Banking Market Power, the Deposit Channel of Monetary Policy and Capital

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Our Contribution

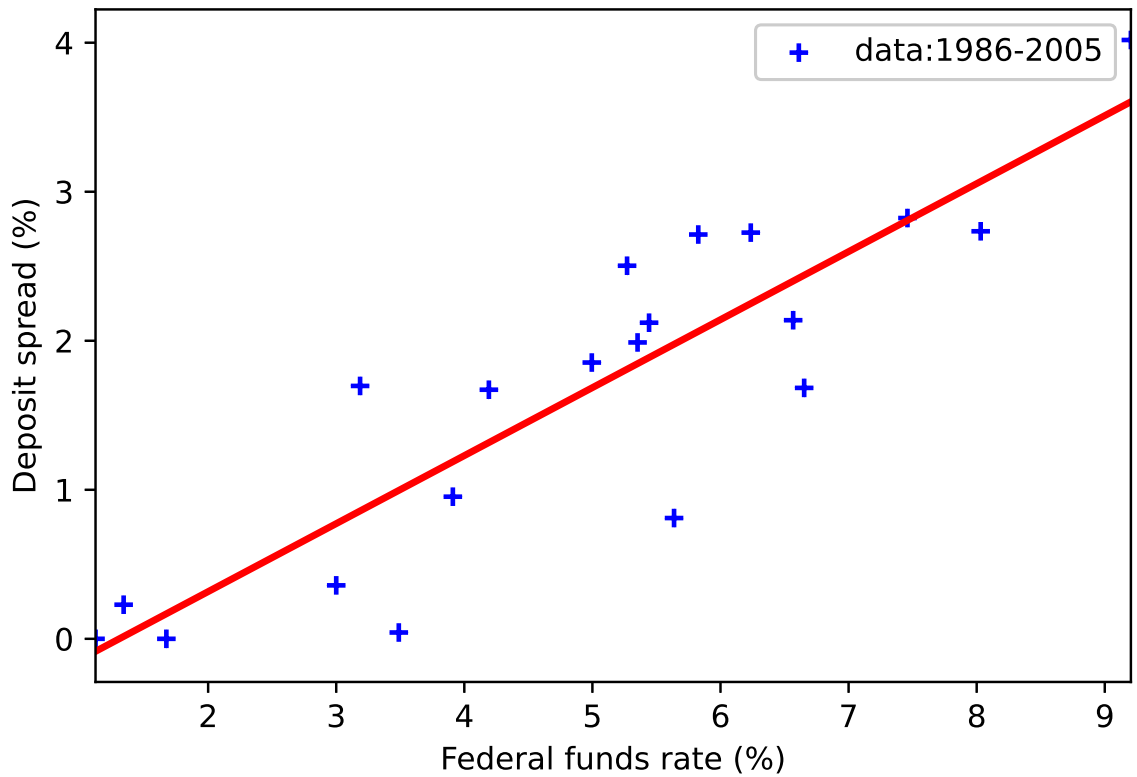
1. A (new) *deposit channel* of monetary policy:
   - Bank market power in noisy search: Equilibrium dispersion of markdown (MD) on deposit rates
   - Incomplete and policy-dependent policy pass-through
2. New state-level evidence (RateWatch bank-branch data) corroborates model prediction: corr$(std_{MD}, MD) > 0$.
3. Growth consequences:
   - Banking improves growth (if money-capital dynamics not decoupled)
   - Incomplete pass-through via markdown distribution sucks juice out, but still better than no-bank equilibrium

Motivation I: Deposit channel I

Consider the deposit channel of monetary policy causal narrative in (Drechsler, Savov and Schnabl, 2017).

1. FFR $\uparrow \implies$ deposit spread (FFR - deposit rate) $\uparrow$

... We do see implied correlation in data:

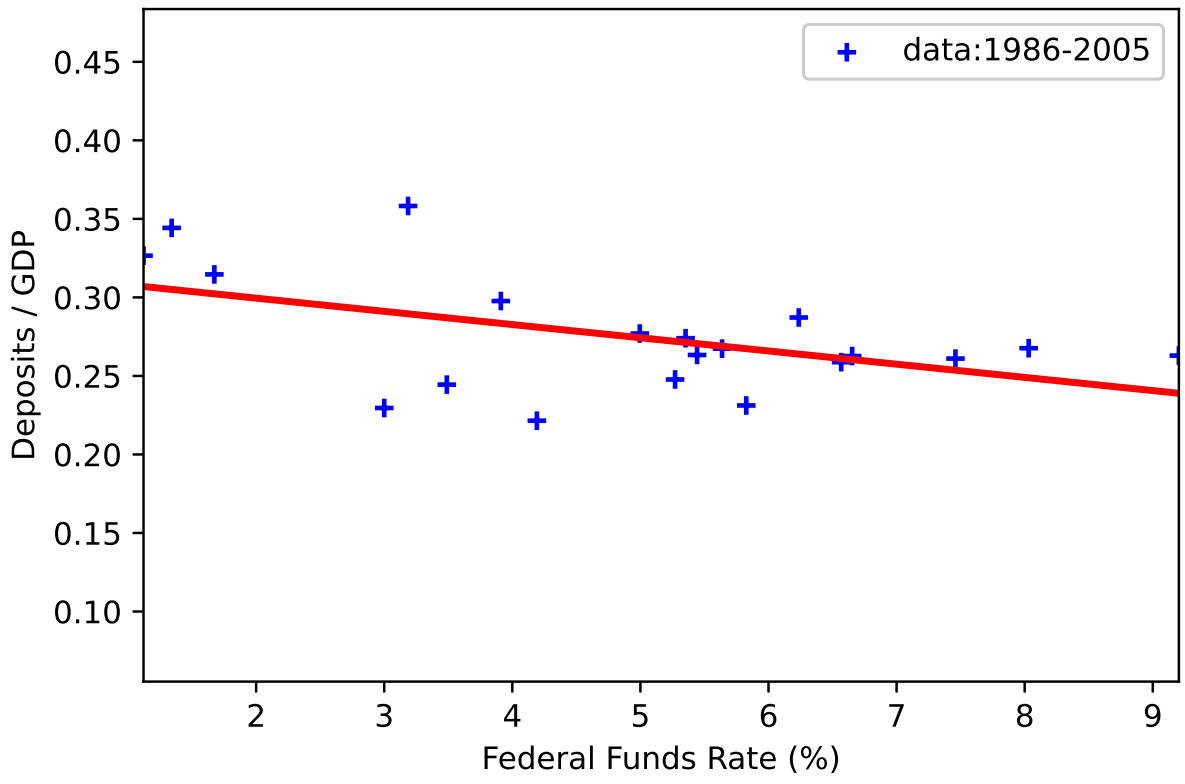


Motivation I: Deposit channel II

2. FFR ↑

$\Longrightarrow$ deposit spread (FFR - deposit rate) ↑ $\Longrightarrow$ deposits ↓

... also, observable correlation in data:



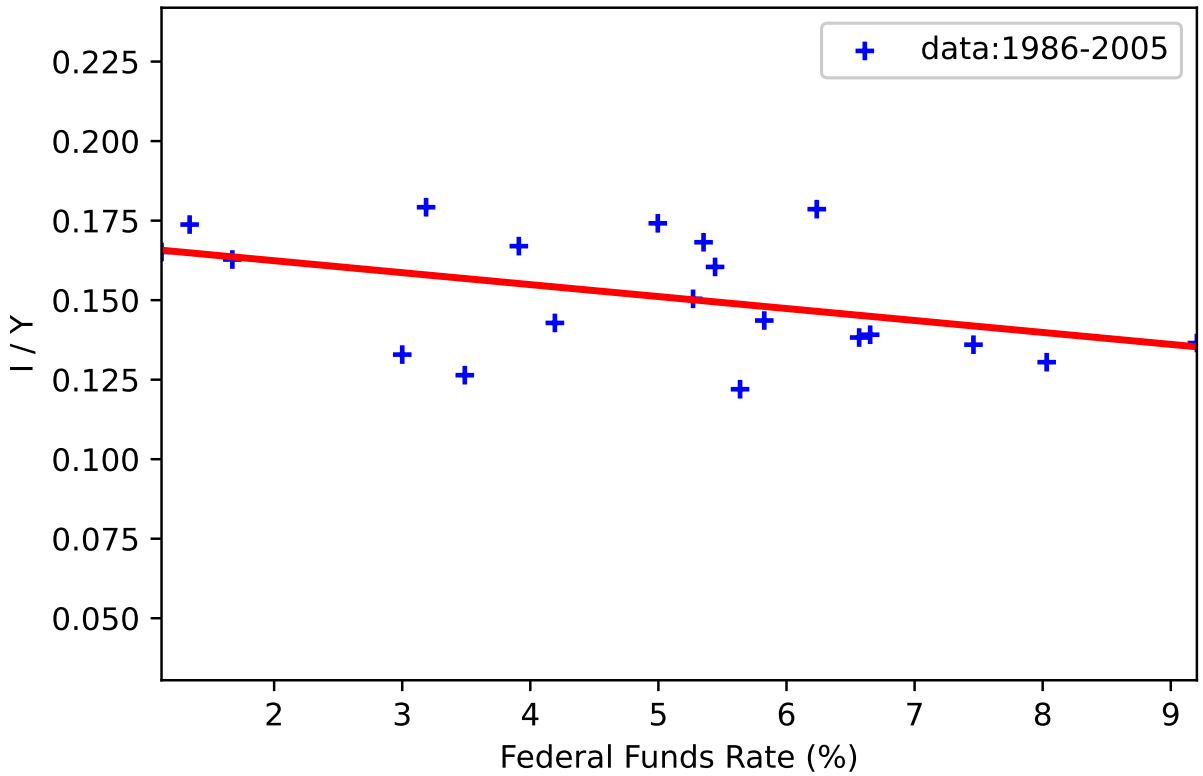
Motivation I: Deposit channel III

3. FFR ↑

$\Longrightarrow$ deposit spread (FFR - deposit rate) ↑

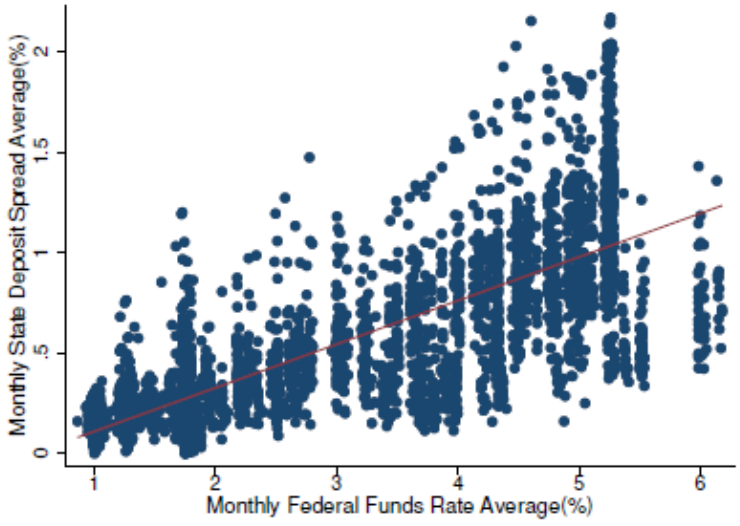
$\Longrightarrow$ deposits ↓ $\Longrightarrow$ loans ↓

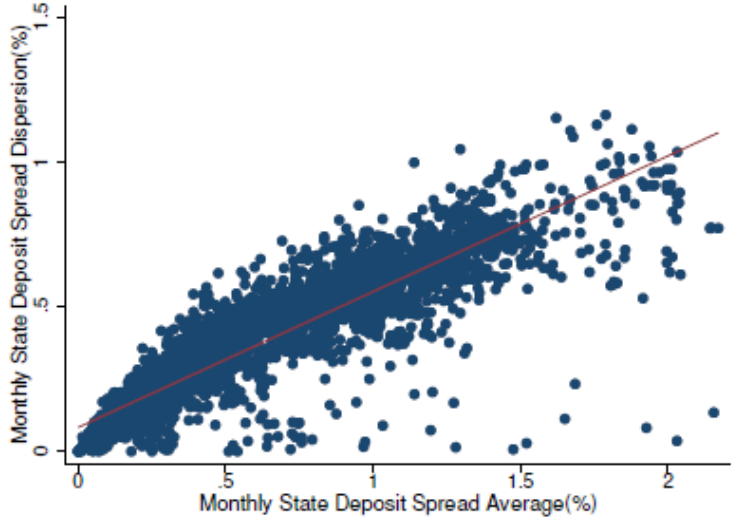
... rationalizes correlation in data:



New Motivation! I

Deposit spreads and dispersion at the bank-branch level





Also, formal regressions (state-level FE, TE, controls) in paper:

- Deposit-rate Markdowns and their dispersion (std) are positively associated

Source: Weekly deposit rates, $\$10K$, 12-month certification of deposit (RateWatch)

New Motivation! II

Deposit spreads and dispersion at the bank-branch level

Need a model of deposit channel:

- non-trivial, policy-dependent dispersion in deposit-rate markdowns
- feedback on money and capital decisions
- dynamic and long-run growth consequences of deposit market power

Our approach

- Start with a money-capital model: Aruoba, Waller and Wright (2011)
- Need banking, focus on liquidity transformation: Berentsen, Camera and Waller (2007). *Caveat emptor* ...
  - Not a model of bank risk taking or shadow banking!
- Rationalize market power and deposit pricing dispersion: Burdett and Judd (1983)
- Connect to dynamics and growth: Waller (2011)

Main insights

A deposit channel of monetary policy and capital working through deposit-rate markdown dispersion.

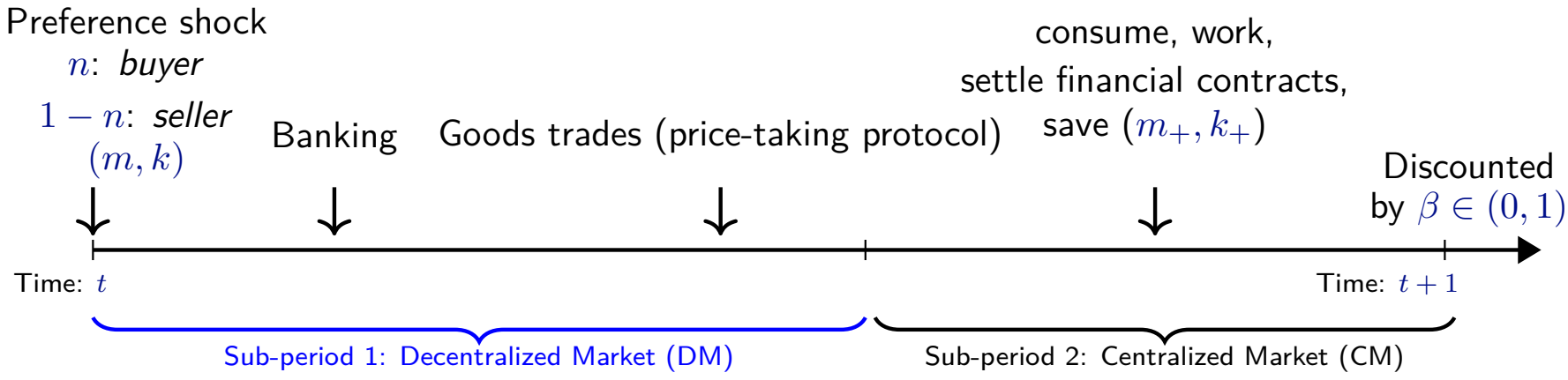
As (long-run) inflation target increases:

- Banks extract more depositor rent: Higher dispersion and average spread on deposit rates.
- Households carry fewer real money balances inducing a fall in total deposits.
- Reduction in goods trades and capital formation.

Perfectly competitive banking improves growth.

Imperfect competition: Markdowns dispersion works against that.

Model: overview



Aruoba et al. (2011), Berentsen et al. (2007), Burdett and Judd (1983)

Model: banks' problem (overview)

- Source funds to make consumer loans and/or investment with the central bank.
- An analytical formula for the deposit interest rate distribution G with $\text{supp}(G) = [\underline{i}_d, \bar{i}_d]$.
- Each bank (posting i_d) trades off Go to Appendix: Banks' trade-offs:
  - intensive-margin: lower i_d earns higher profit per depositor

    — against —

  - extensive-margin: lower i_d induces potential loss of depositors ($\text{d}G$ falls).
- Banks faced with noisy-search depositors earn the same expected profit equal to monopolist's profit.
- Two special cases: Bertrand and Monopoly

Stationary Monetary Equilibrium

Definition

Given policy $\gamma = 1 + \tau$, and taxes/transfers (τ_1, τ_2), a stationary monetary equilibrium (SME) with money, credit and capital is a steady-state CM allocation $(x^\star, z^\star, k^\star, h^\star, Z, K, H)$, DM allocation $(q^\star, l^\star, d^\star)$ and deposit-rate distribution $G(i_d)$ and relative prices (ρ, i, r, w) such that

1. Households optimize ▸ Go to Appendix: Household optimizes
2. Firms optimize: ▸ Go to Appendix: Firms optimize
3. Banks optimize ▸ Go to Appendix: 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

Existence and uniqueness: ▸ Go to Appendix: SME.

Stationary Monetary Equilibrium

Neoclassical growth model (capital is only productive in CM):

$$\frac{1}{\beta} = 1 + \alpha \hat{k}^{\alpha-1} - \delta. \tag{1}$$

A monetary economy without banks $(\alpha_1 = \alpha_2 = 0)$, i.e., Aruoba et al. (2011):

$$\frac{1}{\beta} = \underbrace{\left[1 + \alpha \hat{k}^{\alpha-1} - \delta\right]}_{=:R_{CM}(\hat{k})} + \underbrace{\underbrace{\Theta}_{>0} \left[1 + \frac{i(\gamma)}{n}\right]^{-1} \left[\frac{1-\alpha}{1-\delta \hat{k}^{1-\alpha}}\right]^{-1} \hat{k}^{\alpha-1}}_{=:R_{DM}^{no-banks}(\hat{k},\gamma)}. \tag{2}$$

A monetary economy with perfectly competitive banks $(\alpha_2 = 1)$:

$$\frac{1}{\beta} = \underbrace{\left[1 + \alpha \hat{k}^{\alpha-1} - \delta\right]}_{=:R_{CM}(\hat{k})} + \underbrace{\underbrace{\Theta}_{>0} \left[1 + i(\gamma)\right]^{-1} \left[\frac{1-\alpha}{1-\delta \hat{k}^{1-\alpha}}\right]^{-1} \hat{k}^{\alpha-1}}_{=:R_{DM}^{PC}(\hat{k},\gamma)}. \tag{3}$$

Stationary Monetary Equilibrium

Our baseline model economy:

$$\frac{1}{\beta} = \underbrace{[1 + \alpha \hat{k}^{\alpha-1} - \delta]}_{=:R_{CM}(\hat{k})} + \underbrace{\underbrace{\Theta}_{>0} \left[\tilde{c}(\gamma)\right]^{-1} \left[\frac{1-\alpha}{1-\delta\hat{k}^{1-\alpha}}\right]^{-1} \hat{k}^{\alpha-1}}_{=:R_{DM}(\hat{k},\gamma)}, \qquad (4)$$

where $\tilde{c}(\gamma) := 1 + \frac{1}{n}\left[i(\gamma) - (1-n)\mu_d(\gamma)\right] =$

$1 + \underbrace{\mu_d(\gamma)}_{\text{average deposit rate}} + \frac{1}{n} \underbrace{[i - \mu_d(\gamma)]}_{\text{average deposit spread}}$.

Insight: G in $\mu_d(\gamma)$!

... Matters for deposit channel: Monetary policy $\rightarrow$ banking $\rightarrow$ capital.

Allocation with banks versus without banks

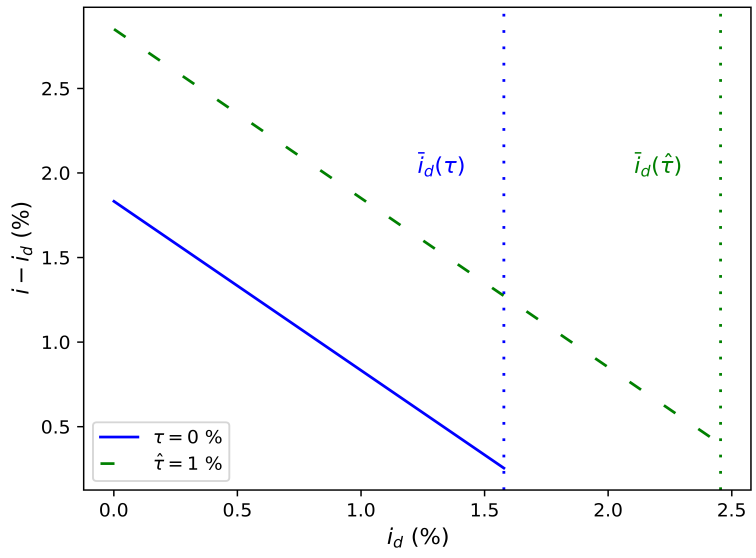
Proposition

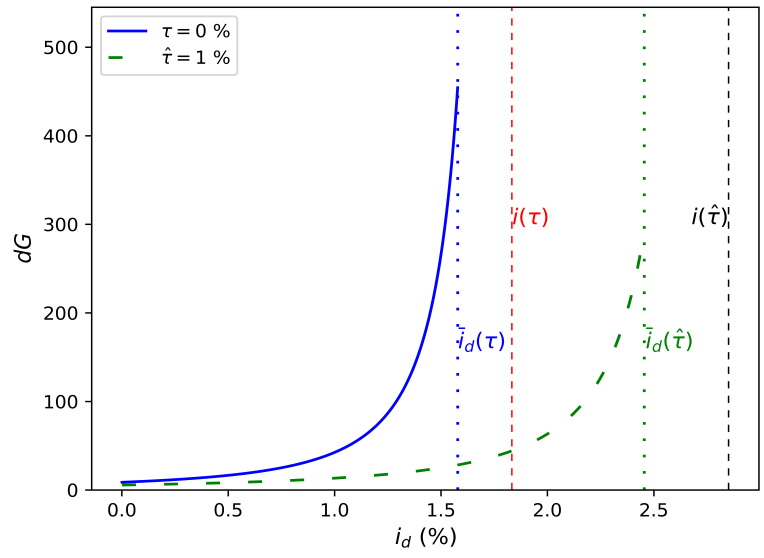
Assume inflation is away from the Friedman rule, $\gamma > \beta$ and $\alpha_2 < 1$. Financial intermediation improves allocation and welfare relative to a no-bank economy:

$$q^{\star,no-bank} < q^{\star} < q^{\star,PC} \quad \text{and} \quad K^{\star,no-bank} < K^{\star} < K^{\star,PC},$$

where equilibrium allocation $(q^{\star}, K^{\star})$ approaches $(q^{\star,PC}, K^{\star,PC})$ as the baseline economy tends to its perfect-competition limit, i.e., $\alpha_2 \to 1$.

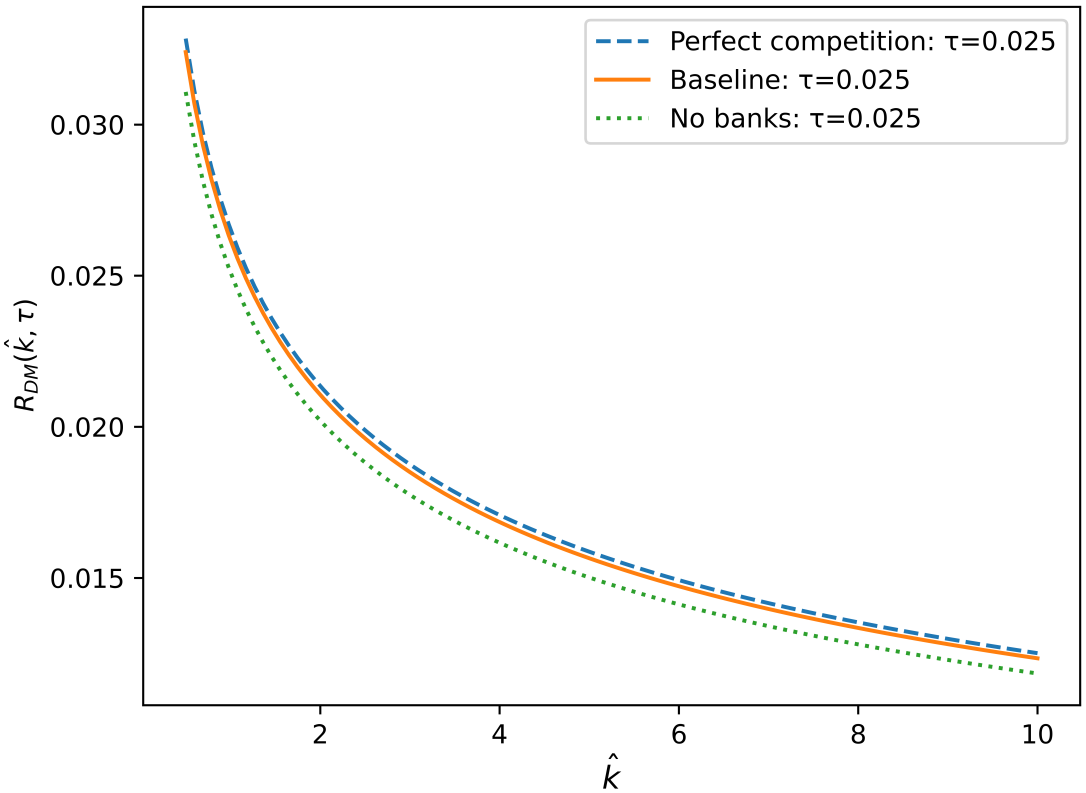
Inflation and markdowns dispersion (Lemmata 1-2, Proposition 5)





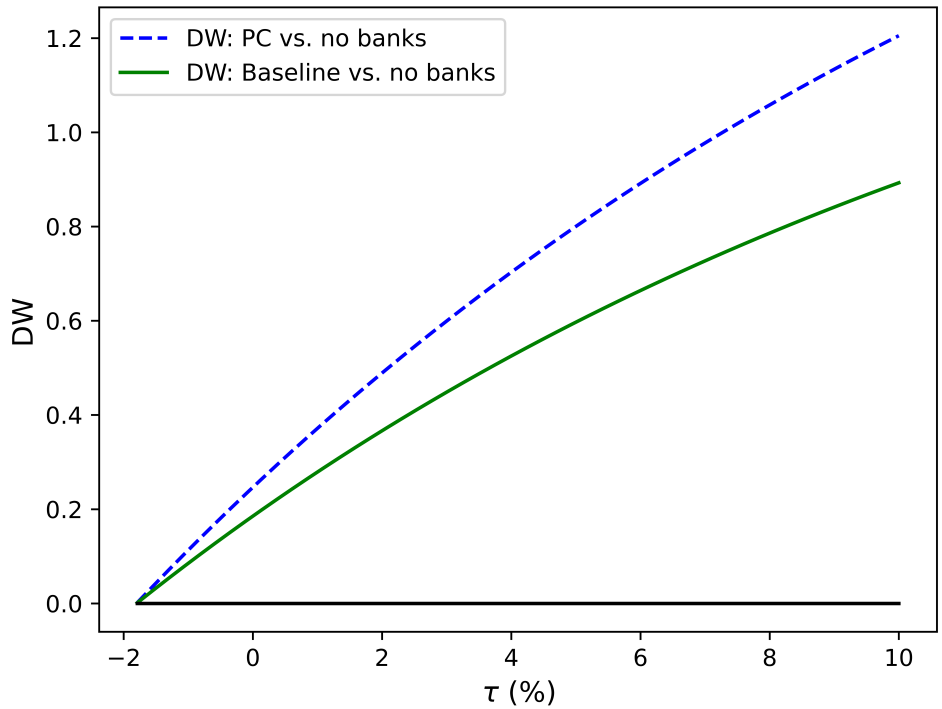
- Spread (*intensive*) versus frequency trading with depositors (*extensive*) margin tension.
- Higher inflation, upper bound of $\text{supp}(G(\cdot, \gamma))$ shifts right, increases dispersion (and average spread) of posted deposit rates.

Inflation, dispersion and DM capital returns (Proposition 4)



- Deposit-rate markdown by banks reduces the additional gain of investing capital.

Inflation, banking competition and welfare (Proposition 4)



- Welfare is measured in terms of households ex-ante lifetime utility. ▸ Welfare criterion
- $DW = W^{i} - W^{no-bank}$, $i \in \{\text{baseline, perfect competition}\}$.
- Gains from banking due to insurance on liquidity risks.

Summary of model insights

1. Higher trend inflation rate reduces the rate of return on holding money.
2. Banking liquidity transformation reduces the cost of being stuck with idle money balances.
3. But, bank market power removes some of the benefits of banking.
4. Distortion on allocation (consumption and capital) and welfare.

More details on policy experiment and model implied relationships:

- ▸ Comparative steady states;
- ▸ Money, Capital, Banking Market Power and Monetary Policy;
- ▸ Deposit Spread Dispersion.

Economic growth (overview)

- We consider an exogenous growth setup similar to that in Waller (2011).
  - CM technology: $F(K, AH) = K^{\alpha}(AH)^{1-\alpha}$.
  - DM technology: $f(k, Ae) = k^{\psi}(Ae)^{1-\psi}$.
  - Labor-augmenting technology factor evolves according to $A_{+} = (1 + \mu)A$.
- Insight from Waller (2011): monetary policy affects both the balanced growth path and growth dynamics of the economy.
- Here: The difference in the implications of economic growth is due to the policy-dependent banking market power.
- In what follows, we focus on the growth dynamics for discussion.

Economic growth (details) I

Neoclassical growth model (capital is only productive in CM):

$$1 + g_k^{\text{neoclassical}} \equiv \frac{\hat{K}_+}{\hat{K}} = \frac{1}{1+\mu}\left[\alpha\beta\hat{K}^{\alpha-1}\right]. \tag{5}$$

SME without banks $(\alpha_1 = \alpha_2 = 0)$, i.e., Waller (2011):

$$1 + g_k^{\text{Waller}} \equiv \frac{\hat{K}_+}{\hat{K}} = \frac{1}{1+\mu}\left[\frac{\alpha\beta + \Theta[1+\frac{i}{n}]^{-1}}{1+\Theta[1+\frac{i}{n}]^{-1}}\right]\hat{K}^{\alpha-1}. \tag{6}$$

SME with perfectly competitive banks $(\alpha_2 = 1)$:

$$1 + g_k^{\text{PC}} \equiv \frac{\hat{K}_+}{\hat{K}} = \frac{1}{1+\mu}\left[\frac{\alpha\beta + \Theta[1+i]^{-1}}{1+\Theta[1+i]^{-1}}\right]\hat{K}^{\alpha-1}. \tag{7}$$

Economic growth (details) II

- Monetary policy affects the capital growth rate, an insight from Waller (2011)
  - Higher i induces lower g_k^{Waller}.
- Banking facilitates more investment in transitional path, $g_k^{\text{Waller}} < g_k^{\text{PC}}$.

Economic growth (details) III

Our baseline model economy:

$$1 + g_k^\star \equiv \frac{\hat{K}_+}{\hat{K}} = \frac{1}{1+\mu}\left[\frac{\alpha\beta + \Theta[\tilde{c}(\gamma)]^{-1}}{1 + \Theta[\tilde{c}(\gamma)]^{-1}}\right]\hat{K}^{\alpha-1}, \tag{8}$$

where

$$\tilde{c}(\gamma) := 1 + \underbrace{\mu_d(\gamma)}_{\text{average deposit rate}} + \frac{1}{n}\underbrace{[i(\gamma) - \mu_d(\gamma)]}_{\text{average deposit spread}}.$$

The difference in the implications of economic growth relative to Waller (2011):

- Banking market power raises the cost of holding money distorting DM goods trades.

Economic growth (details) IV

- A fall in the additional benefits of investing capital lowering capital growth rate, but better than no-bank equilibrium:

$$g_k^{\text{Waller}} < g_k^{\star} < g_k^{\text{PC}}.$$

Conclusion I

1. A (new) *deposit channel* of monetary policy:
   - Bank market power in noisy search: Equilibrium dispersion of markdown (MD) on deposit rates
   - Incomplete and policy-dependent policy pass-through
2. New state-level evidence (RateWatch bank-branch data) corroborates model prediction: corr$(std_{MD}, MD) > 0$.
3. Growth consequences:
   - Banking improves growth (if money-capital dynamics not decoupled)
   - Incomplete pass-through via markdown distribution sucks juice out, but still better than no-bank equilibrium

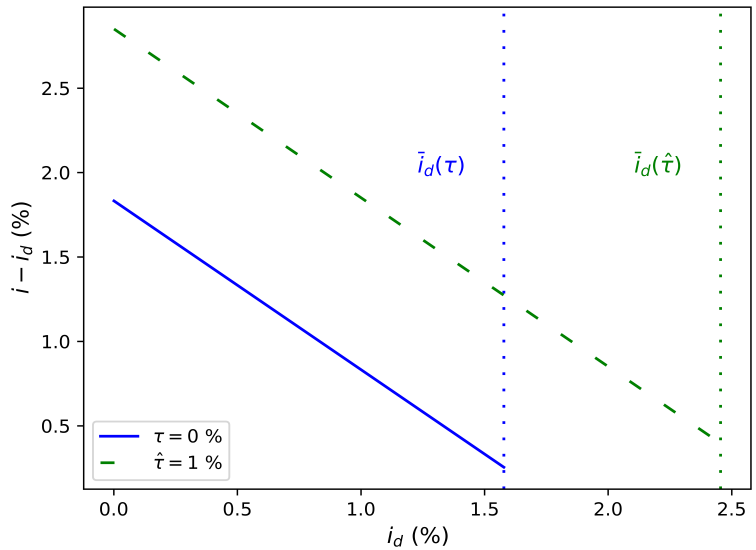
Conclusion II

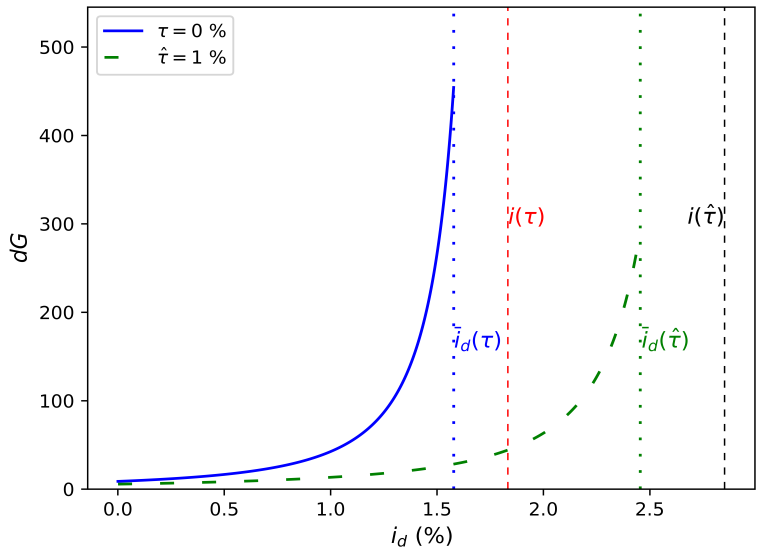
4. Optimal policy? (Conjecture):

- Model provides rationale for opening up central-bank depository facility to public. CBDC!
- CBDC helps discipline deposits-side bank market power.
- Possible to restore efficient banking equilibrium and long run growth rate g_k^{PC}.
- Results seems straightforward?
- In reality not so obvious. A more elaborate model will have private banks substituting between loans and alternative assets (bonds?). Also, CBDC may distort banks' risk-taking incentives.

Thank you!

Banks' intensive vs. extensive margins trade-offs





- Spread (*intensive*) versus frequency trading with depositors (*extensive*) margin tension.
- Higher inflation rate, equilibrium support of distribution shifts right and becomes wider, reflecting an increase in dispersion of posted deposit rates.

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Appendix: Household optimizes

Money demand Euler equation:

$$\frac{\gamma-\beta}{\beta}=(1-n)\mu_d(\gamma)+n\left[\frac{u_q(q)}{c_q(\frac{n}{1-n}q,K)}-1\right], \tag{9}$$

where

$$\mu_d(\gamma):=\int_{\underline{i}_d}^{\bar{i}_d}\left[\alpha_1+2\alpha_2-2\alpha_2 G(i_d,\gamma)\right]i_d \mathrm{d}G(i_d,\gamma).$$

Capital investment Euler equation:

$$\frac{1}{\beta}=[1+F_K(K,H)-\delta]-(1-n)\left[\frac{c_K(\frac{n}{1-n}q,K)}{U_X(X)}\right]. \tag{10}$$

CM consumption-labor trade-off: $U_X(X)=\frac{1}{F_H(K,H)}$.

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Appendix: Firms optimize

- Centralized market (CM):
  - Firms are perfectly competitive
  - hire labor and capital
  - Profit-max strategy: $w = F_H(K, H)$ and $r = F_K(K, H)$
- Decentralized market (DM):
  - Walrasian price taking
  - Cost of producing $c(q, K)$
  - Cost-min strategy: $c_q(q, K) = \rho/w$.

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Appendix: Banks optimize

- The posted deposit rate cumulative distribution function is:

$$G(i_d) := G(i_d, z, \gamma) = 1 - \frac{\alpha_1}{2\alpha_2}\left[\frac{R(i_d^m)}{R(i_d)} - 1\right] \quad \text{for all } i_d \in \text{Supp}(G), \tag{11}$$

  where $R\left(i_d\right) = \left(z + \tau_1 Z\right)\left[i - i_d\right]$ is the profit per deposit customer served.

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

- All posted deposit rates yield equal expected profit overall:

$$R\left(i_d\right) = \frac{\alpha_1}{\alpha_1 + 2\alpha_2} R(i_d^m) \tag{12}$$

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Appendix: Deposit interest is feasible

Total amount of loans cannot exceed total amount of deposits

$$\underbrace{(1-n)\int_{\underline{i}_d}^{\bar{i}_d}[\alpha_1+2\alpha_2-2\alpha_2 G(i_d,z,\gamma)](z+\tau_1 Z)\mathrm{d}G(i_d,z,\gamma)}_{\text{total deposits}} \geq \underbrace{nl^\star(i,z,\gamma)}_{\text{total loans}}, \tag{13}$$

and aggregate balance sheet constraint is satisfied

$$\underbrace{(1-n)\int_{\underline{i}_d}^{\bar{i}_d}[\alpha_1+2\alpha_2-2\alpha_2 G(i_d,z,\gamma)](z+\tau_1 Z)\mathrm{d}G(i_d,z,\gamma)}_{\text{total liabilities}} = \underbrace{b+nl^\star(i,z}_{\text{total assets}} \tag{14}$$

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Appendix: Goods market clear (both DM and CM)

DM goods market:

$$\underbrace{(1-n)q_s}_{\text{total supply}} = \underbrace{nq}_{\text{total demand}} . \tag{15}$$

CM goods market:

$$\underbrace{F(K,H)}_{\text{total supply}} = \underbrace{X + K - (1-\delta)K}_{\text{total demand}} . \tag{16}$$

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Existence and uniqueness of SME

Proposition

Under sufficient conditions, there exists a unique SME co-existing with money, capital and credit.

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Endogenous variables: more details

$$K = \frac{(1-\alpha)\hat{k}}{1-\delta\hat{k}^{1-\alpha}}, \tag{17}$$

$$q = \left[\omega\left(\frac{n}{1-n}\right)^{\omega-1}\tilde{c}(\gamma)\right]^{\frac{1}{1-\sigma-\omega}} K^{\frac{1-\omega}{1-\sigma-\omega}}, \tag{18}$$

where

$$\tilde{c}(\gamma) := 1 + \frac{1}{n}\Big[i(\gamma) - (1-n)\mu_d(\gamma)\Big].$$

Once $\hat{k}^\star$ is pinned down from Equation (4), we can back out K and q using Equations (17) and (18). Finally, we get H by $K/\hat{k}$ and X by the CM goods market clearing condition.

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Allocation with banks versus without banks

Proposition

Assume inflation is away from the Friedman rule, $\gamma > \beta$ and $\alpha_2 < 1$. Financial intermediation improves allocation and welfare relative to a no-bank economy:

$$q^{\star,no-bank} < q^{\star} < q^{\star,PC} \quad \text{and} \quad K^{\star,no-bank} < K^{\star} < K^{\star,PC},$$

where equilibrium allocation $(q^{\star}, K^{\star})$ approaches $(q^{\star,PC}, K^{\star,PC})$ as the baseline economy tends to its perfect-competition limit, i.e., $\alpha_2 \to 1$.

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Imperfect pass-through of monetary policy to the banking sector

Proposition

Let the average posted deposit-rates spread to be defined as

$$s(\gamma) = i(\gamma) - \int_{i_d^m}^{\bar{i}_d} i_d \mathrm{d}G(i_d;\gamma). \tag{19}$$

The deposit spread increases with inflation γ.

- Higher inflation induces a fall in the supply of deposits, and supply becomes more inelastic.
- Banks on-average exploit more of their intensive-margin channel to charge a higher spread.
- Higher inflation gives more market power to the banks on their deposit pricing.

Welfare criterion

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

$$W^{\text{baseline}}(\tau) = \frac{1}{1-\beta}\Bigg[nu[q(K)] - (1-n)c\Bigg[\frac{n}{1-n}q(K), K\Bigg] + U[X(K)] - \overline{A}H(K)\Bigg], \tag{20}$$

where q and K are respectively determined by Equation (18) and Equation (17).

Similarly, we can calculate welfare for the no-bank economy and the economy with perfectly competitive banks.

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Comparative Steady States: more details

- Model calibration to the macro-level data ▸ calibration;
- Consider a set of economies, each distinguished by their long-run inflation rates, τ
- How does the change in inflation rate affect:
  - banks profit, ▸ Profits;
  - goods trades and capital formation ▸ Consumption and capital.

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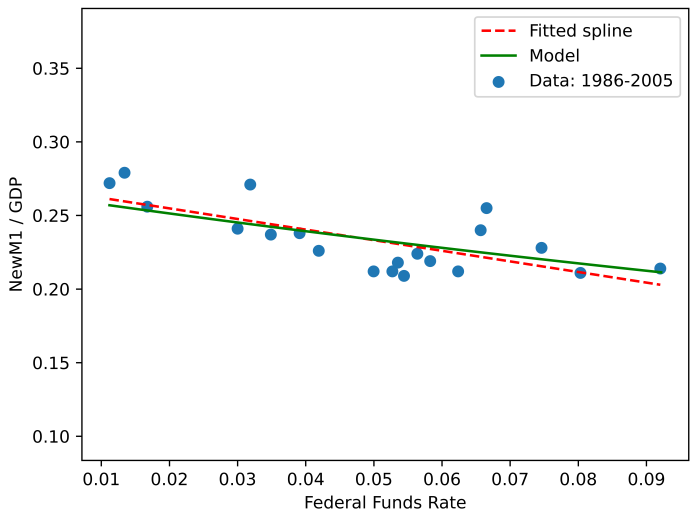
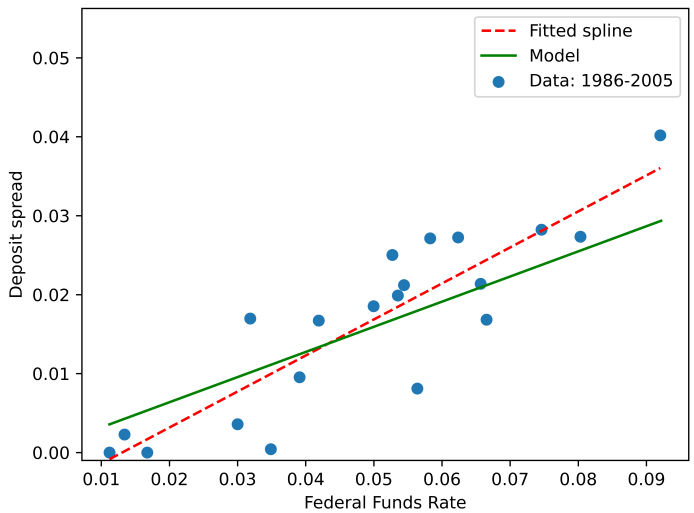
Calibration

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

Method of Simulated Moments:





to pin down preference $(\bar{U}_{\mathsf{CM}}, \sigma)$ and bank contact rates (α_1, α_2).

Data: Lucas-Nicolini (2015); Call reports (FDIC)

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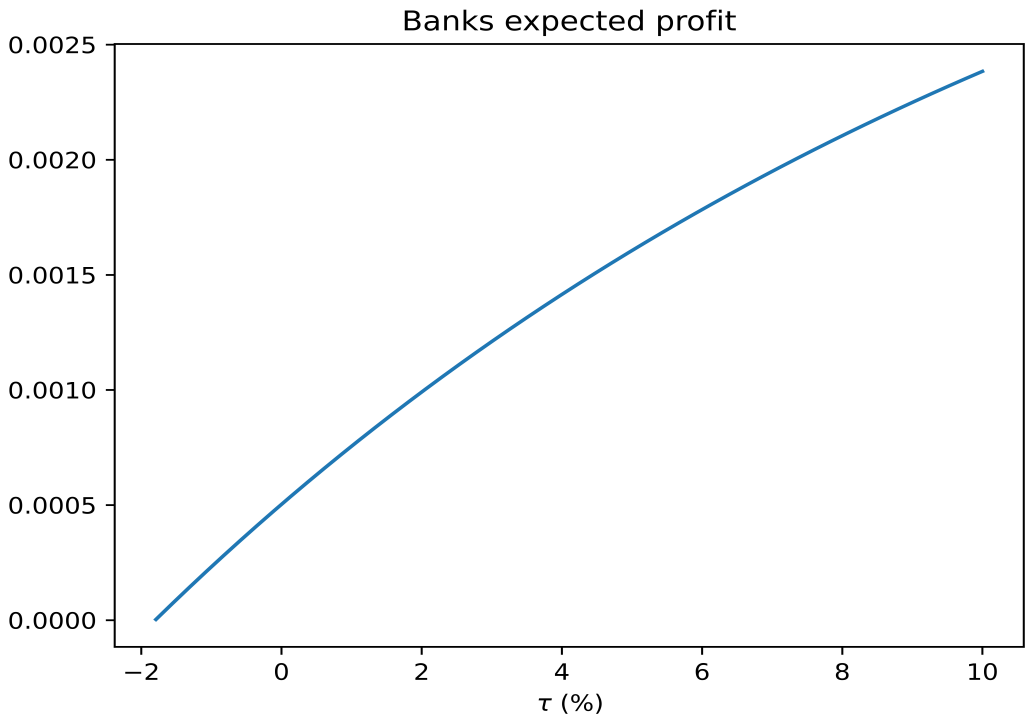
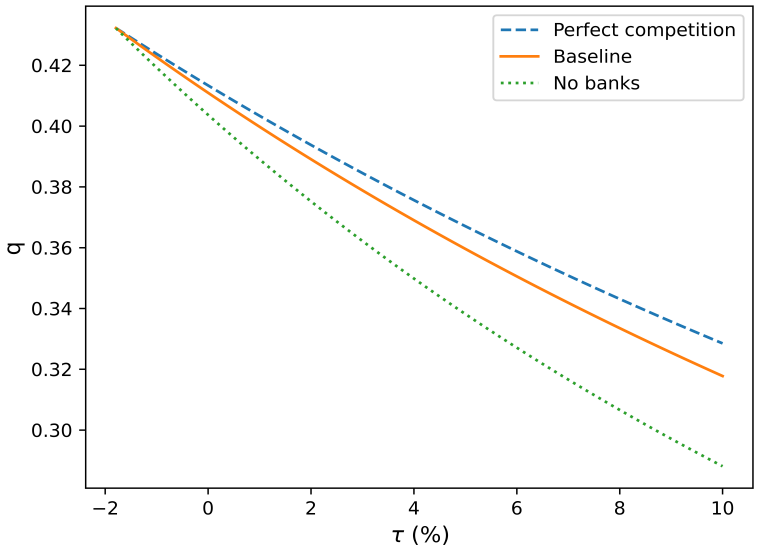
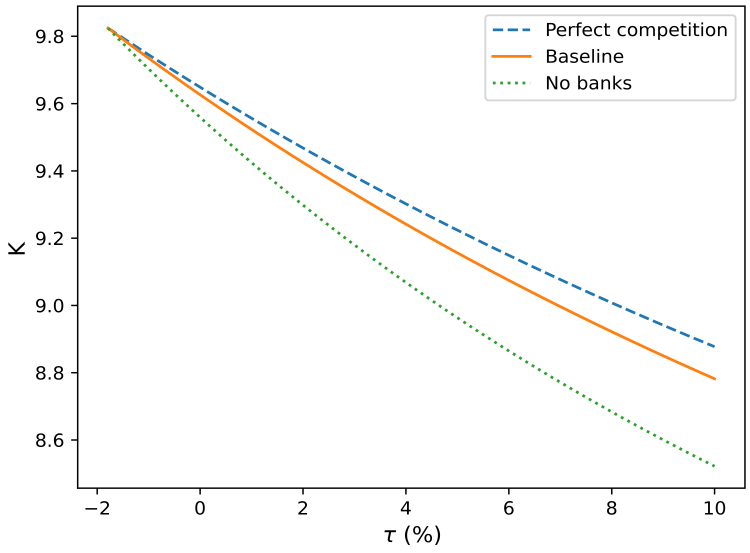
Bank profits



- Higher trend inflation induces a fall in deposits supply.
- Banks extract more rent from depositors.
- Eventually, bank's expected profits $\Pi(i_d) \searrow 0$ as the τ goes to infinity (we verify that in robustness check). The reason is value of liquidity becomes small in hyperinflationary economies and the supply of deposits falls to zero.

Allocation q, K





- Banking improves both consumption and capital than the no-bank economy.
- But, a reduction in consumption and capital due to imperfect competition among banks.

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Model implied relationships: money, capital and banking market power

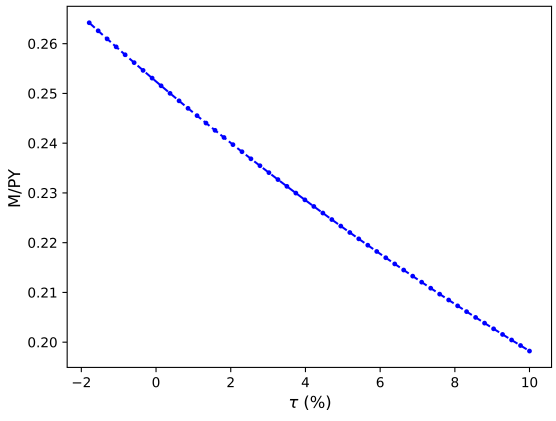

Figure: M/PY and τ

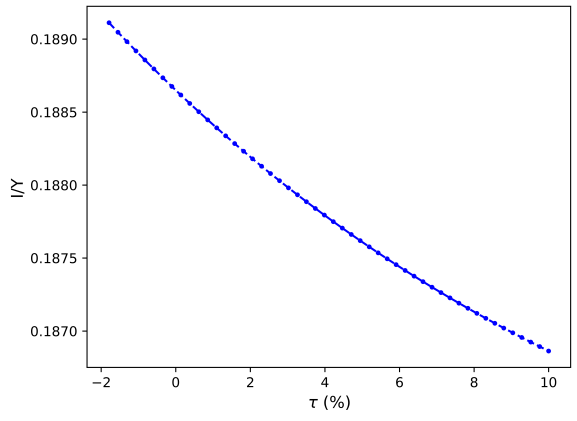

Figure: I/Y and τ

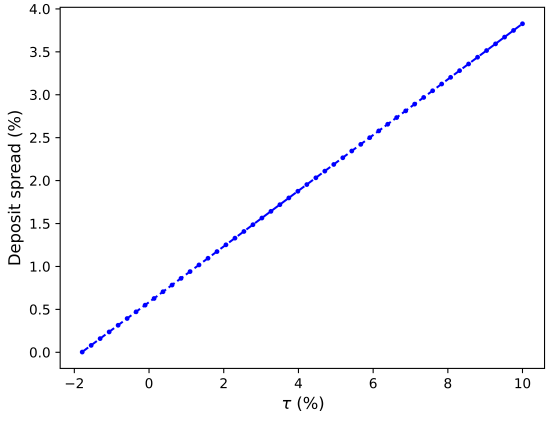

Figure: Deposit spread and τ

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Model implied relationships: deposit spreads and dispersion

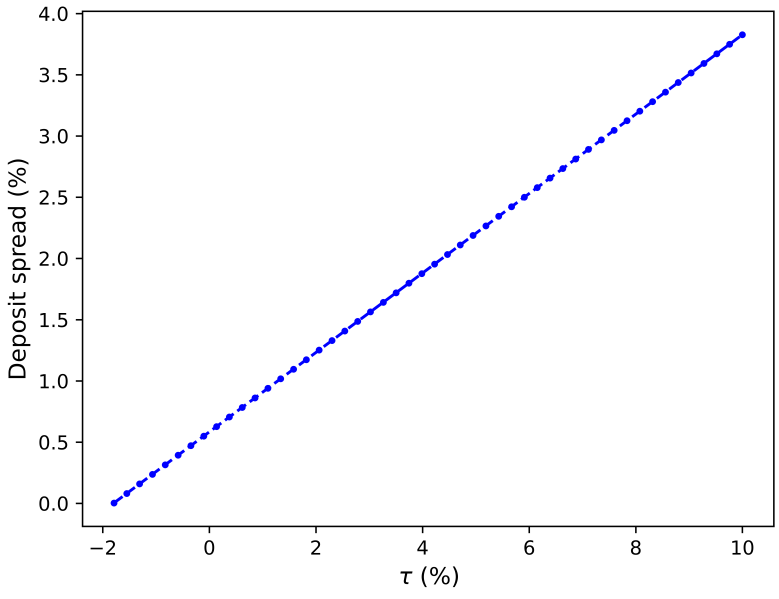

Figure: Deposit spread and τ

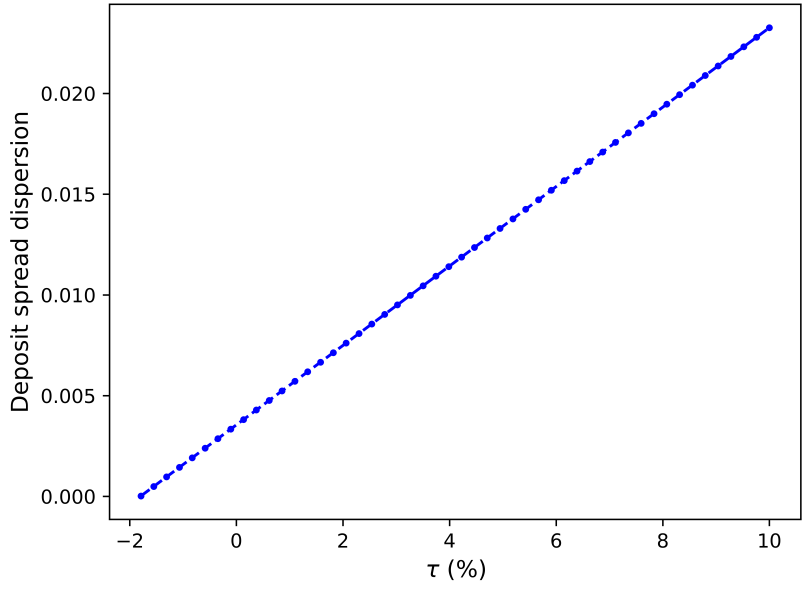

Figure: Deposit spread dispersion and τ

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