i}, i^m\}$.

Two special cases:

- If $\alpha_2 = 1$, F is degenerate at the deposit rate i_d (perfect competition).
- If $\alpha_1 = 1$, F is degenerate at the largest possible loan rate $\bar{i}$ (monopoly).

Stationary Monetary Equilibrium

Definition

Given monetary policy τ, and taxes/transfers (τ_1, τ_2), a stationary monetary equilibrium (SME) with money and credit is a steady-state allocation $(x^\star, z^\star, Z)$ in the centralized market, allocation $(q^\star, l^\star)$ in the decentralized market, and (relative) pricing functions $(\rho, F(i))$ such that

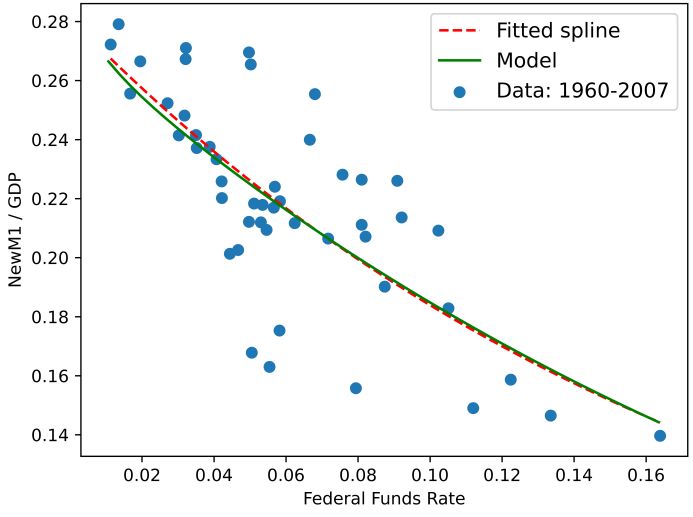
1. Households optimize ▸ Go to Appendix: Household optimizes
2. Firms optimize: ▸ Go to Appendix: Firms optimize
3. Lending banks optimize ▸ Go to Appendix: Lending banks optimize
4. Aggregate loans supplied are feasible ▸ Go to Appendix: Deposit interest is feasible
5. Goods market clears in both DM and CM ▸ Go to Appendix: Goods market clear

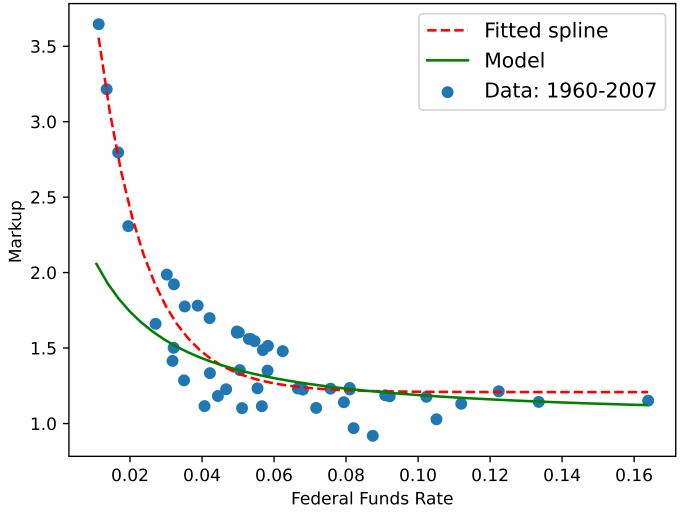
▸ Unique SME

Calibration

Some parameters externally calibrated from long-run statistics.

Internal calibration:





to pin down preference $(\bar{U}_{\text{CM}}, \sigma)$ and lender contact rates (α_0, α_1).

Data: Lucas-Nicolini (2015)
Bank Prime Loan Rate/Federal Funds Rate

Comparative Steady States

- Consider a set of economies, each distinguished by their long-run inflation rates, τ, or equivalently, the policy rate $i^{FFR} = \frac{1+\tau}{\beta} - 1$.
- How does the change in inflation rate affect:
  - Banks intensive vs. extensive margins trade-offs,
  - Lending-rate markups and dispersion, and
  - Welfare effects of banking?

Comparative Steady States

Markups and dispersion (Lemma 2, Proposition 15)

Proposition

Under regularity conditions, average loan-rate markup declines with inflation.

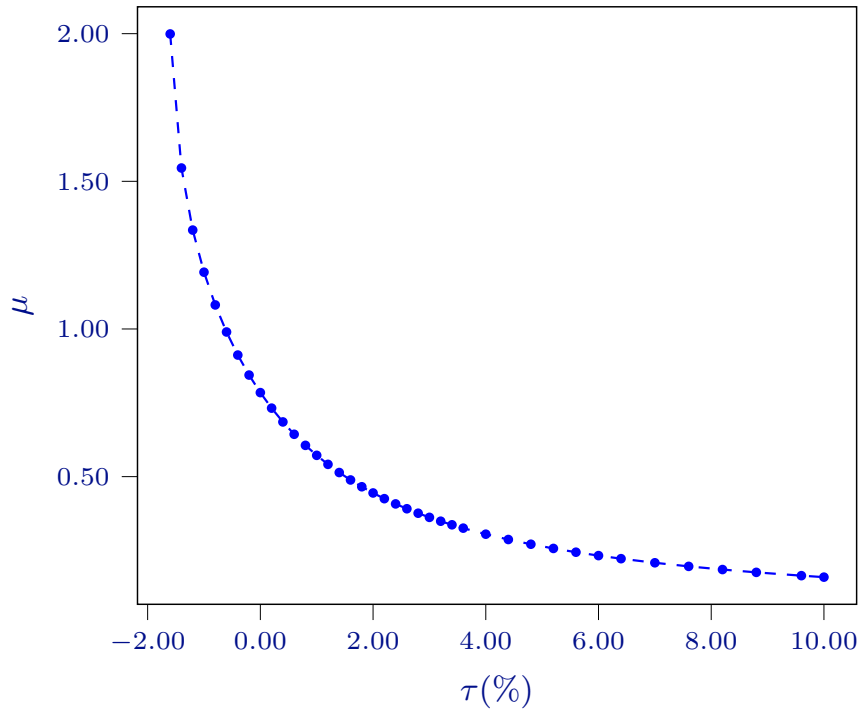


Figure: loan (percentage) markups average, $\tau \in (\beta - 1, \bar{\tau}]$

Two moving, opposing parts in average markup:

$$\mu(\tau) = (1 - \hat{\delta}) \int_{\underline{i}(\mathbf{z})}^{\bar{i}(\mathbf{z})} \left[\frac{i}{i_d(\tau)} - 1 \right] \mathrm{d}F(i, \mathbf{z}),$$

Numerator (average loan rate).

One paw:

- Higher inflation τ, lower real money balance, expect borrowers to take out more loans.
- Lemma 2 (FOSD result) implies lenders have more incentive to charge higher loan rate.

Other paw:

- Borrowers demand less loans if draw higher i from $F(\cdot, \mathbf{z})$.
- Banks charging higher i have less customers showing up.
- So banks "compete harder" for borrowers as inflation rises.

Denominator (marginal cost of funds). Independent of F. Linearly increases with τ.

Dispersion of markups

"Other paw" (banking competitiveness incentive) dominates/rises as inflation rises.

- Support of $F(\cdot, \mathbf{z})$ shifts right, becomes wider — increased dispersion.
- Banks posting the lowest rates, post closer to their marginal cost, serve more borrowers.
- Lower bound falls toward banks' marginal cost of funds.

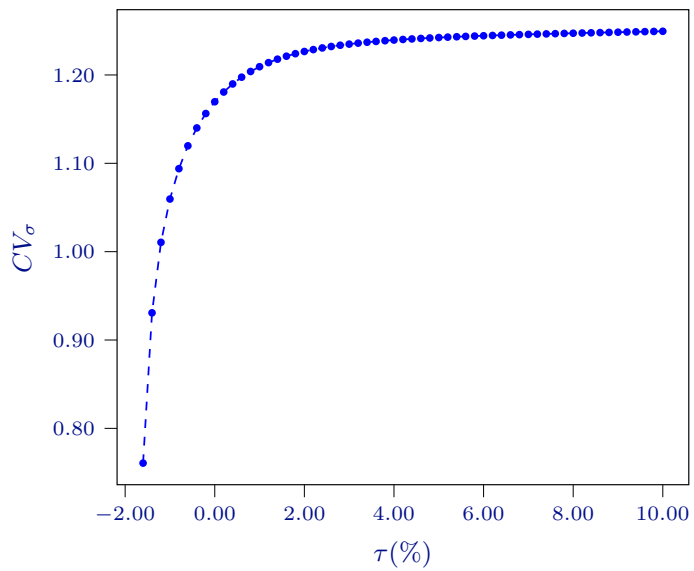


Figure: loan (percentage) markups dispersion (CV), $\tau \in (\beta - 1, \bar{\tau}]$

More details: ▸ bank profits ; ▸ markups

Recall Empirical Evidence/motivation

So model also predicts . . .

Negative relation between average markup and markups dispersion.

Comparative Steady States

Welfare effects of banking

When bank-lending market power is endogenous to policy

Two opposing welfare effects of banking liquidity transformation:

- Benefit: Banks serve an insurance role by paying deposits interest on idle cash.
- Cost: Extraction of buyers surplus (lender market power) reducing DM goods trades.
  - Households can use credit to avoid the inflation tax by carrying less money and taking out a loan
  - But lowering z tightens the liquidity constraint for buyers who failed to meet a lender
  - Also, this drives up the loan rate (in the sense of FOSD) posted by banks

Comparative Steady States

Welfare criterion

Our welfare criterion is measured in terms of household ex-ante lifetime utility.

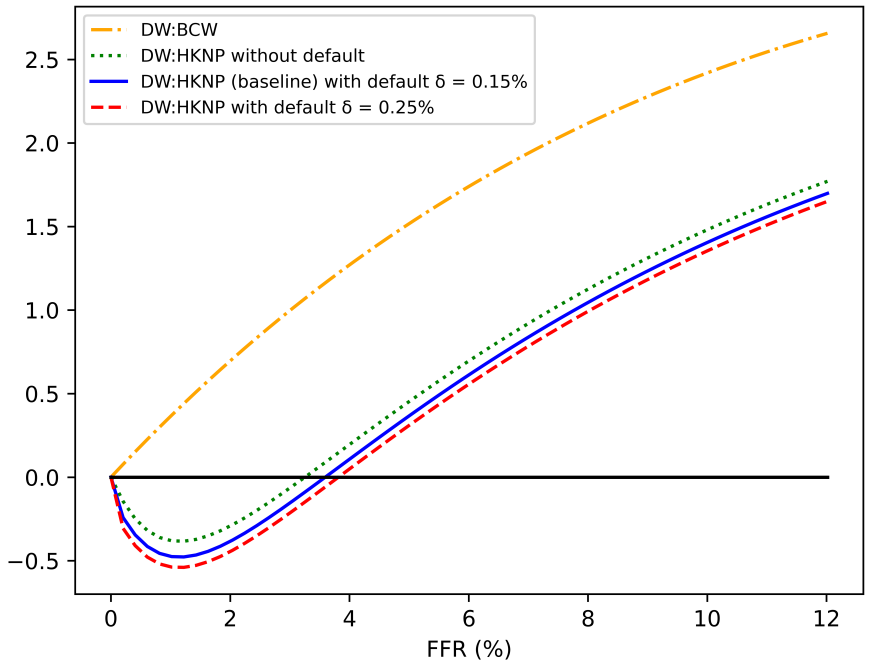
$$W^{HKNP}(\tau) = \frac{1}{1-\beta}\left[U(x^\star) - x^\star - c[q_s^\star(\mathbf{z})]\right] + \frac{n}{1-\beta}\left[\alpha_0 u[q_b^{0,\star}(\mathbf{z})] + \int_{\underline{i}(\mathbf{z})}^{\bar{i}(\mathbf{z})} [\alpha_1 + 2\alpha_2 - 2\alpha_2 F(i,\mathbf{z})] u[q_b^\star(i,\mathbf{z})] \mathrm{d}F(i,\mathbf{z})\right].$$

Two special cases:

- An economy with perfectly competitive banks $(\alpha_2 = 1)$.
- An economy without banks $(\alpha_0 = 1)$.

Comparative Steady States

Difference in welfare: Economy with banks vs. no banks



- $DW = W^{i} - W^{no-banks}$, $i \in \{\text{Baseline/Variations, Perfect Competition}\}$
- Gain from banks reallocating idle money balances as long as inflation $\tau > \beta - 1$.
- Market power in lending extracts surplus from households in the goods market, reducing real money balances.
- Imperfect competition destroys welfare-gain from intermediation role of banks.

Welfare effects of banking: Summary

In Berentsen et al. (2007), banking improves welfare by insuring households against being stuck with idle money balance (in the event of not trading with prob. $1 - n$).

Here, the banking system plays the same insurance role as in BCW.

But, borrowing is more expensive due to imperfect competition.

Stabilization Policy (overview) I

- We focus on stationary equilibrium with *i.i.d* aggregate demand shocks.
- An optimal policy problem as in Berentsen and Waller (2011):
  - Commits to an overall long-run inflation target.
  - Engages in a state-contingent liquidity management (via taxes/transfers).
  - Goal: maximize households' lifetime utility.
- Novelty: market power of banks is endogenous to both policy and state of the economy.

Stabilization Policy (overview) II

Extra layer of policy trade-offs in altering bank-lending markups

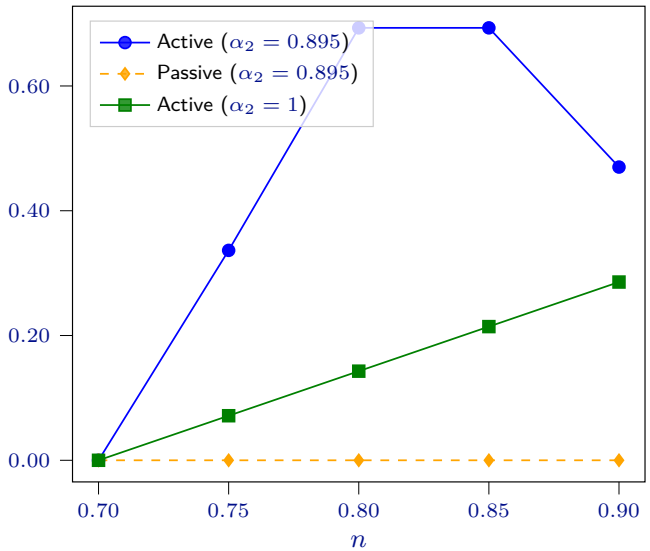
Fix a particular state, central bank injects more money induces:

1. a lower ex-post markup by directly reducing the monopoly loan rate, but
2. a fall in households' ex-ante real money demand on average, which raises ex-post markup (in the sense of first-order stochastic dominance).

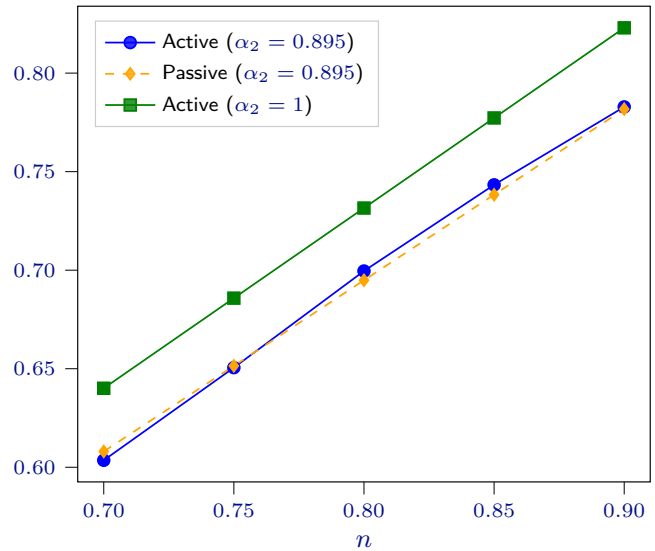
Optimal "elastic-currency" stabilization policy internalizes endogenous response of banking market power.

- Optimal policy tolerates higher markups when demand is low, and lowers them when it is high.

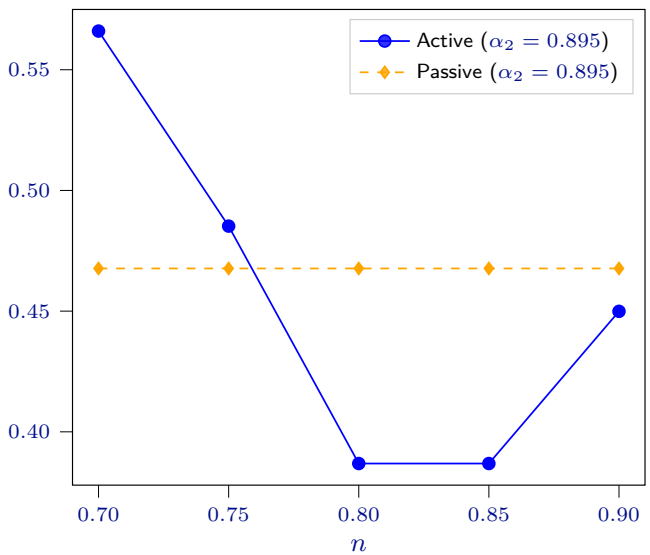
Figure: Optimal elastic-currency demand-stabilization policy.



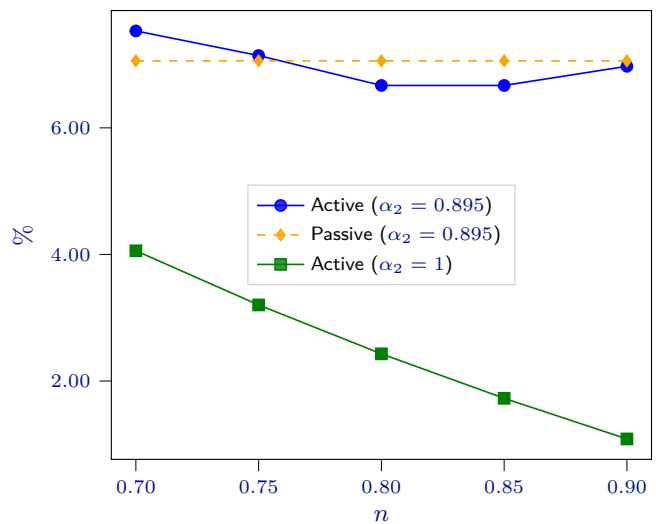
(a) state-contingent liquidity injection



(b) state-contingent DM allocation



(c) state-contingent loan (%) markup



(d) state-contingent loan interest rate

Conclusion

- We provide new evidence on interest rate markups and dispersion on loans in the United States.
- A policy-varying distribution of interest rate markups on loans distorting frictional goods trades and welfare.
- Stabilization policy can raise welfare by limiting some of banking market power in lending.

Appendix: Household optimizes

Consider the case where both loan demand and the probability of not having the chance to borrow (α_0) are positive:

Optimal money demand satisfies:

$$\underbrace{\frac{1+\tau}{\beta}-1}_{\text{MC of extra dollar}} = \underbrace{(1-n)i_d}_{\text{marginal value of money deposited}} + \underbrace{n\alpha_0\left[u^{'}[q_b^0(z)]-1\right]}_{\text{No-bank: marginal value of money in real consumption}} + \underbrace{n\int_{\underline{i}(z)}^{\bar{i}(z)} \mathbb{I}_{\{0<\rho<\tilde{\rho}_i\}}\left[\alpha_1+2\alpha_2\left(1-F\left(i;z,\tau\right)\right)\right] i\mathrm{d}F(i;z,\tau)}_{\text{Meet bank, marginal reduction of loan interest if borrow one less unit of money}} \tag{1}$$

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Appendix: Firms optimize

- Centralized market (CM):
  - Firms are perfectly competitive
  - linear production with labor
  - Profit-max strategy: $w = 1$
- Decentralized market (DM):
  - Walrasian price taking
  - Cost of producing $c(q)$
  - Cost-min strategy: $c^{'}(q) = \rho$

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Appendix: Lending banks optimize

- The posted loan rate cumulative distribution function is:

$$F(i) := F(i; z, \tau) = 1 - \frac{\alpha_1}{2\alpha_2}\left[\frac{R(\bar{i})}{R(i)} - 1\right] \quad \text{for all } i \in \text{Supp}(F), \tag{2}$$

  where $R(i) = l(i; z)[i - i_d]$ is the lender profit per loan customer served.

- The support of distribution F is denoted by $\text{Supp}(F) = \left[\underline{i}(z), \bar{i}(z)\right]$.

- All posted loan rates yield equal expected profit overall:

$$R(i) = \frac{\alpha_1}{\alpha_1 + 2\alpha_2} R(\bar{i}) \tag{3}$$

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Appendix: Deposit interest is feasible

Deposit interest is feasible, i.e., interest on loans weakly exceeds that on deposits:

$$\underbrace{(1-n)i_d(z+\tau_1 Z)}_{\text{interest on total deposits}} \leq \underbrace{n\int_{\underline{i}(z)}^{\bar{i}(z)} \mathbb{I}_{\{0<\rho<\tilde{\rho}_i\}}\left[\alpha_1+2\alpha_2\left(1-F\left(i;z,\tau\right)\right)\right] il^{\star}(i;z,\tau)\mathrm{d}F(i;z,\tau)}_{\text{interest on total loans}} \tag{4}$$

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Appendix: Goods market clear (both DM and CM)

$$\underbrace{q\left(z,\rho,Z,\tau\right)}_{\text{Total supply}}=\underbrace{n\alpha_0 q_b^{0,\star}\left(z;\rho,Z,\tau\right)+n\int_{\underline{i}(z)}^{\bar{i}(z)} q_b^{1,\star}\left(z;i,\rho,Z,\tau\right)\mathrm{d}J\left(i;z,\tau\right)}_{\text{Total demand}} \tag{5}$$

where $\mathrm{d}J(i;z,\tau):=\left[\alpha_1+2\alpha_2-2\alpha_2F(i;z,\tau)\right]\mathrm{d}F(i;z,\tau)$.

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Appendix: Existence and Uniqueness SME

Proposition

Assume loan contracts are perfectly enforceable. If $\gamma > \beta$, $0 < z^\star < \left(\frac{1}{1+\bar{i}(z^\star)}\right)^{\frac{1}{\sigma}}$, and n satisfies an endogenous lower bound such that $n \geq N(z^\star) \in [0,1]$, then there exists a unique SME with co-existing money and credit.

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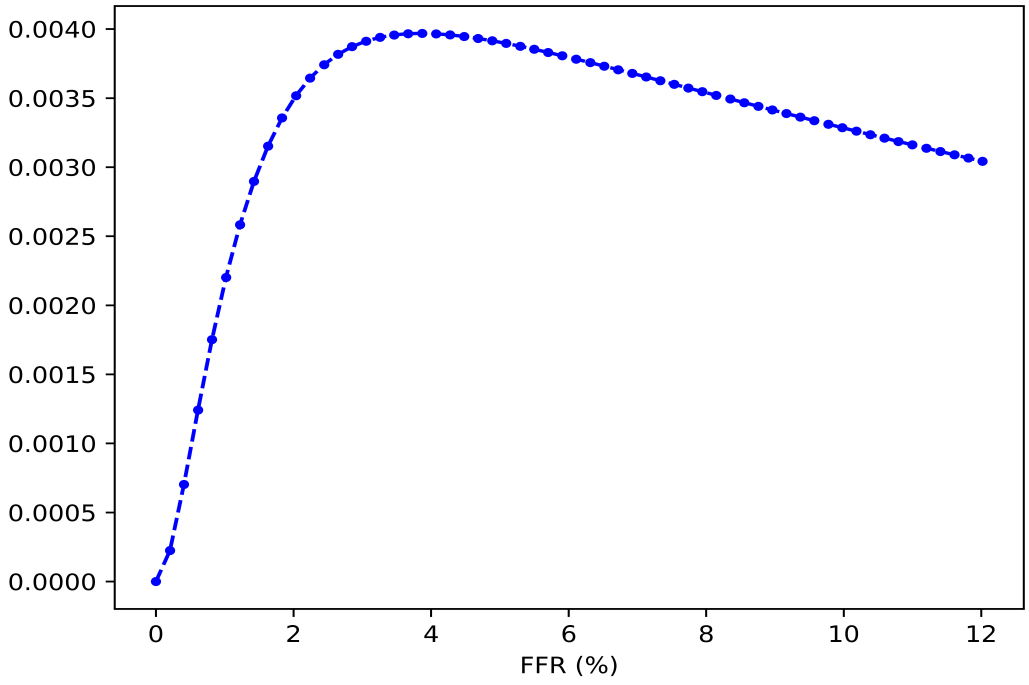
Bank profits



Higher inflation τ,

- increases banks' marginal cost of funds $i_d = (1+\tau)/\beta - 1$
- fall in loan demand and markup
- eventually erodes bank's expected profits as competition (via extensive margin) drives $\Pi(i) \searrow 0$

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Appendix: Bank market power and Inflation targeting

Lemma

In an SME, $F(z^{'})$ stochastically dominates $F(z)$ for real money balances such that $z^{'} < z$.

Corollary

In an SME, $F(z;\tau^{'})$ stochastically dominates $F(z;\tau)$ for inflation rate such that $\tau^{'} > \tau$.

Proposition

Under regularity conditions—equilibrium support of loan-rate distribution not too wide and min loan rate not too high above cost of funds—equilibrium *average markup falls with inflation*.

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More evidence

Imperfect competition in banking

- Evidence of high markups and imperfect pass-through of bank costs to interest rates.
- Substantial concentration across developed countries.

  Corbae and D'Erasmo (2018) and Corbae and D'Erasmo (2021).

Concerns about bank market power among policy makers

- Australian Competition and Consumer Commission, Sims (2016).
- Bank of Canada, Wilkins (2019).

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Related literature

1. Berentsen et al. (2007):
   - Banks provide insurance against holding idle money.
   - Banks improve welfare if inflation is away from the Friedman rule.

2. Imperfect competition in banking:
   - Chiu, Davoodalhosseini, Jiang and Zhu (2019), Altermatt and Wang (2021) and Dong, Huangfu, Sun and Zhou (2021)

What's new in our project:

- dispersion in loan interest rates in equilibrium
- a channel from monetary policy to bank-lending markups (market power)

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Measurements

Bank-branch-level (b) markup over Fed Funds rate:

$$Markup_{b,i,c,s,t} = (Rate_{b,i,c,s,t} - FF_t)/(1 + FF_t)$$

- i commercial bank owning branch
- c county location of branch
- s state
- t day RateWatch reports branch rate information

Two *markup dispersion* definitions:

- Std Deviation of branch markups from state s in month t. (Also aggregate nationally.)
- Coefficient of variation (Std/Mean)

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Measurements

Identification – Local confounding factors

Branch level loan rate pricing behavior could also depend on *local* factors:

- socio-economic
- deposit market competition
- bank branch networks
- bank's characteristics

Orthogonalize the branch level markup on those potential factors:

$$Markup_{b,i,c,s,t} = a_0 + a_1 \underbrace{X_{b,i,c,s,t}}_{\text{Branch controls}} + a_2 \underbrace{X_{i,t}}_{\text{Owner-entity controls}} + a_3 \underbrace{X_{c,s,t}}_{\text{County controls}} + \underbrace{\epsilon_{b,i,c,s,t}}_{\text{Residual m/up}}$$

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