Money, Credit and Equilibrium Imperfectly Competitive Banking

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SaMMF and Study Center Gersenzee, Nov 4, 2020

https://github.com/phantomachine/BJBANKS

Facts: Imperfect Competition in Banking

- For example, U.S.:
  - High profit margins: Markups (90%)
  - Imperfect interest-rate pass through: Rosse-Panzar H-statistic[1] (50%)
- Market share of top-3 banks: Portugal (89%), Germany (78%), the United Kingdom (58%), Korea (1998-2006: 80%-100%, post 2007: 50%), Japan (44%), United States (35%)
- Data source:
  - FDIC, Call Reports, U.S. Commercial Banks, 1984-2010
  - Bankscope
  - (Corbae and D'Erasmo, 2015; Corbae and D'Erasmo, 2018)

[1] Sum of the elasticities of a bank's total revenue with respect to that bank's input prices

Monetary Policy and Regulator Concerns

- Rod Sims (Chair of ACCC), *Committee Hansard*, 2016-10-14:

  There seems a lack of very robust competition in banking . . .

- Australian Productivity Commission Inquiry (No.89, 2018-06-29):

  [I]t is the way market participants gain, maintain and use their market power that may lead to poor consumer outcomes. . . . Reforms that alter incentives of ... banks, ... aimed directly at bolstering consumer power in markets, and reforms to the governance of the financial system, should be the prime focus of policy action.

- Carolyn Wilkins (Asst. Gov. BoC), *Why Do Central Banks Care About Market Power?*, G7 Conference at Banque du France (2019-04-08):

  Still-unanswered questions for central banks about implications for people, inflation dynamics, and monetary policy transmission.

In Theory ...

Berentsen, Camera, and Waller (2007, JET) ...

Financial Intermediation (Banks) improve welfare by supporting "anonymous" exchange ...

so long as holding money is somewhat costly (not at Friedman Rule)

... or borrowers have incentive constraints (even at Friedman Rule):
Boel and Waller (2019)

... Or is it? What if banking industry is **not perfectly competitive**?

What We Do

Empirical, Theoretical/Normative questions

1. Data: (Consumer) Loan-rate markups *positively correlated* with dispersion.

2. How does equilibrium market power of banks distort *basic* intermediation, welfare-enhancing (essential) role of banks?

   When is financial intermediation ("banking") *essential*?

3. What is an optimal redistributive liquidity policy?

Irrelevant when no banking market power

What We Find I

1. Empirical/External Validity ...
   - Model fitted to empirical money demand and average markups
   - Predicts positive correlation between markups and dispersion of loan rates

What We Find II

2. Financial intermediation not always "essential" (welfare enhancing):

   Low inflation ...

   - Banks exploit more *intensive margin* markup channel
   - This destroys welfare-gain from intermediation role of banks.

   Higher inflation ...

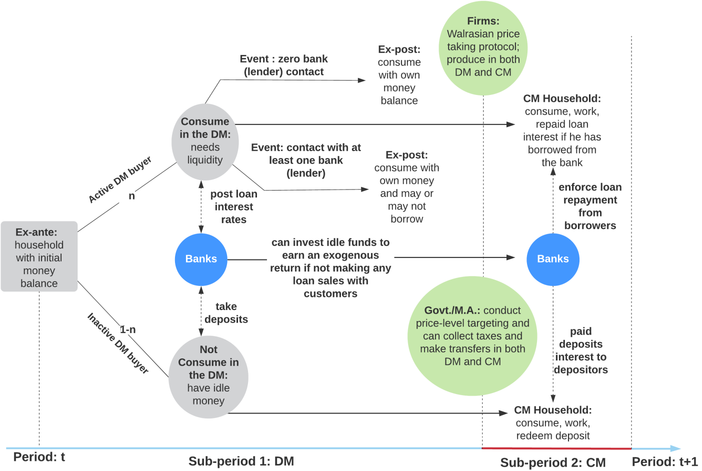
   - Equilibrium loan price dispersion rises
   - Banks trade-off markup incentives (Intensive Margin) for making more loans (Extensive Margin)
   - Extensive Margin dominates, loan market more competitive, approaching BCW's original insight.

What We Find III

3. Given a long-run inflation target there is room for a *contra-Keynesian* demand stabilization via liquidity-management policy
   - When aggregate demand "heats up" ...
   - Optimal stabilization prescribes injecting liquidity to high-valuation/demand buyers in the market
   - This somewhat counter-intuitive policy makes sense when we take into account endogenous market power and markup responses by banks!

Model

Overview



Timing, events, actions, payoffs

Lagos and Wright (2005), Berentsen, Camera, and Waller (2007), Burdett and Judd (1983)

Model: Households I

Second Market (CM)

Household's valuation of initial money balance (plus transfers) $m + \tau_2 M$, credit debt l, and deposit holding d, is

$$W\left(m + \tau_2 M, l, d\right) = \max_{x,h,m_{+1}} \left[U\left(x\right) - h + \beta V\left(m_{+1}\right)\right] \tag{1}$$

subject to

$$x + \phi m_{+1} = wh + \phi\left(m + \tau_2 M\right) + \phi\left(1 + i_d\right)d - \phi\left(1 + i\right)l + \Pi \tag{2}$$

Model: Households II

First Market (DM)

An ex-ante agent m at the opening of the first market has expected lifetime utility

$$V(m) = n\left\{\alpha_0 B^0(m) + \alpha_1 \int_{[\underline{i},\bar{i}]} B(m;i)\,\mathsf{d}F(i) + \alpha_2 \int_{[\underline{i},\bar{i}]} B(m;i)\,\mathsf{d}\left[1-(1-F(i))^2\right]\right\} (1-n)W(m+\tau_s M - d, 0, d) \quad (3)$$

Model: Households III

An ex-post buyer (with positive contact with at least one credit line) has value:

$$B(m;i) = \max_{q_b,l}\left[u(q_b) + W(m + \tau_b M + l - pq_b, l, 0)\right]$$

subject to

$$pq_b \leq m + l + \tau_b M, \qquad 0 \leq l \leq \bar{l}$$

where $\bar{l} = \infty$

Model: Households IV

An ex-post buyer who fails to make contact with any credit provider has valuation:

$$B^0(m) = \max_{q_b} \left[u(q_b) + W(m + \tau_b M - pq_b, 0, 0) \right]$$

subject to

$$pq_b \leq m + \tau_b M$$

Firms

- Second market (CM):
  - Firms are perfectly competitive
  - linear production with labor
  - Profit-max strategy: $w = 1$
- First market (DM):
  - Walrasian price taking
  - Cost of producing $q \mapsto c(q)$
  - Cost-min strategy: $c'(q) = \phi p$

Banks I

- $i^d \equiv \gamma/\beta - 1$ be the marginal cost of the Bank (competitive depository insitutions, perfect enforcement assumption)
- Ex-ante profit from posting loan price i:

$$\Pi(i) = n\left[\alpha_1 + 2\alpha_2(1 - F(i)) + \alpha_2\zeta(i)\right]R(i) \tag{4}$$

where

$$\zeta(i) = \lim_{\varepsilon \searrow 0}\{F(p) - F(p - \varepsilon)\} \tag{5}$$

$$R(i) = l^{\star}(m; i, p, M, \gamma)\left[(1+i) - \left(1 + i^d\right)\right] \tag{6}$$

  - $n\alpha_2\zeta(i)$ is the measure of consumers contacting bank, when consumers also face the same price i from another bank
    - Customers randomize between them
    - In equilibrium probability two banks set same price is zero

Banks II

We can prove that:

1. Bank's faced with noisy-search loan customers earn maximal expected profit equal to monopolist's profit
2. Each bank (pricing at some $i \sim F$) trades off
   - intensive-margin profit $R(i)$

     — against —

   - extensive-margin loss: probability of agents showing up ("queue length") $\alpha_1 + 2\alpha_2(1 - F(i))$
3. All earn the same expected profit

SME

SME: Households I

Household optimizes

Assume $\sigma < 1$. Work with stationary variables:

- $\rho := \phi p$
- $z := \phi m$
- $Z := \phi M$
- $\xi := \phi l$

Then we have the ordering $0 < \tilde{\rho}_i < \hat{\rho}$ and $0 < \hat{i}$:

- Relative price above which DM liquidity not exhausted:
  $\hat{\rho} := \hat{\rho}(z; Z, \gamma) = [z + \tau_b Z]^{\frac{\sigma}{\sigma-1}}$
- Relative price below which DM liquidity binds with borrowing top-up:
  $\tilde{\rho}_i := \hat{\rho}\,(1+i)^{\frac{1}{\sigma-1}}$
- Bank-lending rate below which there is borrowing:
  $\hat{i} = \rho^{\sigma-1}\,[z + \tau_b Z]^{-\sigma} - 1 > 0$

SME: Households II

Household optimizes

... and optimal DM loan demand is:

$$\xi^{\star}(z;i,\rho,Z,\gamma)=\begin{cases}\rho^{\frac{\sigma-1}{\sigma}}(1+i)^{-\frac{1}{\sigma}}-(z+\tau_b Z) & 0<\rho\leq\tilde{\rho}_i \text{ and } 0\leq i<\hat{i}\\ 0 & \tilde{\rho}_i<\rho<\hat{\rho} \text{ and } i\geq\hat{i}\\ 0 & \rho\geq\hat{\rho} \text{ and } i\geq\hat{i}\end{cases} \tag{7}$$

SME: Households III

Household optimizes

There is an equilibrium upper and lower bound on the support of the equilibrium loan interest-rate distribution F:

- $i_{\max} := \min\left\{i^m, \hat{i}\right\}$
- $i_{\min} > \gamma/\beta - 1$

where

- i^m is a well-defined monopoly price
- $i_{\min} < i_{\max} \leq i^m$

SME: Households IV

Household optimizes

Perfect Competition (BCW):

$$\underbrace{\frac{\gamma-\beta}{\beta}}_{\text{MC of extra dollar}} = \underbrace{(1-n)i_d}_{\text{[A]: MB, idle funds}} + \underbrace{ni}_{\text{[B]: MB, less borrowing, PC } (i \nwarrow i_d)} \tag{8}$$

$$\equiv i$$

No-bank, self-insurance (BCW, us):

$$\underbrace{\frac{\gamma-\beta}{\beta}}_{\text{MC of extra dollar}} = \underbrace{n[u'(q_b)-1]}_{\text{[C]: MB, liquidity premium}} \tag{9}$$

Perfect-competition banking

If money yields lower return than other risk-free assets (not at Friedman rule) ...

BCW: Banks always improve on allocations/trade and thus welfare.

SME: Households V

Household optimizes

Our setting, non-degenerate F: Consider equilibria with positive loans demand and $\alpha_0 = 0$ (everyone meets at least one bank) ...

Optimal money demand satisfies Euler functional equation:

$$\underbrace{\frac{\gamma - \beta}{\beta}}_{\text{MC of extra dollar}} = \underbrace{(1-n)i_d}_{\text{[A*]: MB of idle funds (BCW, PC)}} + \underbrace{n \int_{i_{\min}}^{i_{\max}} \mathbb{I}_{\{0 \leq \rho < \tilde{\rho}_i\}} \left[\alpha_1 + 2\alpha_2 \left(1 - F\left(i\right)\right)\right] i \mathrm{d}F(i)}_{\text{[B*]: Borrow, MB less borrowing } \leq ni \text{ (BCW, PC)}} \tag{10}$$

SME: Households VI

Household optimizes

Simplifies to:

$$1 = \underbrace{\int_{i_{\min}}^{i_{\max}} \mathbb{I}_{\{0 \leq \rho < \tilde{\rho}_i\}} \underbrace{\left[\alpha_1 + 2\alpha_2 \left(1 - F\left(i\right)\right)\right]}_{\text{Extensive margin}} \underbrace{\left(\frac{i}{i_d}\right)}_{\text{Intensive margin markup}} \mathrm{d}F(i)}_{\text{Ex-ante markup from h/hold perspective}} \quad (11)$$

Proposition (Banks can be inessential)

At certain τ_b and thus $F(z, \tau_b)$, nett MB [A*]+[B*] can be less than (equal to) MB of self-insurance world, i.e., $n[u'(q_b) - 1]$.

- In calculus of intertemporal money demand, household anticipates bank's ex-post markup vs. matching probability trade-off ...
- (Earlier) banks' ex-ante profit encodes this too ...

SME: Banks

Banks optimize

Distribution of loan rates F:

$$F\left(i; z, \rho, Z, \gamma\right) = 1 - \frac{\alpha_1}{2\alpha_2}\left[\frac{R\left(i^m\right)}{R\left(i\right)} - 1\right], \quad (12)$$

- $\text{supp}\left(F\right) = \left[i_{\min}, i_{\max}\right]$
- given monopoly price i^m and max. willing to pay $\hat{i}$, $i_{\min}$ solves:

$$R\left(i_{\min}\right) = \frac{\alpha_1}{\alpha_1 + 2\alpha_2} R\left(i_{\max}\right) \quad (13)$$

where

$$R\left(i\right) \equiv R\left(i; z, \rho, Z, \gamma\right) = \left[\rho^{\frac{\sigma-1}{\sigma}}\left(1+i\right)^{-\frac{1}{\sigma}} - \left(z + \tau_b Z\right)\right]\left(i - i^d\right) \quad (14)$$

is (real) bank profit per customer served

SME: Firms and Markets

Firms optimize, goods markets clear, loans feasible

DM sellers optimize and the Walrasian price-taking DM market clears:

$$\begin{aligned} q_s(z, Z, \gamma) &\equiv c'^{-1}(\rho) \\ &= n\alpha_0 q_b^{0,\star}(z; \rho, Z, \gamma) \\ &+ n\left[\int_{i_{\min}}^{i_{\max}} [\alpha_1 + 2\alpha_2 - 2\alpha_2 F(i)]\, q_b^{\star}(z; \rho, Z, \gamma)\, \mathsf{d}F(i)\right] \end{aligned} \tag{15}$$

(CM also clear ...)

Total deposits weakly exceed total loans:

$$\begin{aligned} (1-n)\delta^{\star}(z, Z, \gamma) &\equiv (1-n)\left(\frac{z + \tau_b Z}{\rho}\right) \\ &\geq n\left\{\int_{i_{\min}}^{i_{\max}} [\alpha_1 + 2\alpha_2 - 2\alpha_2 F(i)]\, \xi^{\star}(z; i, \rho, Z, \gamma)\, \mathsf{d}F(i)\right\} \end{aligned} \tag{16}$$

SME: Market Power and Inflation Targeting

Lemma

In an SME, $F(z')$ stochastically dominates $F(z)$, for $z' < z$.

Proposition

For high-enough long-run inflation target τ (or γ) ...

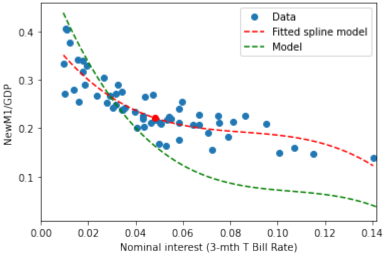
- Real money demand z falls.
- Stochastic dominance result $\Rightarrow$ agent-z more likely to draw lower ex-post markups.
- Banks tend to care more about customers showing up, mark up less (i.e., tends toward Bertrand competition).

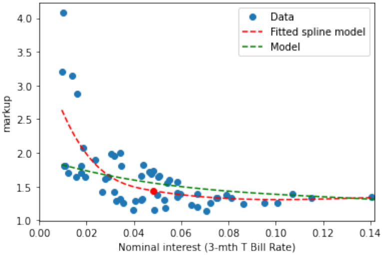
Empirical Validation

Statistical calibration

Some parameter can be externally calibrated from long run data statistics.

Method of Simulated Moments (min. weighted L^2-norm):

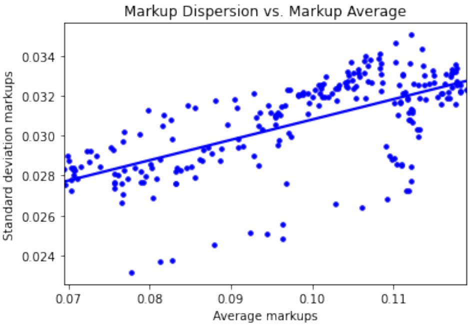




to pin down preference (B, σ_{DM}) and BJ contact rates (α_0, α_1).

Data: Lucas-Nicolini New M1 series;
Bank Prime Loan Rate/3 month TB rate

External validity I



- Personal unsecured loan (Tier 1) rates (RateWatch, USA)
- National level statistics for dispersion vs average (percentage) markups

corr$(Dispersion, Markups) > 0$

- Data: 0.64
- Model: 0.69

Comparative Steady States

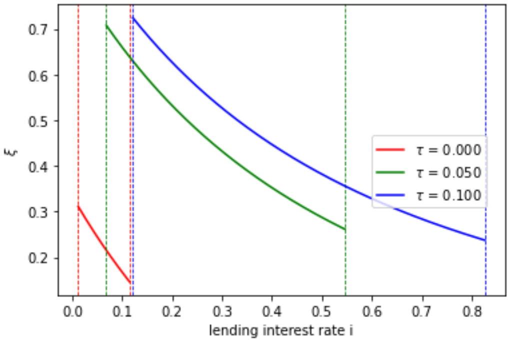
Comparative Steady States

- Consider a set of economies, each distinguished by their long-run inflation rates, τ
- Questions to ask:
  - Inflation tax and demand for loans
  - Inflation tax and bank profits: intensive vs. extensive margins
  - When are banks essential?

c.f., Berentsen, Camera, and Waller (2007)

Comparative Steady States

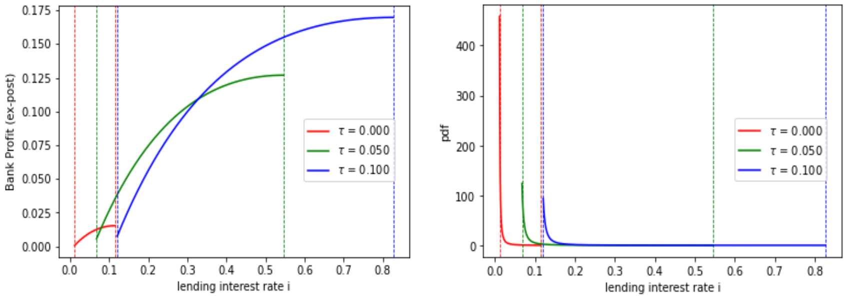
DM demand (credit line): partial equilibrium thinking



- Higher inflation τ, support of $F \sim i$ shifts right
- Also z falls with higher τ
- Loan demand $\xi^{\star}(z, \cdot; \tau)$ shifts right: Self-insurance by holding money more costly

Comparative Steady States

DM banks' intensive vs. extensive profit



- Higher inflation τ, marginal cost $i_d \equiv (1+\tau)/\beta$ higher
- Markup (intensive) vs. queue-length (extensive) margin tension.
- Can show: markup

Comparative Steady States

DM banks' expected profit

Tension tends to resolve as follows:

- the equilibrium support of $F \sim i$ shifts right, and is wider
- the probability mass shift to the tails of F

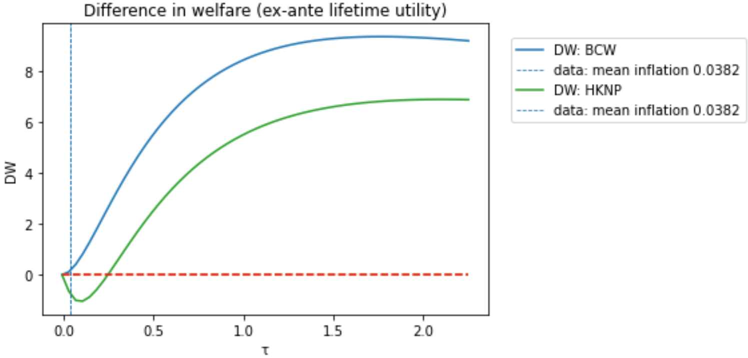
in order that firms are still meeting their equal-expected-profit condition.

As a result:

- At low enough τ banks tend to exploit the intensive (markup) channel
- At high enough τ extensive margin dominates

Comparative Steady States

Welfare difference: Banks vs. no banks



- Low τ: Banks exploit more *intensive margin* markup channel
- High τ: Equilibrium loan price dispersion rises, loan quantity *extensive margin* dominates, loan market more competitive, approaching BCW's original insight.

Welfare and Policy Implications

Policy Implications I

Perfectly competititive banking ($\alpha_0 = \alpha_1 = 0$, $\alpha_2 = 1$):

1. Away from the Friedman rule, financial intermediation improves welfare.
2. Due to payment of interest to depositors. Insuring idle funds.

Imperfectly competitive banks $\alpha_1 \in (0, 1]$:

1. Away from the Friedman rule, financial intermediation does not necessarily improve welfare.
2. Expected gain from insurance role lost through price dispersion ($\equiv$ banks extract borrowers' surplus)

Additional redistributive/liquidity policies can improve welfare towards Berentsen, Camera, and Waller (2007) ideal

Optimal Stabilization Policy I

Active vs. Passive: n aggregate demand shock

Long run policy. Interpret τ as desired inflation target $\equiv$ central bank has targeted price path

- fixed (legislated, mandated)
- Cannot run Friedman rule, $\tau > 0$ (an institutional given)

Optimal Stabilization Policy II

Active vs. Passive: n aggregate demand shock

Short run policy. Commitment to policy functions $\omega \mapsto (\tau_1, \tau_2)(\omega)$

- $\omega = \{\epsilon, n\}$ is a aggregate random variable
- demand-side stabilization
- any state-contingent injection of liquidity to DM agents will be undone in CM, i.e., $\tau_2(\omega) = -\tau_1(\omega)$;
  i.e., a repo agreement where central bank sells money in DM and commits to buy back in CM
- w.l.o.g., we have $\tau_1 = \tau_b$

Stationary equilibrium optimal policy. Focus on equilibria where real balance z is time invariant.

Optimal Stabilization Policy III

Active vs. Passive: n aggregate demand shock

Active central bank

$$\max_{\{q_b^0(\omega),\ q_b^1(\omega),\tau_b(\omega)\}_{\omega\in\Omega}} U(x) - x - c(q_s)$$

$$+\int_{\omega\in\Omega} n\alpha_0\epsilon u\left[q_b^0(z;\rho,Z,\gamma,\tau_b,\omega)\right]\psi(\omega)\,\mathrm{d}\omega$$

$$+\int_{\omega\in\Omega} n\int_{i_{\min}}^{i^{\max}}\left[\alpha_1+2\alpha_2\left(1-F(i;z,\gamma,\tau_b,\omega)\right)\right]$$

$$\times\,\epsilon u\left[q_b^1(z;i,\rho,Z,\gamma,\tau_b,\omega)\right]\mathrm{d}F(i)\,\psi(\omega)\,\mathrm{d}\omega$$

subject to:

- optimal money demand (Euler condition) $\hookrightarrow z^\star(\tau)$
- credit search and bank profit max $\hookrightarrow F(\cdot,\tau,\omega)$
- goods markets clearing $\hookrightarrow x^\star,(q^0,q^1)(z^\star(\tau),\omega)$
- Aggregate loan feasibility
- GBC: $\frac{\gamma-\beta}{\beta}=\tau+\tau_1(\omega)+\tau_2(\omega)$ and $\tau_1(\omega)=-\tau_2(\omega)$

Optimal Stabilization Policy IV

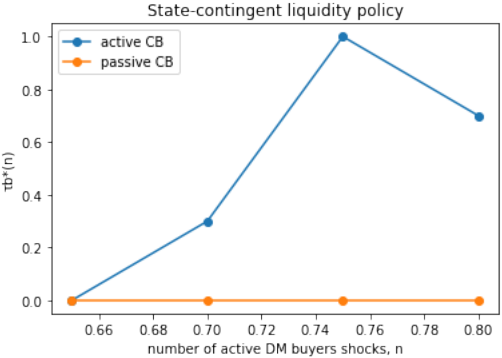
Active vs. Passive: n aggregate demand shock

Passive central bank

- Policy constrained by $\tau_1(\omega) = \tau_2(\omega) = 0$ for all $\omega \in \Omega$.
- The outcomes will be very similar to our deterministic, baseline SME.

Optimal Stabilization Policy V

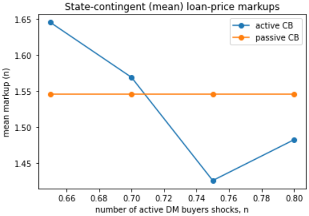
Active vs. Passive: n aggregate demand shock

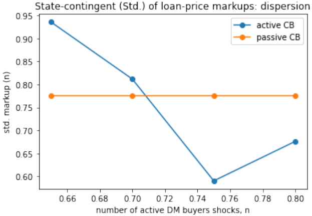


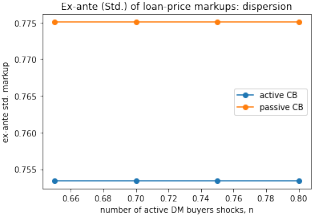
More transfers in high-demand state (relative to passive policy) ...

Optimal Stabilization Policy VI

Active vs. Passive: n aggregate demand shock



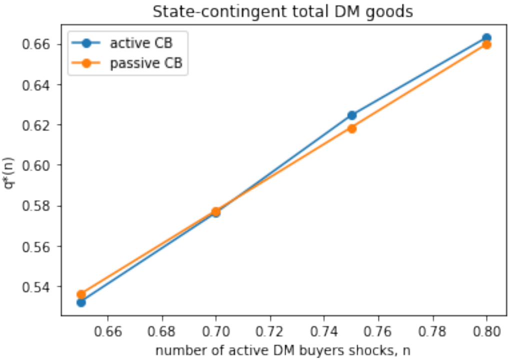




Active policy induces more markup dispersion in lower n states, tolerating higher mean markups. Higher n, higher $\tau_b(n)$, ex-ante z falls, FOSD: higher dispersion at higher n. But, higher $\tau_b(n)$ directly lowers dispersion through reducing monopoly price (support of F).

Optimal Stabilization Policy VII

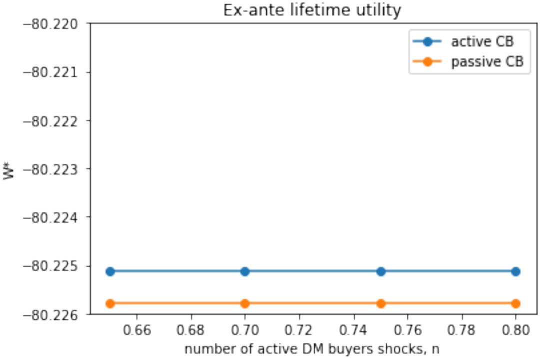
Active vs. Passive: n aggregate demand shock



This induces more (less) consumption and loans in state with more (less) active buyers, relative to passive policy regime.

Optimal Stabilization Policy VIII

Active vs. Passive: n aggregate demand shock



Thus active "demand-side stabilization policy" through liquidity provision results in higher ex-ante welfare for agents.

Punchline I

Pass-through and welfare

With information frictions, banks can be shown to be essential under perfect competition (Berentsen, Camera, and Waller, 2007).

When market power of banks is endogenous to policy:

1. equilibrium imperfect competition renders an otherwise *essential* banking system detrimental in *low-inflation economies*
2. Pass-through of monetary policy (cost of funds variation) to lending interest rates
   - positive relationship between the average markup and the dispersion of lending interest rates

Punchline II

Optimal stabilization policy

Given a long-run inflation target . . .

. . . there is room for a *contra-Keynesian* demand stabilization via liquidity-management policy:

- When aggregate demand "heats up" . . .
- Optimal stabilization prescribes injecting relatively more liquidity to ex-post high-taste (high marginal valuation of money) agents
- This somewhat counter-intuitive (to textbook Keynesianism) policy makes sense when we take into account endogenous market power and markup responses by banks!
- (Not shown). Similar result if ex-post idiosyncratic taste shocks.

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