State-dependent pass-through from monetary policy to lending rates

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Motivation

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- The strength of **pass-through** to lending rates **may vary over time and space**.
- Understanding the **source of pass-through heterogeneity** is crucial to assess the real effects of MP on the macroeconomy.

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$\Rightarrow$ **Positive Skewness**.

2 Length and Fatness vary by location and time.
$\Rightarrow$ **Skewness varies over time and space**.

This Paper: Empirical Contribution

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- **Key Result 1:** Higher initial skewness $\Rightarrow$ stronger MP pass-through to lending rates
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- **HOW:** Local Projections & detailed micro-data on lending
    - **High-Frequency Proxy** identification of exogenous variation in MP rate changes.
    - Panel Local projections with **interaction terms**
    - **Branch/product-level** lending rates on new loans.

This Paper: Theoretical Contribution

Q: How can we explain my empirical findings?

A: Theoretical model of lender imperfect competition

$$\left.\begin{array}{l}\bullet\ \text{Bertrand } \textbf{competition} \\ \bullet\ \text{Customers' } \textbf{switching friction}\end{array}\right\}\ \underline{\textbf{Price Dispersion (absent any shock)}}$$

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6 Stronger complementarity ⇒ larger MP pass-through to lending rates.

Literature Review

State-Dependence of Monetary Policy

- Mortgage Refinancing/Prepayment channel. Berger et al. (2021), Eichenbaum et al. (2022).

⇒ **Explore state-dependence arising from bank's strategic pricing and customer search & switching frictions.**

Monetary Policy Transmission through Banks

- Long stream: banks' regulatory and asymmetric information constraints. Bernanke and Blinder (1988), Kashyap and Stein (2000).
- Recent stream: banks' market power in liquidity provision. Nagel (2016), Drechsler et al. (2017), Wang et al. (2020).

⇒ **Expand to role of bank imperfect competition and consumer frictions.**

IO literature on Customer Search and Switching costs.

- Yankov (2018),Luco (2019), Andersen et al. (2020)

⇒ **Expand on the role of search & switching costs on interest-setting.**

Outline

Core Micro-Data

Branch-Level Lending Rates (S&P GMI Ratewatch):

- Time Span: 2001-2019.
- 100,000+ branches (brick-and-mortar offices, cyber offices).
- 7500 financial institutions (banks, credit unions, savings and loan companies, brokers...).
- 30+ Loan Products (House, Consumer Durables, Small Business Loans, Commercial RE).

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- 30+ Loan Products (House, Consumer Durables, Small Business Loans, Commercial RE).
- Monthly new loan advertised rates (New to the literature).
- Loan product characteristics.
- Branch location, ownership & rate-setting rights.

Data: Macro at all levels.

1. **National - Level** :
    - GDP, CPI Index, Commodity Price Index, Excess Bond Premium, Home Price Index, Home Ownership Indexes.
2. **State - Level** :
    - GDP (total and by Industry), Personal Income,
    - Inflation (Hazell et al. (2020))
    - State Home Price Index.
3. **County/MSA - Level** :
    - Unemployment (BLS-LAUS)
    - Wages (BLS-QCEW & CES)
    - House Prices (Zillow)

Data: Lending at all levels

4 **Lender - level** (Call Reports):
- Assets and liabilities.
- Interest revenue and expense by Asset & Liability category

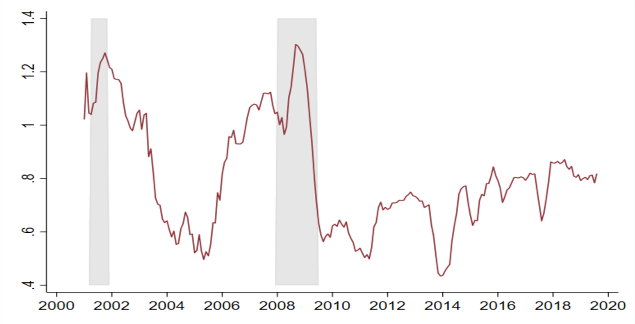
5 **Other: Branch - level** (FDIC Summary of Deposits):
- Anagraphic and total deposits by branch/year.

6 **Other: Loan - level** (Freddie-Mac Data):
- Loan characteristics (Location, LTV)
- New/Renegotiation/Cash-out status
- Borrower characteristics (FICO)

Outline

Branch-Level Data: variation over time and space

Example: New advertised Loan Rates for Personal Recreational Vehicle purchase.



Lending rates skewness, US overall distribution.

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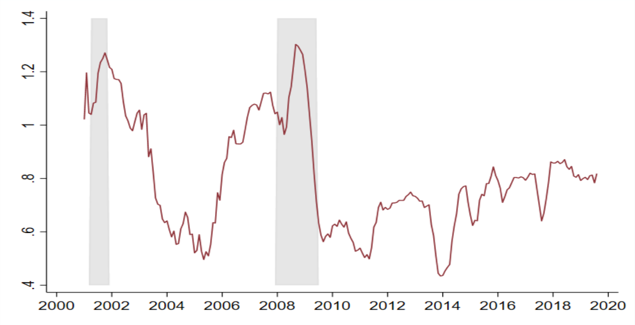


Lending rates skewness, US overall distribution.

▸ Cross-Section ▸ LendingTree ▸ Cross-County Mean ▸ Realized Rates ▸ More Product Types

Outline

Local projection specification

Methodology: Local projections. County (c) /month (m) level.

$$\begin{aligned}\text{Outcome Variable}_{t+h,c} &= \alpha + \boldsymbol{\beta_0}\mathbf{MP}_t + \underline{\boldsymbol{\beta_1}}\left[\mathbf{MP}_t \times \widehat{\mathbf{Skewness}}_{t-1,c}\right] + \sum_{k=0}^{2}\beta_{3,k}\widehat{\text{Skewness}}_{t-k-1,c} + \\ &+ \sum_{k=1}^{2}\rho_{1,k}\text{MP}_{t-k} + \sum_{k=1}^{2}\rho_{2,k}\left[\text{MP}_{t-k} \times \widehat{\text{Skewness}}_{t-k-1,c}\right] + \\ &+ \sum_{k=1}^{2}\gamma_k X_{t-k,c} + \sum_{k=1}^{2}\delta_k X_{t-k,US} + \sum_{k=1}^{2}\chi_k X_{t-k,Bank} + \varepsilon_{t,c}\end{aligned}$$

Outcome Variables: County Average Lending Rate, County Unemployment Rate.

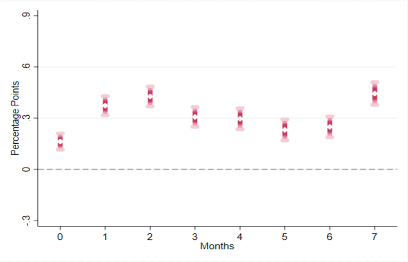
Controls: National GDP, Defl, Stock Market, Excess Bond Premium, county: wage growth, unemployment, home prices, Herfindal Index, ROA, Cost of Funds, Loan Loss Provisions, Category/County FE.

Identification: High Frequency Proxy from Bauer and Swanson (2022).

Note: $\widehat{\text{Skewness}}$ defines the county-level skewness subtracted of its long-run mean.

Coefficient Plots: Lending Rates

Average response of county lending rates to 100 b.p. MP shock



(a) Response with skewness at long-run mean (β_0).

- Pass-Through significantly higher when skewness is high.

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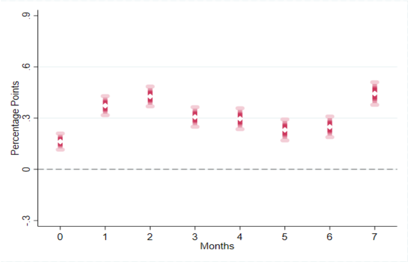

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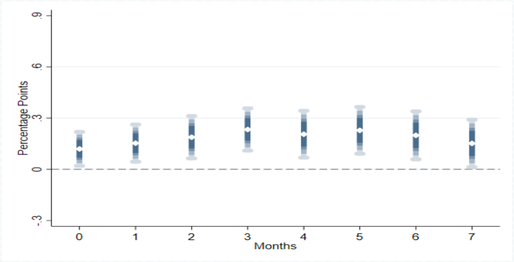

(b) Additional impact with skewness 1 s.d. above mean (β_1)

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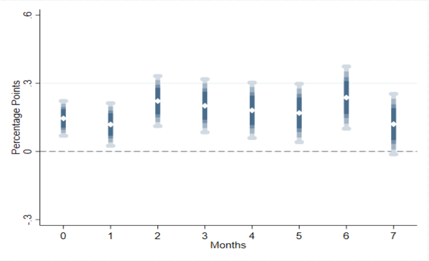
Robust Specification: Lending Rates

Average response of county average lending rates to 100 b.p. MP shock, robust specification



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- Variance is not significant.

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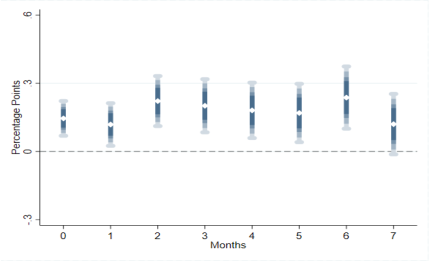

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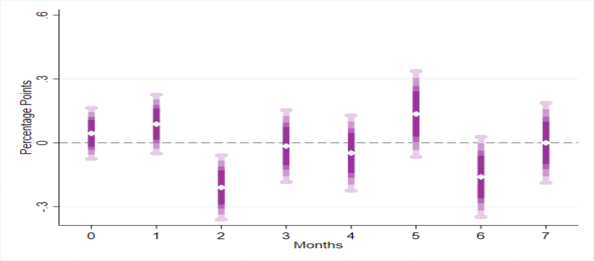

(c) Additional impact: variance 1 s.d. above mean (β_3)

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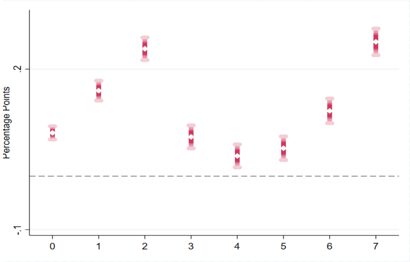
Table Results

Coefficient Plots: Unemployment Rate

Average response of county unemployment rate to 100 b.p. MP shock



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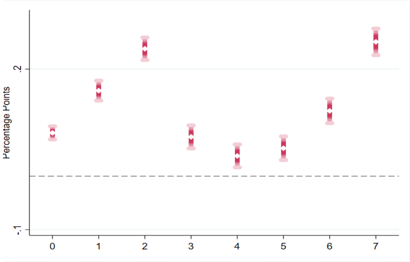

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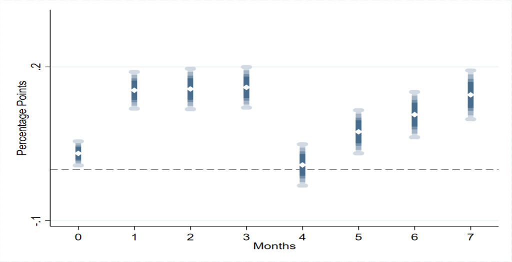

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Robustness

- Variance vs Skewness.
- Increased Set of Interaction Terms.
- Different High-Frequency Proxy.
- Average Interest Rate Expense.
- Robustness with Respect to US pooled Skewness.
- Real Personal Income (State/Lender Level Data).
- Loan-Level Data on Realized Rates.

More Robustness

Outline:

Main Model Ingredients

Skewness to Theory:

- The key mechanism underlying the relevance of the skewness as a state variable involves:

    1 Lenders imperfect price competition.

    2 Consumers' Switching Costs.

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Model Structure:

- Repeated Bertrand Competition: two banks (Bank H & L) and many identical clients.

Very Simple Illustrative Framework

Game Timeline

Each period is made of 4 stages:

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  $S(r^H_{t-1} - r^L_{t-1}) =$ measure of clients with search cost $>$ expected gain from switching to lender L.

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    - Client of L takes loan from L if $v - z_L - r_t^L > 0$.
    - Client of H who did not search borrows if: $v - z_H - r_t^H > 0$

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  - Client of H who did search borrows if: $v - z_H - r_t^H \geq v - z_L - r_t^L$

Where the fun happens: demand functions

Demand Functions:

Bank H:

$$X_H(r_H, r_L) = \bar{Q}_H - \beta_H r_H + \kappa r_L$$

Bank L:

$$X_L(r_H, r_L) = \bar{Q}_L - \beta_L r_L + \kappa r_H$$

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Demand Functions expanded:

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$$X_H(r_H, r_L) = \left[\bar{Q}_H - \underbrace{\left[\lambda_1 S + \frac{1}{2}\lambda_1(1-S) \right]}_{\beta_H} r_H + \underbrace{\left[\frac{1}{2}\lambda_1(1-S) \right]}_{\kappa} r_L \right]$$

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State Dependency: $S = S(r^H_{t-1}, r^L_{t-1})$

Profit Functions

Bank H:

$$\pi_H = [r_H - c]\left[\bar{Q}_H - \underbrace{\left[\lambda_1 S + \frac{1}{2}\lambda_1(1-S)\right]}_{\beta_H} r_H + \underbrace{\left[\frac{1}{2}\lambda_1(1-S)\right]}_{\kappa} r_L\right]$$

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Solution Strategy:

- Best Responses. (details)
- Equilibrium Rates. (details)
- Pass-Through.

Results about the Pass-Through.

Consider the Pass-Through, respectively $\frac{\partial r_L^*}{\partial c}$, $\frac{\partial r_H^*}{\partial c}$

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Proposition 1

$$\frac{1}{2} < \frac{\partial r_i^*}{\partial c} < 1 \qquad \text{for } i = H, L^1.$$

- **Intuition 1.1:** Pass-Through $> \frac{1}{2}$ (Monopolist).
- **Intuition 1.2:** Pass-Through < 1 (Bertrand Paradox).

[1] Technical Condition: $\kappa < \beta_i$

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- **Take-Away** Mass of borrowers searching pins down how close the pass-through is to either of the two extremes.

[1] Technical Condition: $\kappa < \beta_i$

Results about the Pass-Through.

Proposition 2

$$\frac{\partial r_i^*}{\partial c} \text{ is increasing in } \left(r_{t-1}^H - r_{t-1}^L\right) \text{ and } \lambda_1.$$

Intuition: Larger difference among past rates $\Rightarrow$ More clients search.

▸ Variance vs Skewness

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$$\frac{\partial r_H^*}{\partial c} > \frac{\partial r_L^*}{\partial c}$$ [1]

Intuition: L faces only "upside-risk" of acquiring clients from Bank H.

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Implications:

1 Empirical Test of Proposition 3. (next slide)
2 **Path Dependence** of Monetary Policy.

[1] Technical Condition $\lambda_2 > \lambda_1 S$

▸ Variance vs Skewness

Empirical Test of Proposition 3

Table: Responsiveness of High vs Low Rate lender to a 100 b.p. monetary policy shock when skewness is high

Month	0	1	2	3	4	5	6	7	8	9	10
Low Rate	-0.01	-0.01	0.03	0.04*	0.06**	0.08***	0.42***	0.45***	0.38***	0.09***	0.20***
	(-0.69)	(-0.39)	(1.25)	(1.89)	(2.35)	(3.40)	(16.37)	(17.43)	(14.81)	(3.41)	(7.91)
High Rate	-0.06*	-0.04	0.01	0.13***	0.15***	0.13***	0.10***	0.07*	0.09**	0.20***	0.14***
	(-2.56)	(-1.24)	(0.40)	(3.46)	(3.91)	(3.31)	(2.61)	(1.69)	(2.21)	(4.90)	(3.52)
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	2317536	2200605	2139583	2080359	2028567	1983506	1943036	1898621	1860857	1823443	1784944
R^2	0.977	0.968	0.961	0.955	0.950	0.946	0.943	0.940	0.938	0.936	0.934

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Conclusions

- **Lending rate skewness** is a **quantitatively** important **state-variable** for MP effects.

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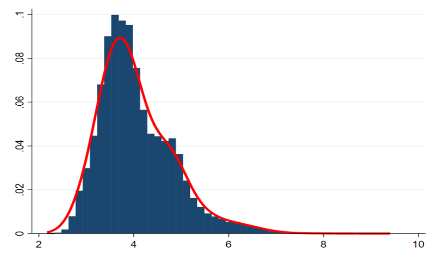
- Can account for **heterogeneity** across **space** and **time** of MP effects.
- **Search Frictions** create skewness-based state-dependent responses of lending rates to MP.
- **Future work:**
    1. Include data on loan applications to measure search efforts empirically.
    2. Extend analysis to deposit rates.
    3. Explore GE outcomes in general dynamic macro model.

THANKS!

APPENDIX

Facts: The curious shapes of the lending rate distributions.



(a) 30Y Mortgage Rates. Minneapolis-MSA. 2019-M1.

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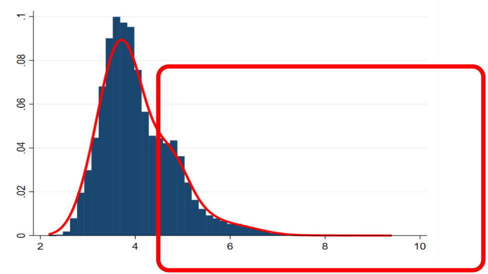

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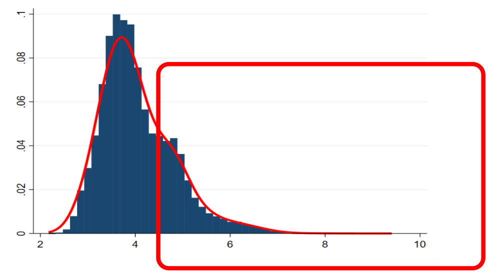

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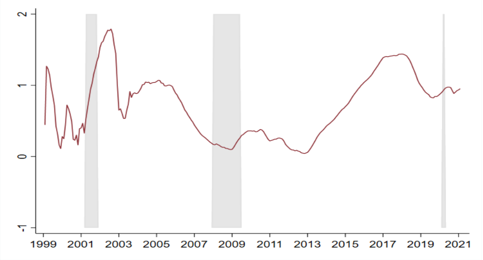


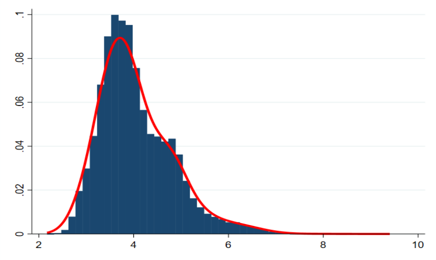
(b) Skewness Time-Series. Minnepolis-MSA

- Pronounced Asymmetric shape, market concentration but...
- Asymmetry is time-varying (next slides)

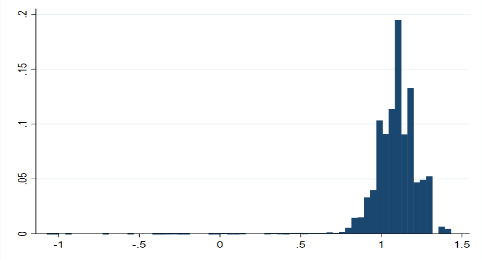
▸ MSA-Cross Distribution ▸ Branch-Level Distribution ▸ Online Marketplace dispersion ▸ Row Rates ▸ MP Pass-Through Heterogeneity ▸ Back

Facts: The curious shapes of the lending rate distributions.

Mortgage Rates cross-section. Minneapolis MSA vs All MSAs. Purged Borrower/Loan type.



(a) Distribution in 2019-M1.



(b) Skewness Distribution Over MSAs. (Recessions in grey)

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- Skewness cross-section MSA distribution centered around 1 and positive.

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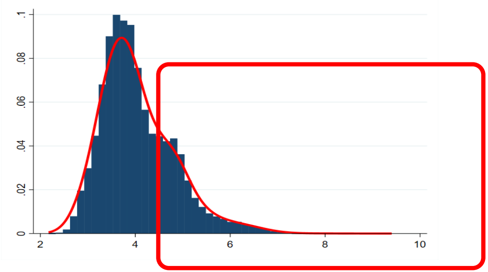

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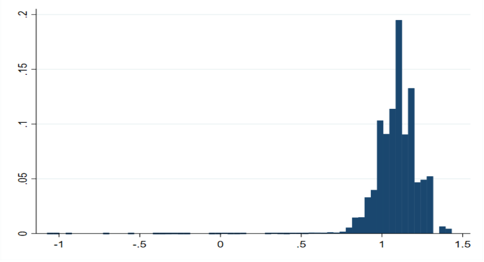

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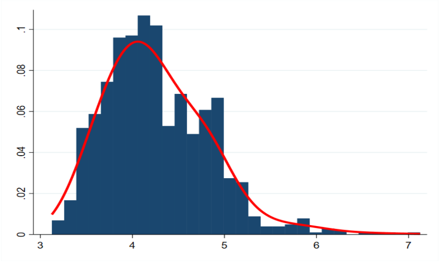
Mortgage Rates cross-section. Minneapolis MSA. Specific Borrower/Loan type.



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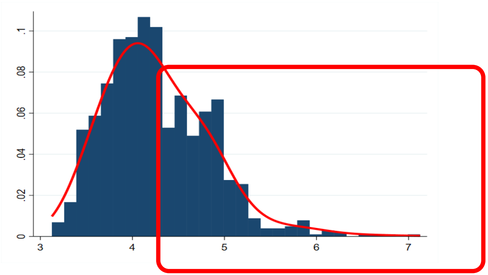

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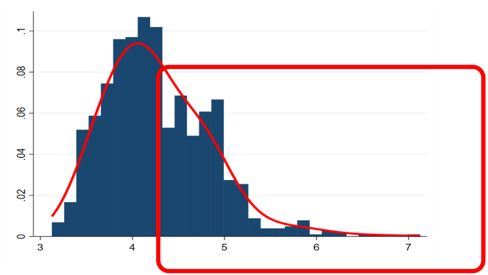

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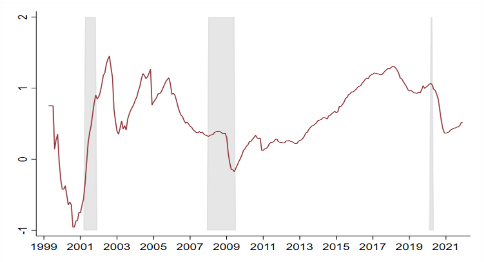

(b) Skewness over time. (Recessions in grey)

- Pronounced Asymmetric shape, market concentration but...
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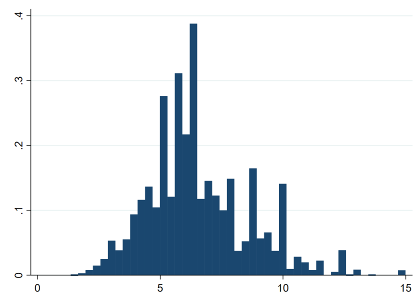
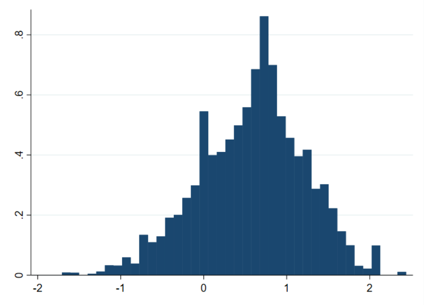
Back

Facts: The Distribution of offered rates by lender branch

Offered Rates on Pers Rec Veichle Loans



(a) L.A. Cross-sectional Distribution Lending Rates. 2016m1.



(b) National distribution of cross-sectional skewness.

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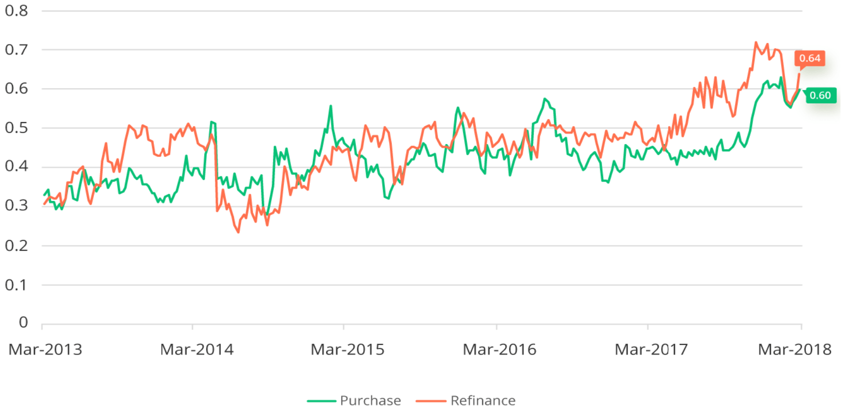
Facts: The lending rate dispersion on Online Marketplaces



Interest Rate Dispersion on LendingTree.com

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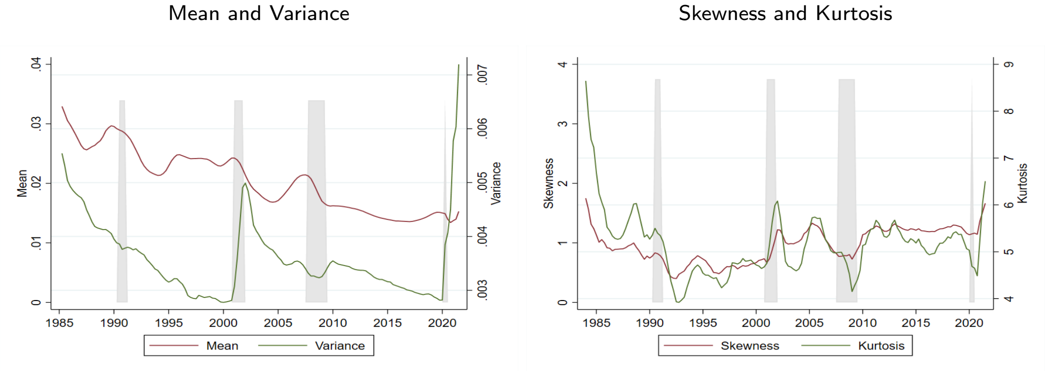
Lender-Level Distribution: higher order moments non-trivial dynamics

C&I Loan average interest rates

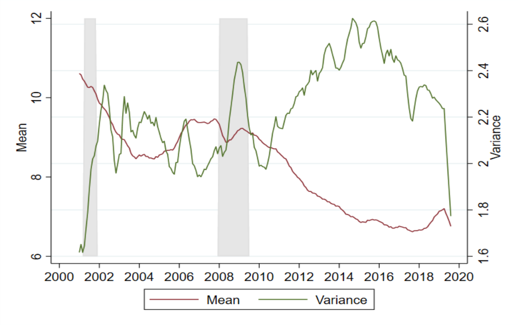


- Significant Time-Variation.
- Correlation between Skewness and Kurtosis.
- Different behaviour across different Recessions.

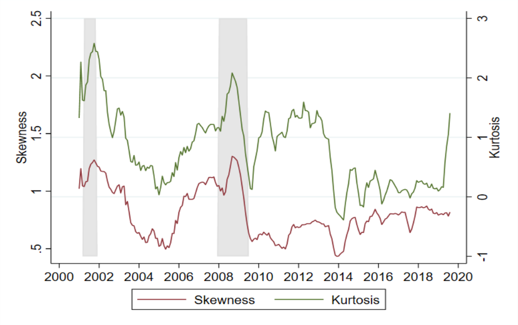
Branch-Level Distribution: higher order moments non-trivial dynamics

Personal Recreational Vehicle Advertised Loan Rates.

Mean and Variance

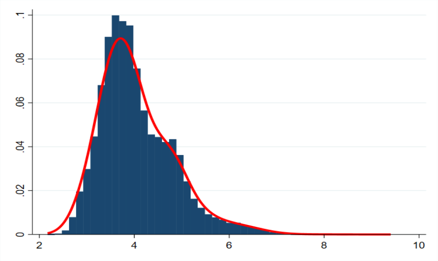


Skewness and Kurtosis



Back to Outline

Freddie Mac Data on Realized House Mortgage Rates



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- Pronounced asymmetry,

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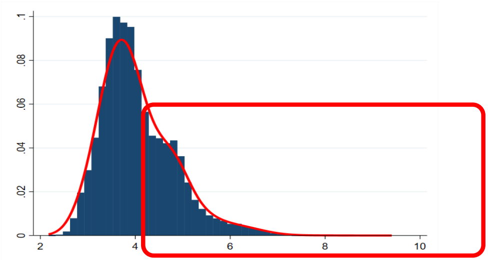

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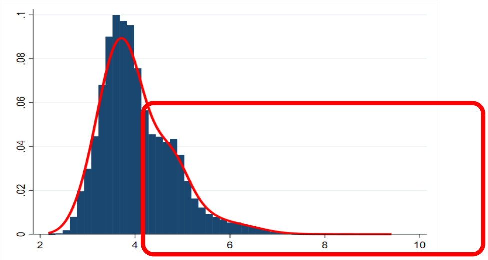

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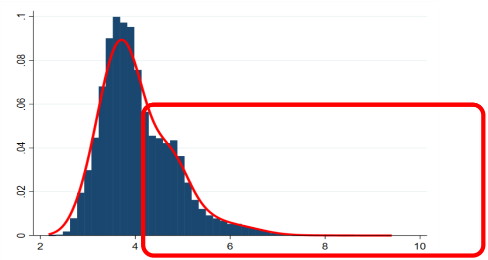

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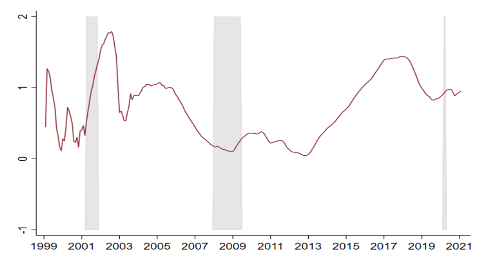

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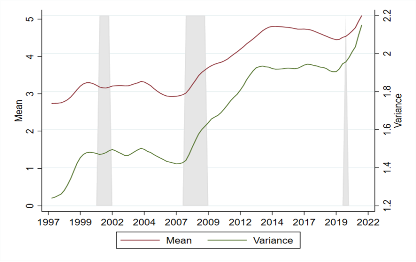
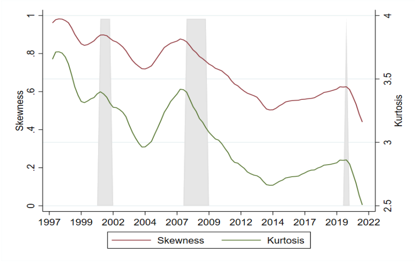
Evolution of Asset Average Maturity Distribution 1st to 4th Moment

Asset average maturity over time.

Mean and Variance



Skewness and Kurtosis



Asset average maturity computed as weighted average maturity assigning mid maturity to each asset category.

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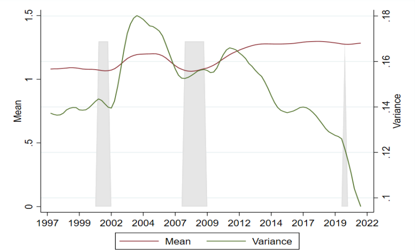
Evolution of Liabilities Average Maturity 1st to 4th Moment.

Liability average maturity over time.

Mean and Variance



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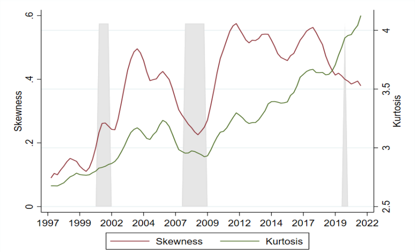

Liability average maturity computed as weighted average maturity assigning mid maturity to each liability category.

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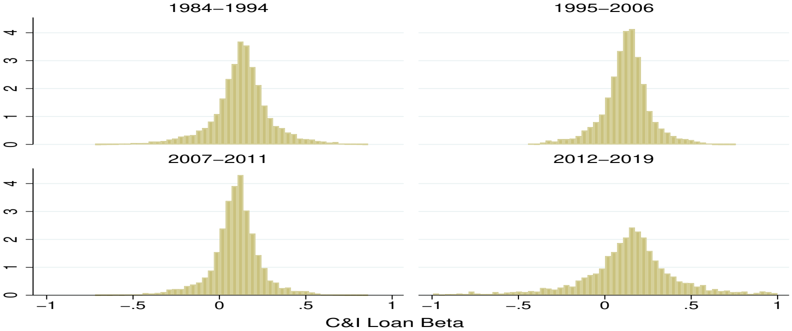
Evolution of C&I Loans Dynamic Beta full distribution

Beta: Measure of sensitivity of Loan Rate to movements in the policy rate (Drechsler et al. (2017))

$$\Delta \text{Rate}_{bank,t} = \alpha_{bank} + \alpha_t + \sum_{k=1}^{4} \beta_{bank,k} \Delta FFR_t + \varepsilon_{bank,t} \quad \textbf{BETA} = \sum_{k=1}^{4} \beta_k$$



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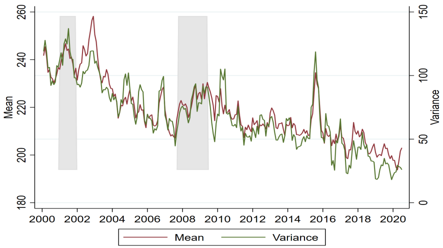
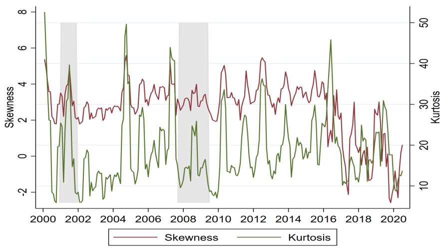
Evolution of Interest Rate Distribution 1st to 4th Moment. Dealscan

Dealscan interest rate spreads moments over time (average moment value over all Loan Types

Mean and Variance



Skewness and Kurtosis



Interest rates spread on base rate from Dealscan Data at monthly frequency.

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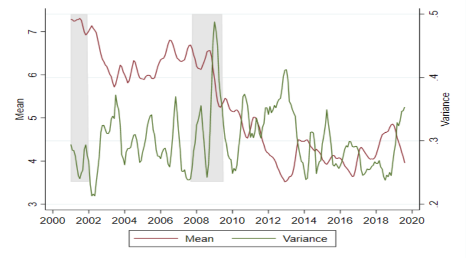
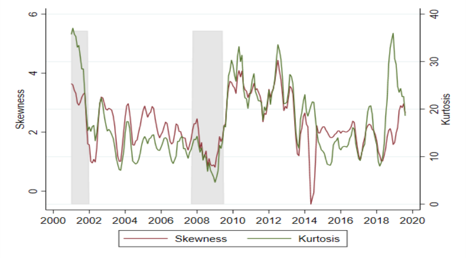
Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

Ratewatch interest rate spreads moments over time (30 Yr Fxd Mtreplace @ 175K)

Mean and Variance



Skewness and Kurtosis



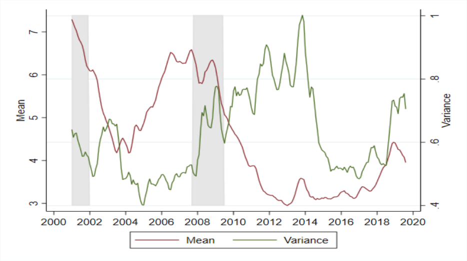
Interest rates at monthly frequency.

Back

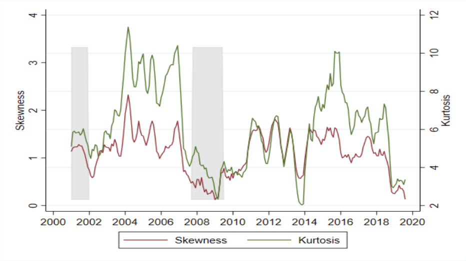
Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

Ratewatch interest rate spreads moments over time (3 Year ARM @ 175K)

Mean and Variance



Skewness and Kurtosis

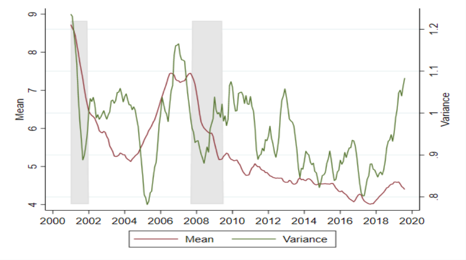


Interest rates at monthly frequency.

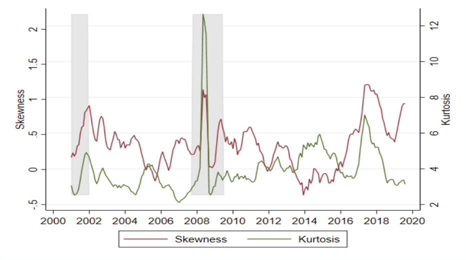
Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

Ratewatch interest rate spreads moments over time (Construction Loan @ 175K)

Mean and Variance



Skewness and Kurtosis

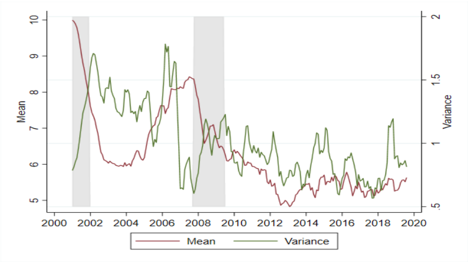


Interest rates at monthly frequency.

Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

Ratewatch interest rate spreads moments over time (Bus Loan Secured @ 50K)

Mean and Variance



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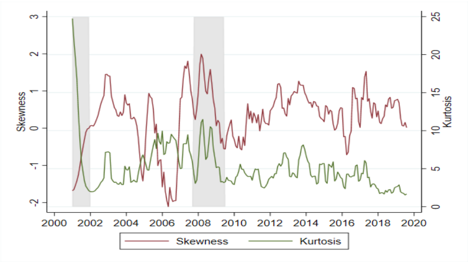
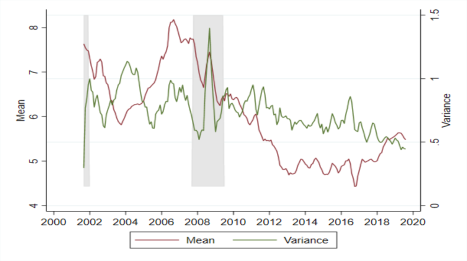


Interest rates at monthly frequency.

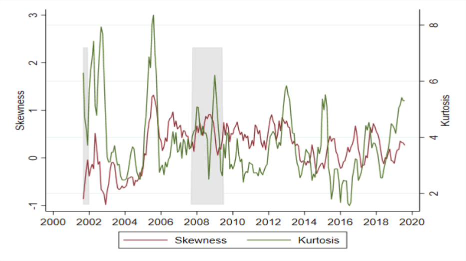
Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

Ratewatch interest rate spreads moments over time (Comm Real Estate @ 1M)

Mean and Variance



Skewness and Kurtosis

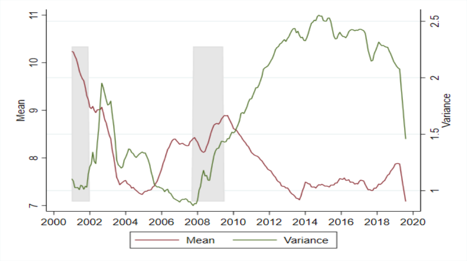


Interest rates at monthly frequency.

Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

Ratewatch interest rate spreads moments over time (Boat New)

Mean and Variance



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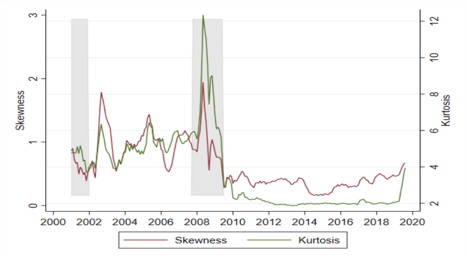
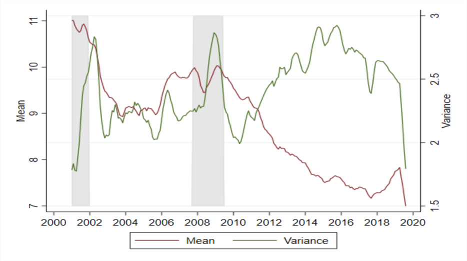


Interest rates at monthly frequency.

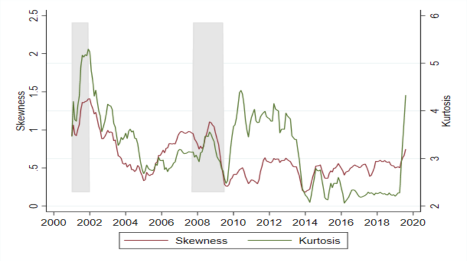
Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

Ratewatch interest rate spreads moments over time (Personal Vehicle New)

Mean and Variance



Skewness and Kurtosis

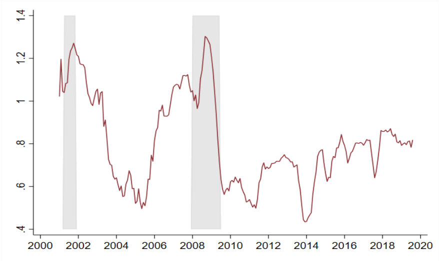


Interest rates at monthly frequency.

Back

Branch-Level Data: cross-sectional skewness over time

Example: New advertised Loan Rates for Personal Recreational Vehicle purchase.



(a) Lending rates skewness, US overall distribution.

Back
Realized Rates
More Product Types
Loan-level Distribution
Syndacated Loans

Branch-Level Data: cross-sectional skewness over time

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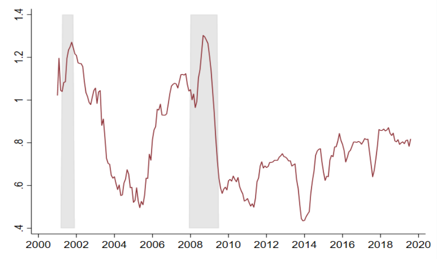

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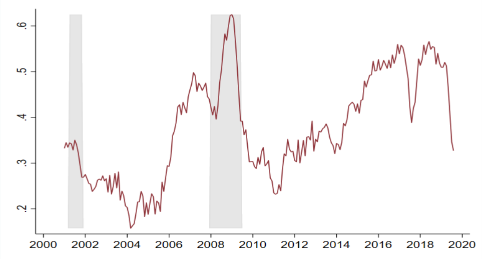

(b) Mean of within-county skewness measures.

Back | Realized Rates | More Product Types | Loan-level Distribution | Syndicated Loans

Branch-Level Data: cross-sectional skewness over time

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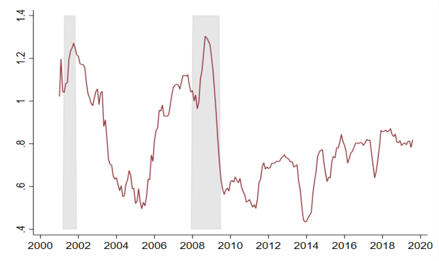

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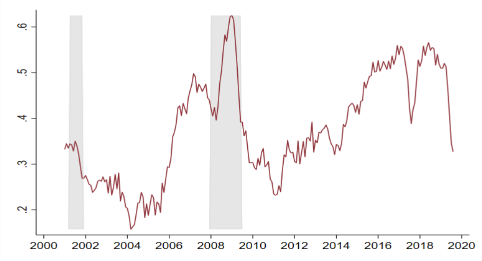


(b) Mean of within-county skewness measures.

⇒ High variation.

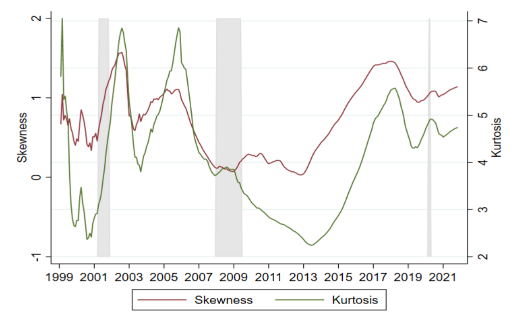
⇒ Distribution of skewness across counties shifts over time.

▸ Back ▸ Realized Rates ▸ More Product Types ▸ Loan-level Distribution ▸ Syndacated Loans

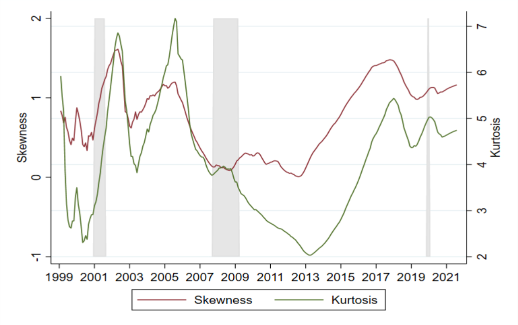
Loan-Level Distribution: higher order moments non-trivial dynamics

Freddie Mac Mortgage Rates. Purged. Moments over time.

Skewness and Kurtosis, County-Level Mean



Skewness and Kurtosis, pooled-US Mean



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MP Pass-Through heterogeneity Across-States

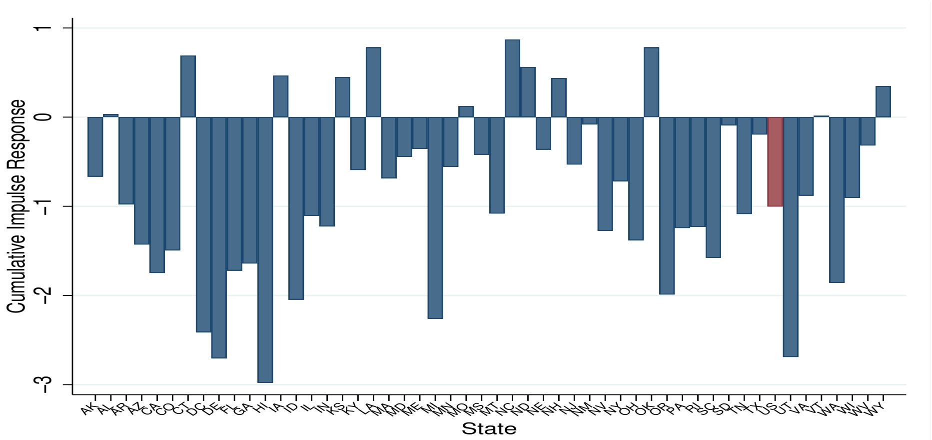


Figure: IRF to 1% MP Shock. IV Local Projections.

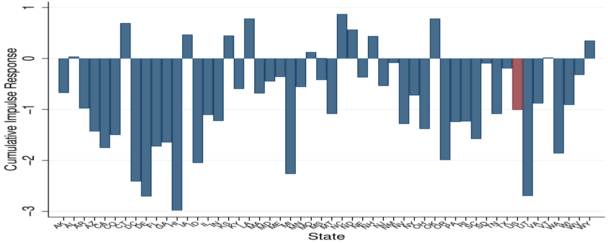
▸ Back

MP Heterogeneity Across States

Methodology: IV Local Projections with High-Frequency Proxy by State.[1]

$$\text{Pers\_Inc}_{t+h,s} = \alpha_s + \beta_s \underline{\mathbf{FFR}}_t + \sum_{k=1}^{2} \rho_k \text{FFR}_{t-k} + \sum_{k=1}^{2} \gamma_k X_{s,t-k} + \sum_{k=1}^{2} \delta_k X_{US,t-k} + \varepsilon_{s,t}$$

2 Years Cumulative Impulse Response of Real Personal Income to MP shock



[2] Proxy Identification as in Jarociński and Karadi (2020)

Estimation Results

$$\text{Average Income response to MP}_s = \alpha + \beta \quad \underline{\textbf{bank moments}}_s + \gamma \quad \text{controls}_s + \varepsilon_s$$

VARIABLES	(1) Baseline	(2) SM Banks	(3) NII
Asset Mat M1	0.57**	0.68***	0.64***
	(0.22)	(0.22)	(0.21)
Liab Mat M1	-5.38	-5.28	-3.67
	(3.29)	(3.13)	(3.22)
Asset Mat M3	-0.05***	-0.06***	-0.05***
	(0.02)	(0.02)	(0.02)
Liab Mat M3	16.09*	19.45**	18.37**
	(8.57)	(8.30)	(8.20)
Constant	9.07***	5.95*	5.75*
	(2.94)	(3.13)	(3.15)
Controls	YES	YES	YES
Observations	51	51	51
R-squared	0.57	0.62	0.62

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Back   More on Controls   Full-Table

Static Cross-Section

$$\text{Average income response to MP}_s = \alpha + \beta \quad \text{bank moments}_s + \gamma \quad \text{controls}_s + \varepsilon_s$$

Bank Moments:

- Asset Average Maturity.
- Liability Average Maturity.
- Average Interest Rate Earned.
  - Mean (M1)
  - Skewness (M3)

Controls:

- House Price Growth
- Percent of total GDP:
  - Durables
  - Non-Durables
  - Construction
  - Services
- Bank Related Variables:
  - Capital Ratio
  - Net Interest Income
  - Percent of Small Medium Banks.

back

Estimation Results

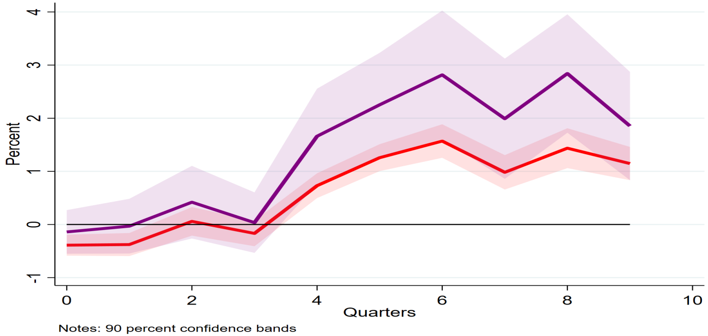
VARIABLES	(1) Baseline	(2) SM Banks	(3) NII
House Prices	-51.50**	-43.04*	-43.00*
	(22.55)	(21.82)	(21.76)
Asset Mat M1	0.57**	0.68***	0.64***
	(0.22)	(0.22)	(0.21)
Liab Mat M1	-5.38	-5.28	-3.67
	(3.29)	(3.13)	(3.22)
Asset Mat M3	-0.05***	-0.06***	-0.05***
	(0.02)	(0.02)	(0.02)
Liab Mat M3	16.09*	19.45**	18.37**
	(8.57)	(8.30)	(8.20)
Int Rate M1	46.32	-3.04	-22.11
	(45.60)	(48.77)	(52.76)
Equity Ratio	-38.37*	-5.84	-11.18
	(21.54)	(25.18)	(23.71)
Non-Durables	-0.02	0.00	0.02
	(0.03)	(0.03)	(0.04)
Durables	-0.05*	-0.04	-0.04
	(0.03)	(0.03)	(0.03)
Constr	-0.22*	-0.12	-0.12
	(0.13)	(0.13)	(0.13)
Services	-0.04**	-0.03	-0.03
	(0.02)	(0.02)	(0.02)
SM Banks		2.59**	
		(1.16)	
Net Interest			24608778.81**
			(10821772.96)
Constant	9.07***	5.95*	5.75*
	(2.94)	(3.13)	(3.15)
Observations	51	51	51
R-squared	0.57	0.62	0.62

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

back

Dynamic US States

Impulse responses to 50bp exogenous decrease in MP Rate. Deposit Rates

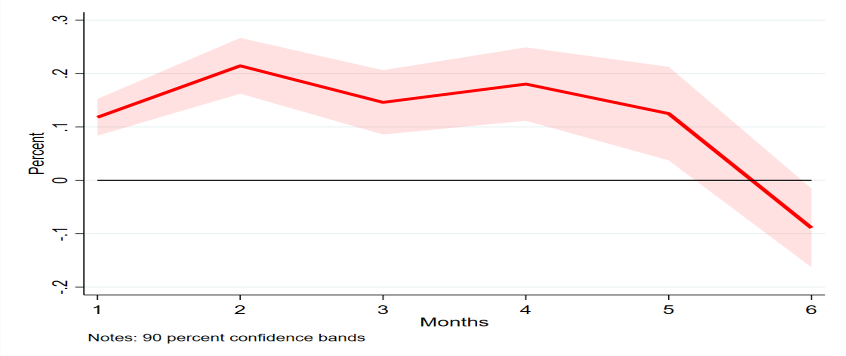


Red line: bank moment channel is shut down. Purple Line: bank moment channel is active.

Back

Dynamic Granular Level Data: Ratewatch Data - Consumer Durable Goods

Impulse Response of offered loan rates to MP: Coefficients

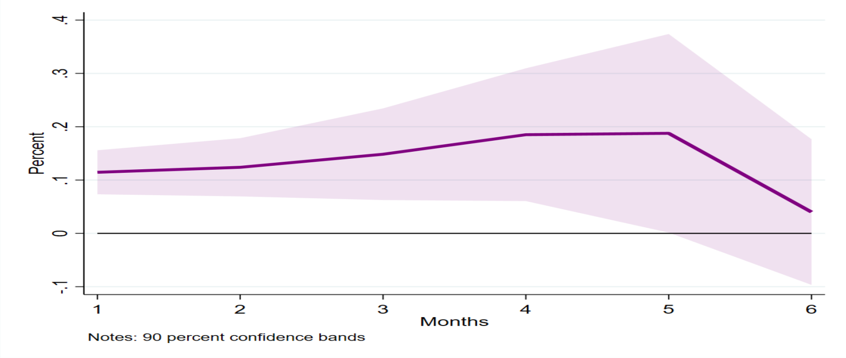


Impulse responses to exogenous increase in the 10Y Treasury. Red line: pure shock. SE clustered at the county/Category category level.

back

Dynamic Granular Level Data: Ratewatch Data - Consumer Durable Goods

Impulse Response of offered loan rates to MP: Coefficients

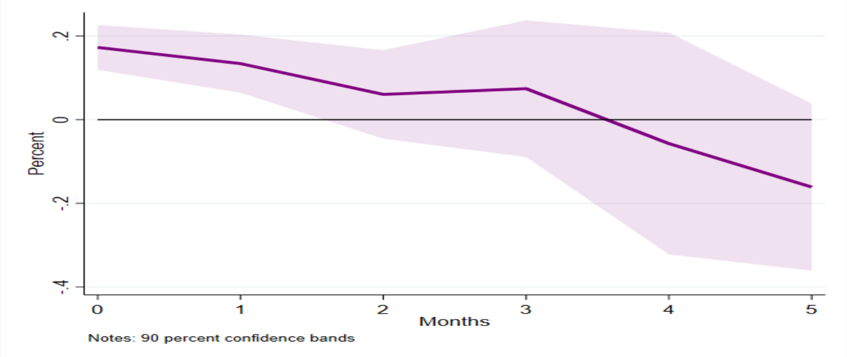


Impulse responses to exogenous increase in the 10Y Treasury. Red line: pure shock. SE clustered at the county/Category category level.

▸ back

Dynamic Granular Level Data: Ratewatch Data - Consumer Durable and House Mortgages

Impulse Response of offered loan rates to MP: Skewness Coeff

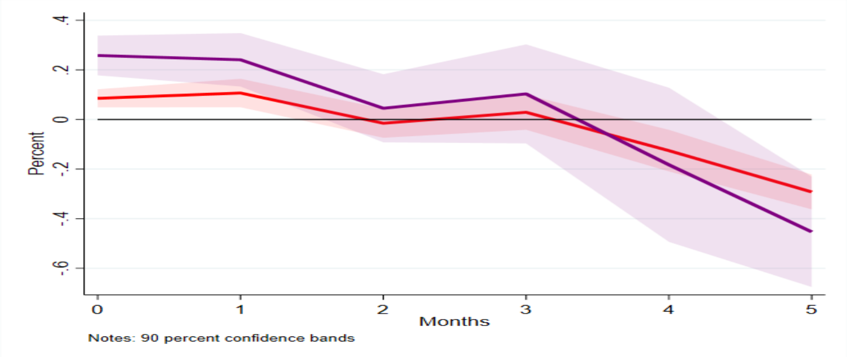


Impulse responses to exogenous increase in the 10Y Treasury. Red line: pure shock. SE clustered at the county/Category category level.

back

Dynamic Granular Level Data: Ratewatch Data - Consumer Durable and House Mortgages

Impulse Response of offered loan rates to MP: 1sd Skewness



Impulse responses to exogenous increase in the 10Y Treasury. Red line: pure shock. SE clustered at the county/Category category level.

back

Dynamic Granular Level Data: Ratewatch Data - Business Investment

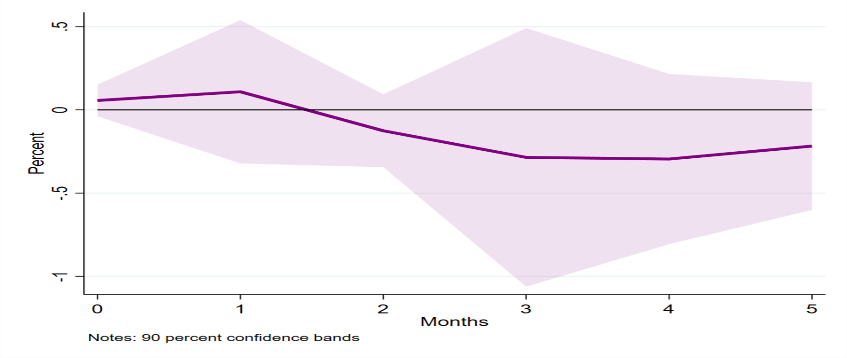
Impulse Response of offered loan rates to MP: Coefficients

Impulse responses to exogenous increase in the 10Y Treasury. Red line: pure shock. SE clustered at the county/Category category level.

back

Dynamic Granular Level Data: Ratewatch Data - Business Investment

Impulse Response of offered loan rates to MP: Coefficients



Impulse responses to exogenous increase in the 10Y Treasury. Red line: pure shock. SE clustered at the county/Category category level.

▸ back

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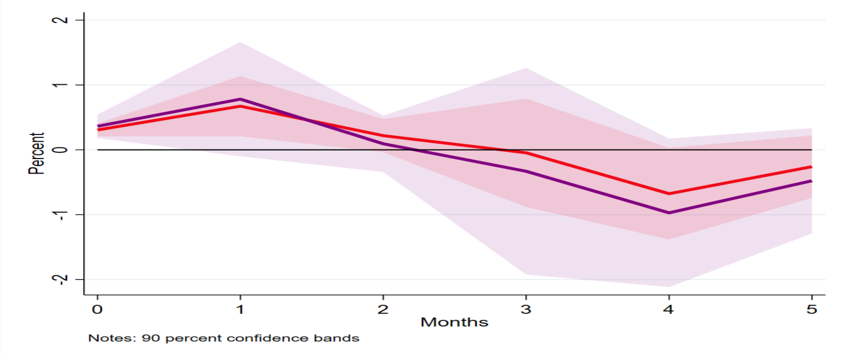

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back

Branch/County-Level Data: Unemployment

Month	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MP shock	0.46**	0.97***	1.02**	1.20**	2.86***	1.06**	1.57***
H.Skew. MP Shock	0.41**	0.85***	0.73**	0.27	1.27***	0.23	0.40
H.Mean. MP Shock	0.18	1.15***	0.33*	0.02	-0.80***	0.08	0.82***
High Concentr	-0.06	0.30	0.42*	0.36*	0.01	0.03	0.26
Avg Loss Prov.	0.51***	0.63***	0.84***	0.90***	0.70***	1.19***	1.34***
Avg Cost Funds	0.21***	0.19**	0.07	-0.05	-0.15	-0.25**	0.03
Controls	✓	✓	✓	✓	✓	✓	✓
N	74668	72251	70360	67228	65164	63834	62358
R^2	0.175	0.109	0.111	0.162	0.020	0.168	0.209

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. S.E. clustered at County/Category level. F-Test: 55.571

Back

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Controls	✓	✓	✓	✓	✓	✓	✓
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⇒ High Skewness increases Unemployment response to MP.

Back

Loan/MSA-Level Data: Freddie Mac House Mortgage Loans

Methodology: IV Local Projections with High Frequency Proxy.

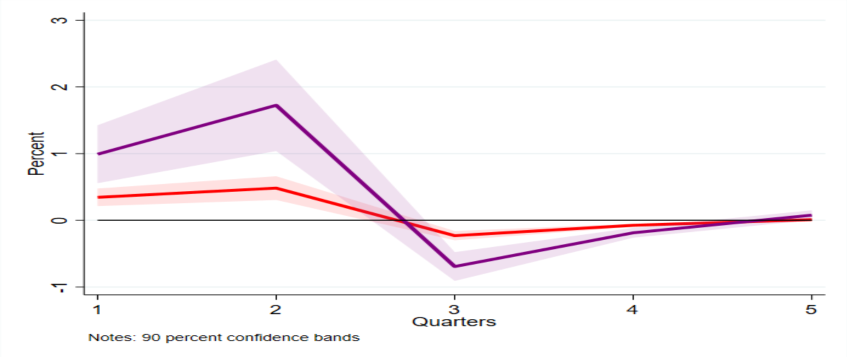
$$
\begin{aligned}
\text{Refinancing Rates}_{t+h,s} \quad = \quad & \alpha + \underline{\beta_0 \textbf{Treasury Rate}}_t + \underline{\beta_H} \left[\underline{\textbf{Treasury Rate}}_t \times \underline{\textbf{Skewness}}_{t,s} \right] + \\
+ \quad & \sum_{k=1}^{2} \rho_{1,k} \text{Treasury Rate}_{t-k} + \sum_{k=1}^{2} \rho_{2,k} \left[TreasuryRate_{t-k} \times Skewness_{t-k,s} \right] + \\
+ \quad & \sum_{k=1}^{2} \gamma_k X_{s,t-k} + \sum_{k=1}^{2} \delta_k X_{US,t-k} + \varepsilon_{s,t}
\end{aligned}
$$

Controls: CPI, GDP, Unemployment, Home Equity, Bank Herfindal Index, LTV, Age/Maturity, FE.

Back

Loan/MSA-Level Data: Freddie Mac House Mortgage Loans

Impulse Response of Refinancing Rate to 50 b.p. exogenous decrease in MP rate.



Red line: Standard Pass-Through. Purple Line: High Skewness Pass-Through. SE clustered at the county level.

⇒ MSA with High Mortage Rate Skewness stronger response in Refinancing rates.

Back

Loan/MSA-Level Data: Freddie Mac House Mortgage Loans

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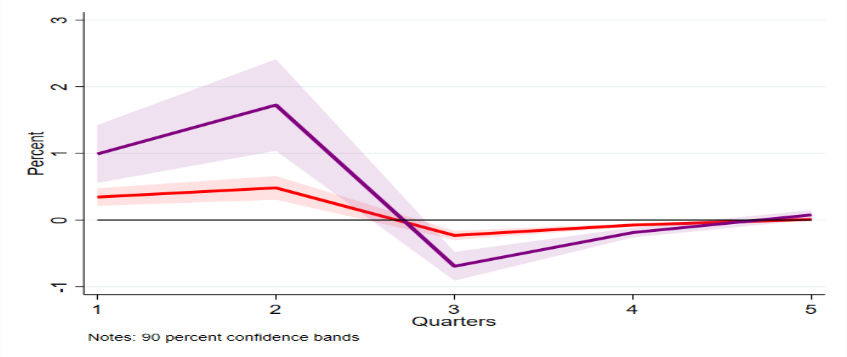

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Sample Dynamics Robustness with Eich et al. (2022) channel Back

US States/Bank Panel: Real Personal Income

Methodology: Local projections. State (s) /month (m) level.

$$
\begin{aligned}
\text{Outcome Variable}_{t|t+h,s} \quad = \quad & \alpha + \beta_0 \mathbf{MP}_t + \underline{\beta_1} \left[\mathbf{MP}_t \times \widehat{\mathbf{Skewness}}_{t-1,s} \right] + \\
+ \quad & \sum_{k=1}^{2} \rho_{1,k} \mathrm{MP}_{t-k} + \sum_{k=1}^{2} \rho_{2,k} \left[\mathrm{MP}_{t-k} \times \widehat{\mathrm{Skewness}}_{t-k-1,s} \right] + \\
+ \quad & \sum_{k=1}^{2} \gamma_k X_{t-k,s} + \sum_{k=1}^{2} \delta_k X_{t-k,s} + \sum_{k=1}^{2} \chi_k X_{t-k,BANK} + \varepsilon_{t,s}
\end{aligned}
$$

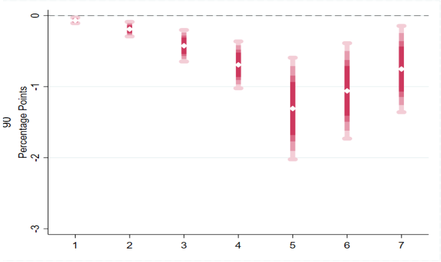
Outcome Variables: State Real Personal Income.

Controls: National GDP, Defl, Stock Market, Excess Bond Premium, state personal income, home prices, Bank Herfindal Index, Bank ROA, Cost of Funds, Loan Loss Provisions, Category/State FE.

Identification: High Frequency Proxy from Bauer and Swanson (2022).

Note: $\widehat{\text{Skewness}}$ defines the state-level skewness subtracted of its long-run mean.

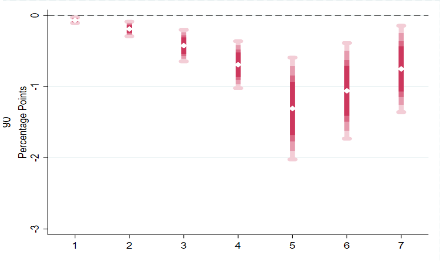
Coefficient Plots



(a) Standard MP response (β_0).

- Response to 100 b.p. MP shock.

Coefficient Plots



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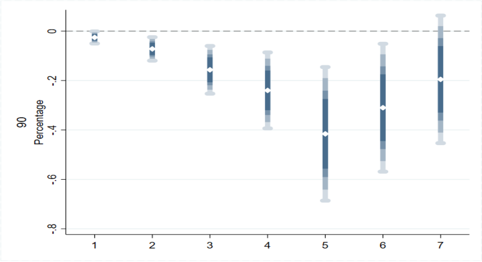
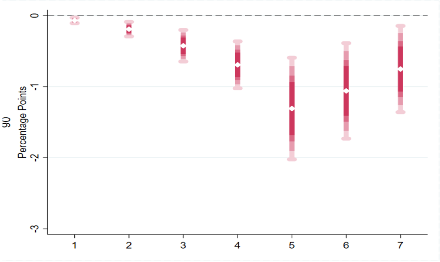


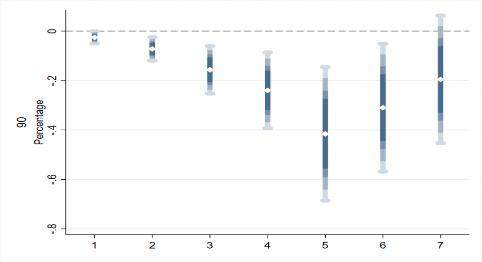
(b) Difference in MP response with high skewness (β_1)

- Response to 100 b.p. MP shock.
- 1/4 higher when skewness is high.

Coefficient Plots



(a) Standard MP response (β_0).



(b) Difference in MP response with high skewness (β_1)

- Response to 100 b.p. MP shock.
- 1/4 higher when skewness is high.

Robust Specification: Lending Rates

Table: Average response of average county lending rates to a 100 b.p. MP shock, robust specification

Month	0	1	2	3	4	5	6	7	8	9	10
MP_t	0.22***	0.34***	0.48***	0.44***	0.37***	0.23***	0.29***	0.55***	0.38***	0.44***	0.52***
	(8.44)	(10.84)	(13.62)	(11.87)	(8.95)	(5.55)	(6.67)	(12.54)	(8.62)	(8.87)	(10.12)
Skew.	0.15***	0.12**	0.22***	0.20***	0.18***	0.17***	0.24***	0.12*	0.16**	0.00	-0.00
	(3.73)	(2.48)	(3.95)	(3.37)	(2.91)	(2.59)	(3.40)	(1.77)	(2.34)	(0.06)	(-0.03)
Mean	-0.13***	-0.04**	-0.17***	-0.28***	-0.31***	-0.15***	-0.27***	-0.22***	-0.18***	-0.30***	-0.32***
	(-6.14)	(-2.03)	(-6.72)	(-9.33)	(-9.16)	(-4.01)	(-7.27)	(-5.38)	(-4.67)	(-7.56)	(-7.90)
Var.	0.04	0.09	-0.21***	-0.02	-0.05	0.14	-0.16*	-0.00	-0.23**	-0.34***	-0.13
	(0.73)	(1.25)	(-2.73)	(-0.18)	(-0.53)	(1.32)	(-1.67)	(-0.00)	(-2.45)	(-3.29)	(-1.16)
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	123775	111611	108658	105835	101058	98156	96266	92717	91096	88863	85569
R^2	0.974	0.967	0.963	0.956	0.950	0.947	0.942	0.937	0.935	0.931	0.927

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Robust Specification: Unemployment Rate

Table: Average response of county unemployment rate to 100 b.p. MP shock, robust specification

Month	0	1	2	3	4	5	6	7	8	9	10
MP_t	0.04***	0.28***	0.36***	0.26***	0.21***	0.23***	0.37***	0.49***	0.56***	0.57***	0.19***
	(4.96)	(20.15)	(24.02)	(17.23)	(13.41)	(14.27)	(21.92)	(26.25)	(29.86)	(31.73)	(11.42)
Skew.	0.04***	0.12***	0.11***	0.09***	-0.05**	0.02	0.04*	0.09***	0.05**	0.02	0.02
	(3.12)	(6.67)	(5.50)	(4.58)	(-2.38)	(0.91)	(1.91)	(3.54)	(2.00)	(0.67)	(1.01)
Mean	0.09***	-0.04***	-0.11***	-0.02*	-0.03**	-0.00	-0.18***	-0.18***	-0.17***	-0.28***	-0.05***
	(14.53)	(-4.12)	(-10.29)	(-1.71)	(-2.44)	(-0.26)	(-14.68)	(-13.21)	(-12.38)	(-21.11)	(-3.81)
Var.	-0.00	0.04*	-0.02	-0.11***	-0.03	-0.11***	0.07**	-0.05	0.02	0.08**	-0.04
	(-0.12)	(1.70)	(-0.65)	(-3.80)	(-1.06)	(-3.77)	(2.39)	(-1.38)	(0.53)	(2.45)	(-1.48)
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	121832	110059	107270	104565	99944	97147	95369	91929	90388	88241	85016
R^2	0.969	0.939	0.928	0.929	0.931	0.928	0.920	0.909	0.907	0.920	0.933

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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More Robustness

- Internal Instrument vs Two Stage Least Square.
- Different Lags of the State Variables.
- Refinancing Channel. Berger et al. (2021), Eichenbaum et al. (2022).

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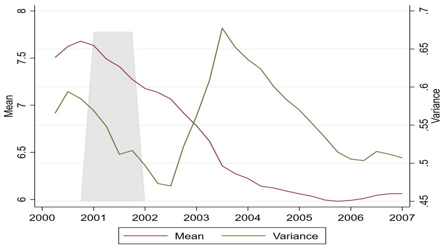
Evolution of Interest Rate Distribution 1st to 4th Moment

Eich. et al. AER 2022 Mortgage Rate interest rate moments over time (average moment value over all counties, FICO scores maturity group

Mean and Variance



Skewness and Kurtosis

Interest rates on Mortgage Loans from the House Mortgage Disclosure Data at quarterly frequency.

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Loan/MSA-Level Data: Freddie Mac House Mortgage Loans

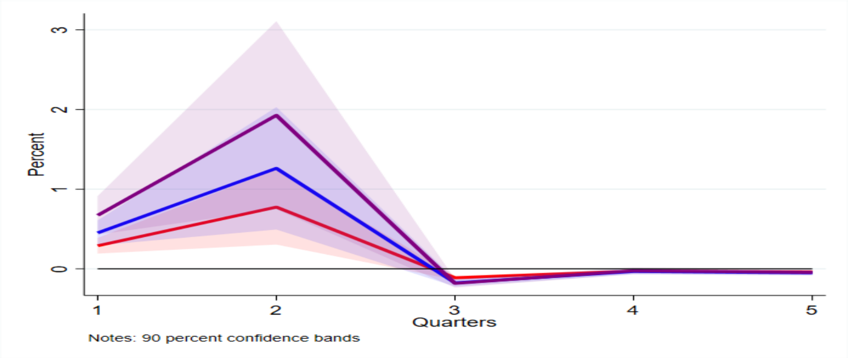
Methodology: IV Local Projections with High Frequency Proxy.

$$
\begin{aligned}
\text{Refinancing Rates}_{t+h,s} \quad = \quad & \alpha + \underline{\boldsymbol{\beta_0}\textbf{Treasury Rate}}_t + \underline{\boldsymbol{\beta_1}} \left[\underline{\textbf{Treasury Rate}}_t \times \underline{\textbf{Skewness}}_{t,s}\right] + \\
+ \quad & \underline{\boldsymbol{\beta_2}} \left[\underline{\textbf{Treasury Rate}}_t \times \underline{\textbf{Rate Gap}}_{t,s}\right] + \\
+ \quad & \sum_{k=1}^{2} \rho_{1,k} \text{Treasury Rate}_{t-k} + \sum_{k=1}^{2} \rho_{2,k} \left[\text{Treasury Rate}_{t-k} \times \textit{Skewness}_{t-k,s}\right] + \\
+ \quad & \sum_{k=1}^{2} \gamma_k X_{s,t-k} + \sum_{k=1}^{2} \delta_k X_{US,t-k} + \varepsilon_{s,t}
\end{aligned}
$$

Controls: CPI, GDP, Unemployment, Home Equity, Bank Herfindal Index, LTV, Age/Maturity, FE.

Loan/MSA-Level Data: Freddie Mac House Mortgage Loans

Impulse Response of **refinancing rates** to MP with Refinancing and Bank Moment Channels



Impulse responses to 50bp exogenous decrease in 30Y Mortgage Rate. Red line: pure shock. Blue Line: Refinancing Channel is active. Purple Line: bank moment channel is active. SE clustered at the county level.

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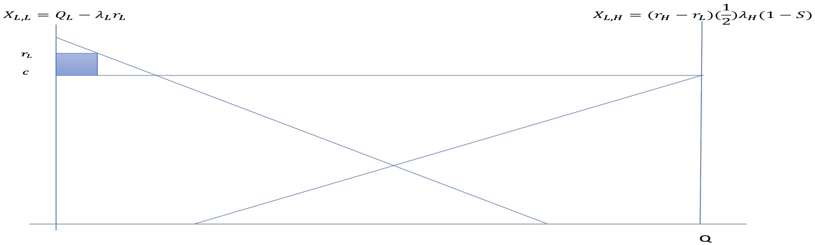
Graphic Intuition, Strategic L fixed H



Low skewness.

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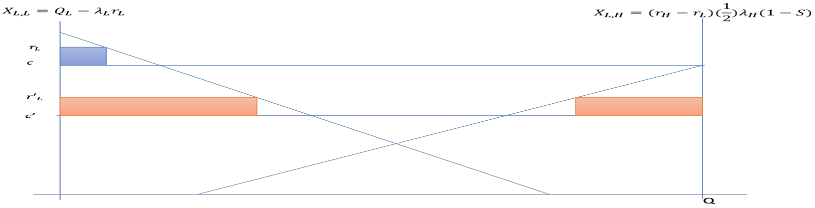
Graphic Intuition



Lower skewness. MP easing.

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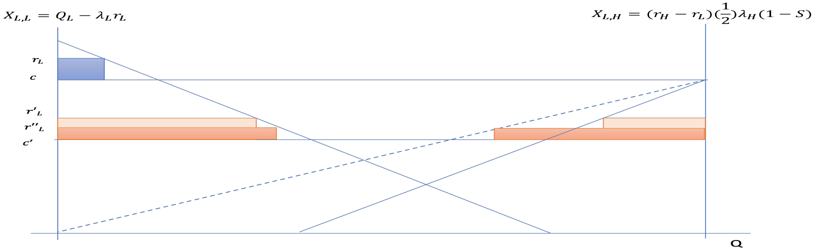
Graphic Intuition



Higher skewness. Same MP easing.

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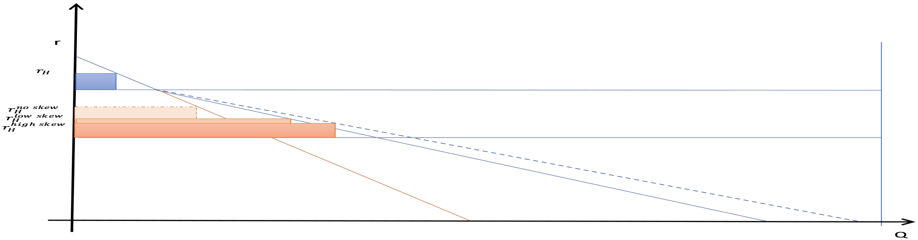
Graphic Intuition



No/Low/High Skewness. MP Easing.

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Model Appendix

Model Appendix: (Very Simple framework and old Model versions)

(Very) Simple Conceptual Framework

	Bank	**Borrower**
Type A	high market power	high switching cost ϕ
Type B	low market power	low switching cost ϕ

Borrower's Choice

$$\min e(r) = \begin{cases} r_{t-1,A}, & \text{if old loan product} \\ r_{t,A} + \psi, & \text{if new loan product} \\ r_{t,B} + \phi_A & \text{if switch bank B} \end{cases}$$

Bank's problem:

$$\begin{aligned} &\max_{r_{t,A},S} && \pi = [r_{t,A} - c]\,\mathbf{1}_{S=\text{Lend}} \\ &\text{(IC1)} && r_{t,A} \leq r_{t,B} + \phi_A && \text{if } r_{t,A} = r_{t-1,A} \\ &\text{(IC2)} && r_{t,A} + \psi \leq r_{t,B} + \phi_A && \text{if } r_{t,A} \neq r_{t-1,A} \end{aligned}$$

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(Very) Simple Conceptual Framework

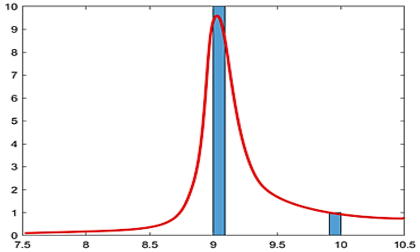
Assume:

- $r_{t,b} = c$
- $c = r_{FED}$
- $n - x$ banks type B, x type A

Starting Point :

$r_{t,B} = r_{t,FED} = c = 9\%$

$r_{t,A} = 10\%$



Quarter 1: Bank Rates Distribution

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(Very) Simple Conceptual Framework

One quarter later FED easens by 0.5%:

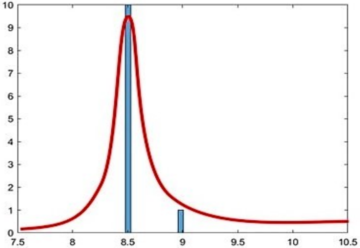
$r_{t,B} = c = 8.5\%$

Assume:

1 $\phi_A = 1\%$
2 $\psi_A = 0.5\%$

$r_{t,A} = 9\%$

Pass-Through: $\frac{(n-x)*(9\%-8.5\%)+x*(10\%-9\%)}{0.5\%} > 1$



Quarter 2: Bank Rates Distribution

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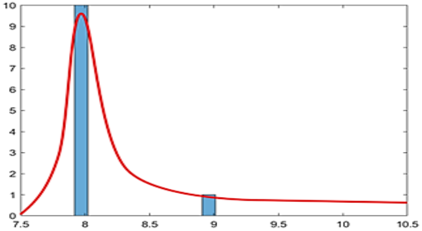
(Very) Simple Conceptual Framework

One quarter later FED easens again by 0.5%:

$$r_{t,B} = c = 8\%$$

$$r_{t,A} = r_{t-1,A} = 9\%$$

Pass-Through: $\frac{(n-x)*(8.5\%-8\%)+x*(9\%-9\%)}{0.5\%} < 1$



Quarter 3: Bank Rates Distribution

- **Competition among banks with local market power gives rise cross-sectional differences among banks**
- **Higher order moments can act as a state for MP efficacy.**

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Best Responses:

Best Responses for Duopoly with Bank H:

Bank H:

$$r_H = \frac{\left[\bar{Q}_H + \kappa r_L + \beta_H c\right]}{2\beta_H}$$

Bank L:

$$r_L = \frac{\left[\bar{Q}_L + \kappa r_H + \beta_L c\right]}{2\beta_L}$$

Substituting r_H into r_L: Bank L:

$$r_L = \left[\frac{\bar{Q}_L}{2\beta_L} + \frac{\bar{Q}_H}{4\beta_H\beta_L}\right] + \left[\frac{\kappa^2}{4\beta_H\beta_L}\right] r_L + \left[\frac{\kappa\beta_H}{4\beta_H\beta_L} + \frac{1}{2}\right] c$$

$$\frac{\partial r_L}{\partial c} = \left[\frac{4\beta_H\beta_L}{4\beta_H\beta_L - \kappa^2}\right]\left[\frac{\kappa\beta_H + 2\beta_H\beta_L}{4\beta_H\beta_L} + \frac{1}{2}\right] = \left[\frac{\kappa\beta_H + 2\beta_H\beta_L}{4\beta_H\beta_L - \kappa^2}\right]$$

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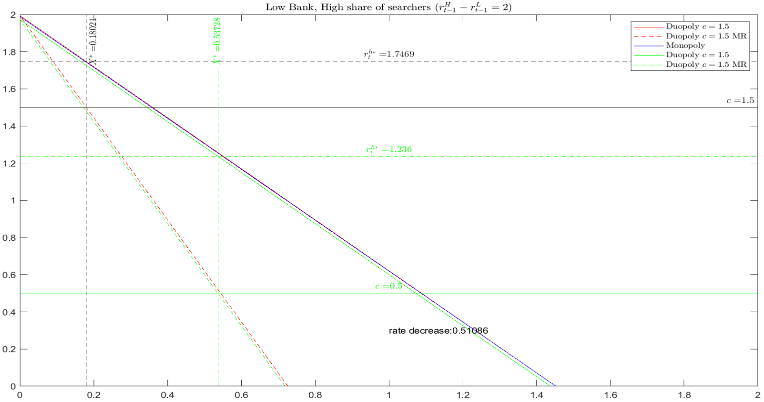
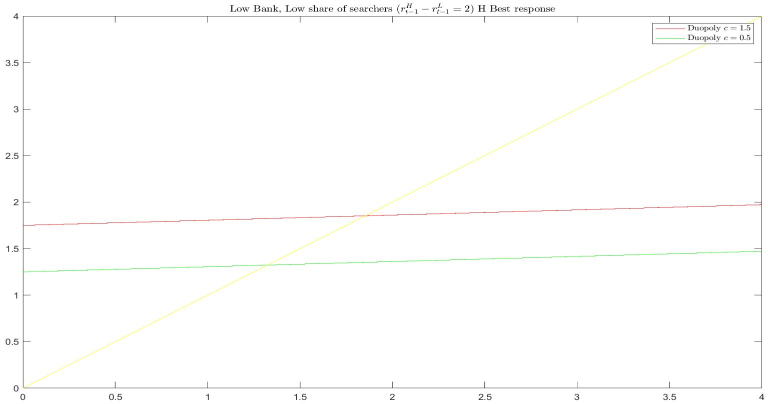
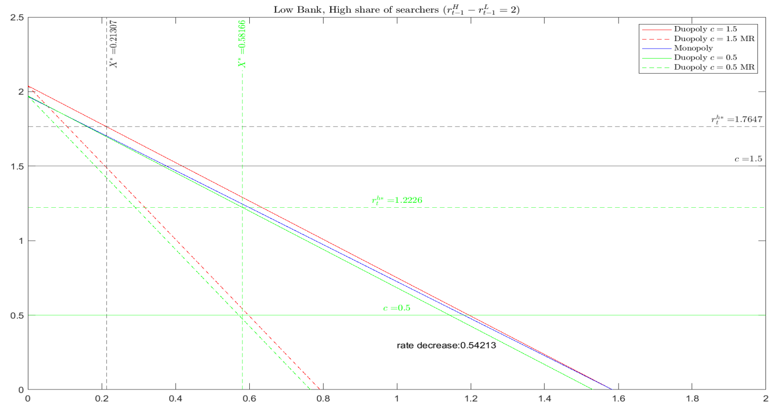
Graphical Intuition



Graphical Intuition



Graphical Intuition



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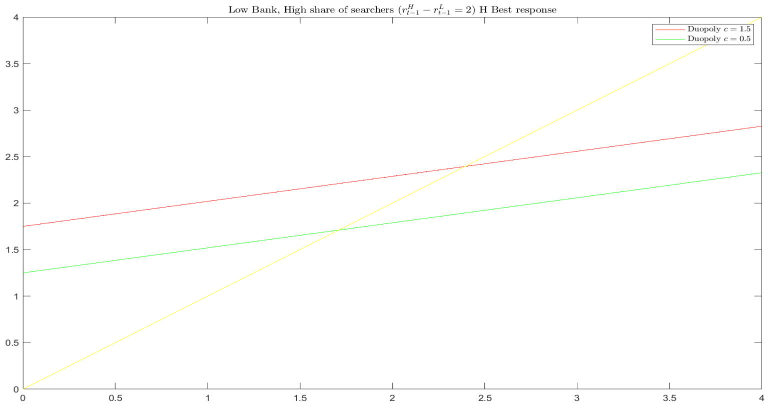
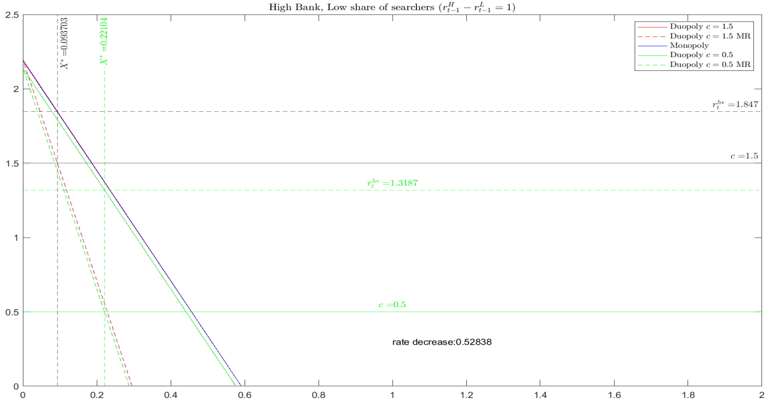


Graphical Intuition



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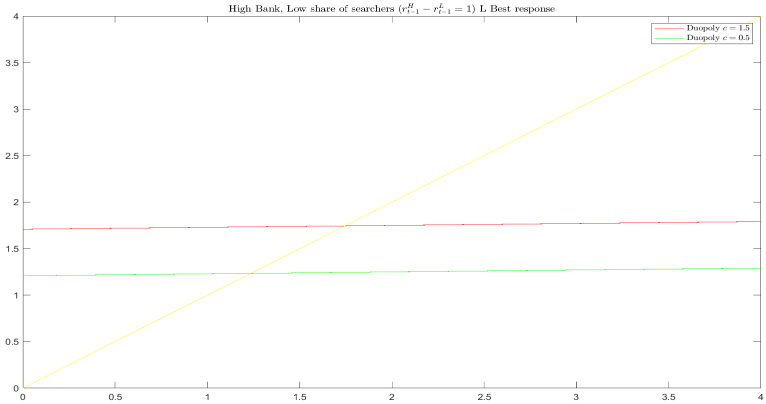

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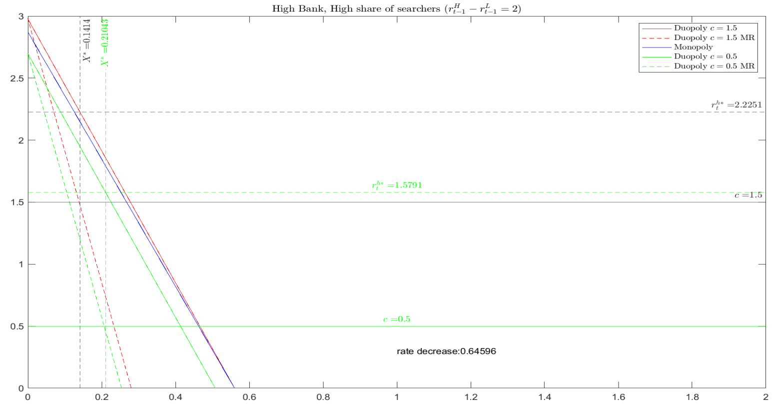
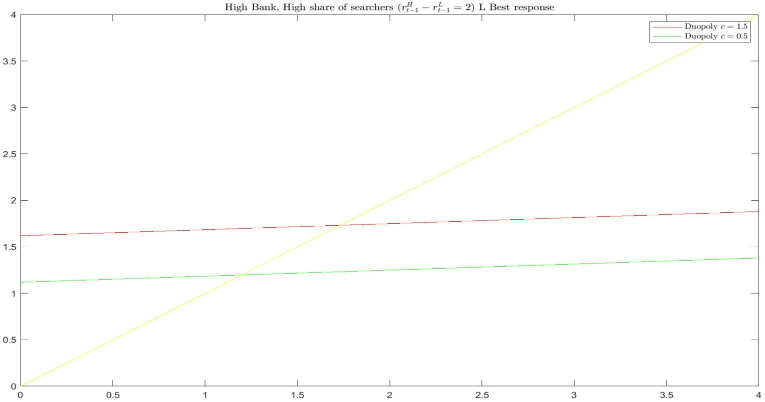
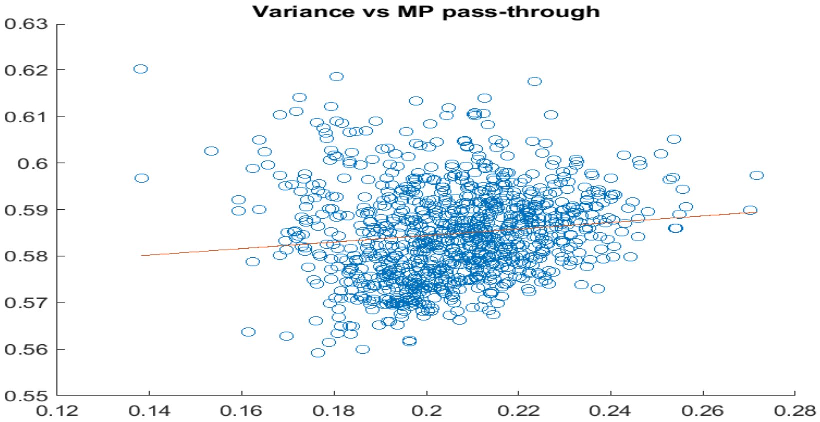


Graphical Intuition



Model Simulation: Variance vs Skewness



Initial Variance vs Pass-Through

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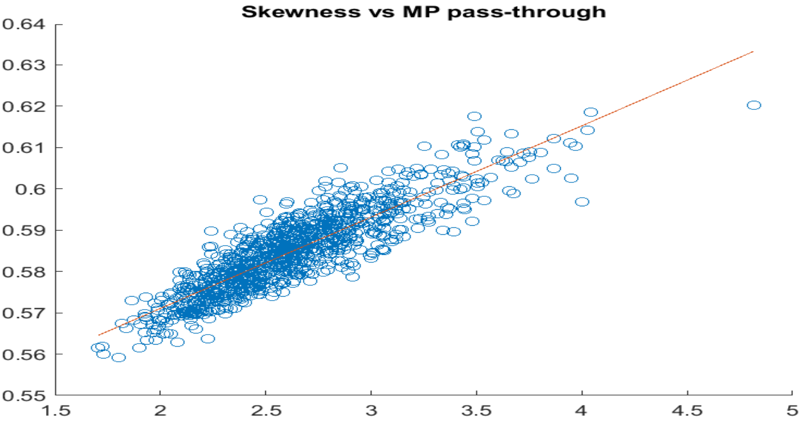
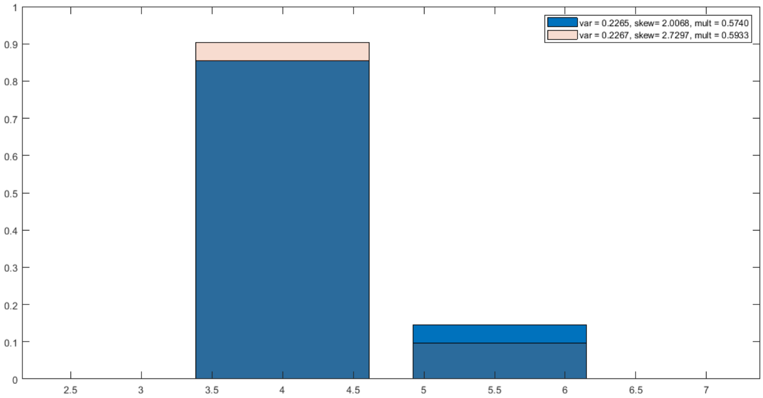
Model Simulation: Variance vs Skewness



Initial Skewness vs Pass-Through

Back

Model Simulation: Variance vs Skewness



Example: 2 parameters draws, different pass-through, different initial skewness, same initial variance.

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Graphical Intuition

Old picturessss

Graphical Intuition

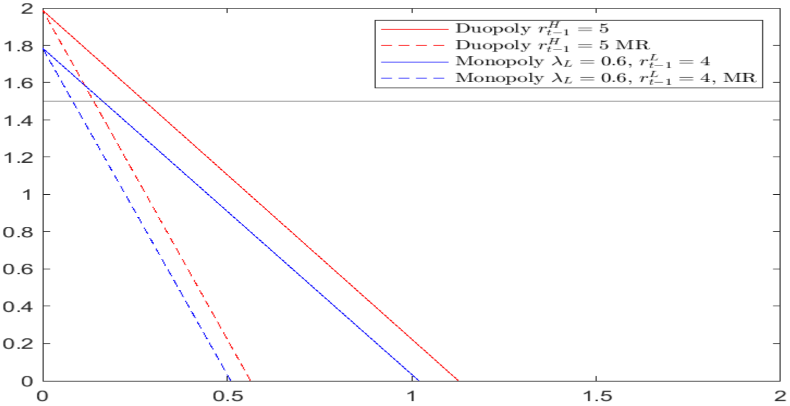

Figure: Monopoly vs Duopoly

Graphical Intuition

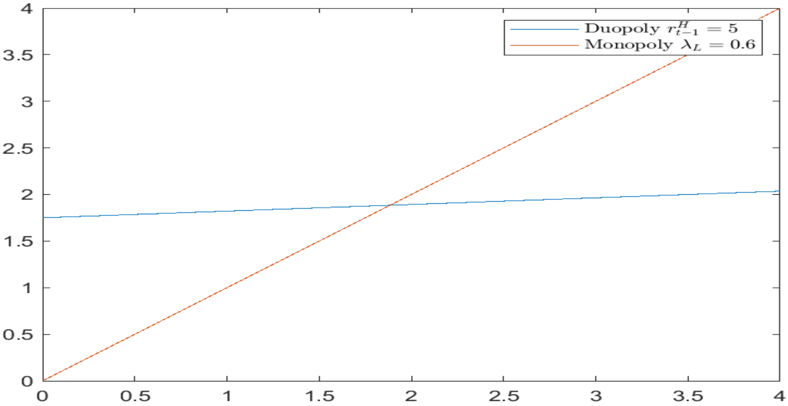

Figure: Monopoly vs Duopoly, Rates

Graphical Intuition

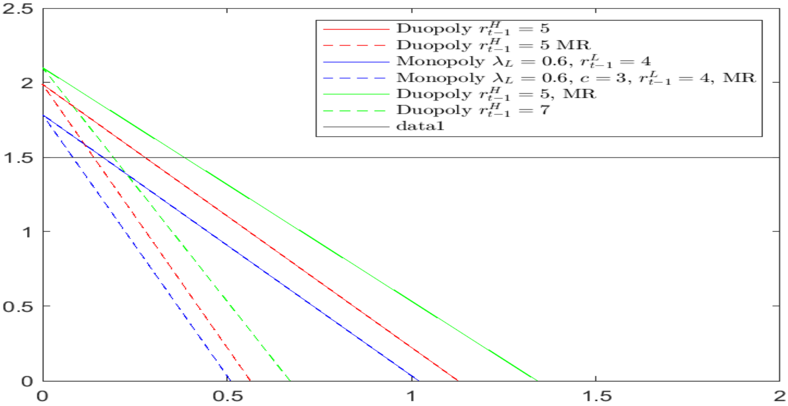

Figure: Monopoly vs Duopoly vs Increased Duopoly

Graphical Intuition

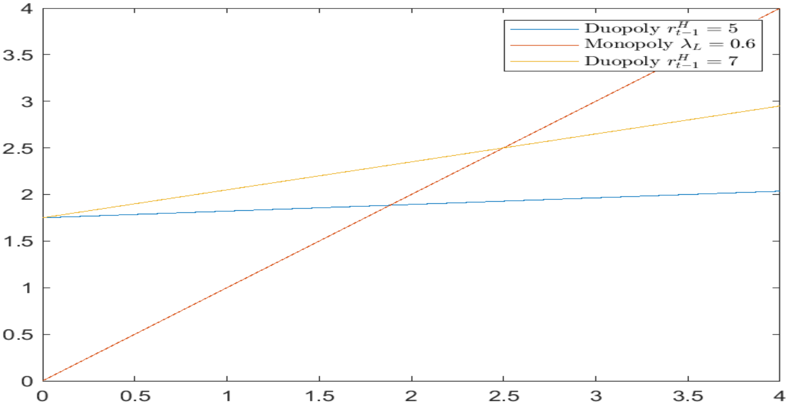

Figure: Monopoly vs Duopoly vs Increased Duopoly

Graphical Intuition

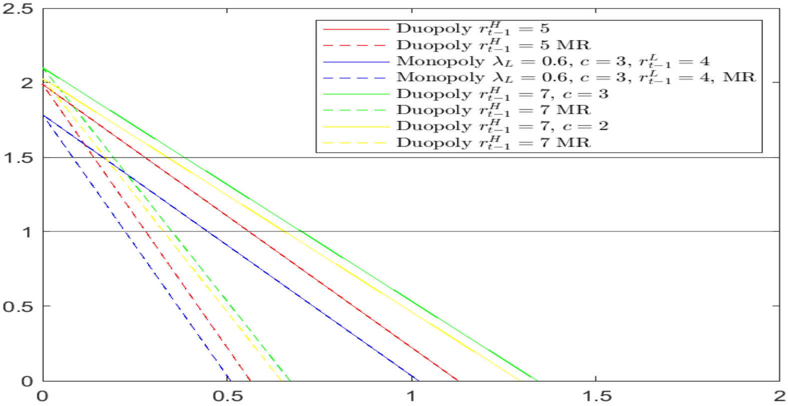

Figure: Monopoly vs Duopoly vs Increased Duopoly vs new MP shock

Graphical Intuition

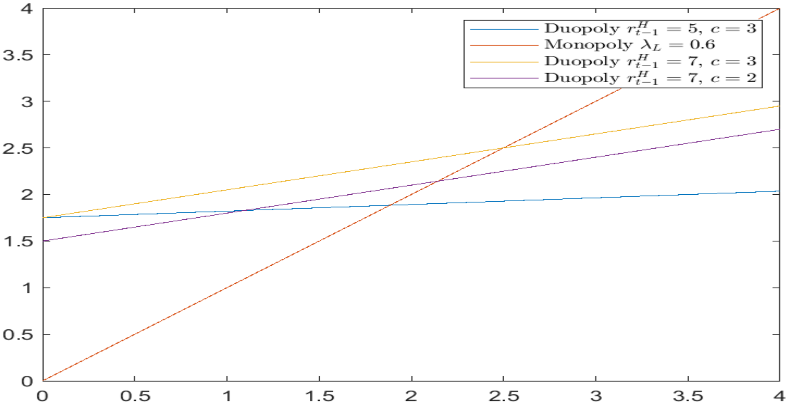

Figure: Monopoly vs Duopoly vs Increased Duopoly vs new MP shock

Consumer Problem: stage 0 to 3

- Consider the case $r^A_{t-1} > r^B_{t-1}$ then:
- For each z only consumers with θ: $v - \mathbb{E}[r^A_t - z] \geq v - \mathbb{E}[r^B_t - (2-z) - \theta]\}$ will stay Type 1.
- Hence $v - r^A_{t-1} - 1 \geq v - r^B_{t-1} - 1 - \theta \leftrightarrow \theta \geq [r^A_{t-1} - r^B_{t-1}]$
- Finally for each z $\int_0^{\bar{\theta}} \frac{1}{\bar{\theta}} \mathbb{1}_{\{\theta > gap_{t-1}\}} = \left[\frac{\bar{\theta} - gap_{t-1}}{\bar{\theta}}\right] = P(gap_{t-1})$
- After z is realized the number of type 1 consumers for each z will be P.
- Once c is realized banks chose r_t. The final demand of type 1 to Bank A will hence be:

$$
\begin{aligned}
X^1_A(r^A_t) &= \int_0^2 \lambda_1 \int_0^{\bar{\theta}} \frac{1}{\bar{\theta}} \mathbb{1}_{\{v - z - r^A_t > 0 |\text{ Type 1 choice}\}} \mathbb{1}_{\{\theta > gap_{t-1}\}} d\theta dz \\
&= \lambda_1 (v - r^A_t) \mathbb{P}(gap_{t-1})
\end{aligned}
$$

- Demand of type 3 to Bank A should hence be: $X^3_A(r^A_t, r^B_t) = \lambda_1 (1 - \mathbb{P})(\frac{r^B_t - r^A_t}{2} + 1)$
- Finally Total demand of type 2 and 3 to Bank B should be: $X_B(r^A_t, r^B_t) = X^2_B(r^B_t) + X^3_B(r^A_t, r^B_t) = \lambda_2(v - r^B_t) + \lambda_1(1 - \mathbb{P})(\frac{r^A_t - r^B_t}{2} + 1)$

back

Model Robustness

z is known since stage 0, and θ is fixed

- Recall in stage 0 people switch iff $v - z - \mathbb{E}[r_t^A \mid I_t] < v - (2-z) - \mathbb{E}[r_t^A \mid I_t] - \theta$
- Marginal switcher is $\theta = [r_{t-1}^A - r_{t-1}^B] + [2\hat{z} - 2]$
- $\hat{z}$ is increasing in θ, so there is a θ for which nobody switches. Say that θ is smaller than that:
- Define $z^1 = v - r_t^A$, marginal loyal-to-A consumer.
- Define $z^3 = \frac{r_t^B - r_t^A}{2} + 1$.
- If $\hat{z} > z^1$:
  - Bank A is not trying to get back any customers, $\frac{\partial r_t^A}{\partial c} = \frac{1}{2}$
  - $\frac{\partial r_t^A}{\partial c} >$ or $= \frac{1}{2}$ depending on the level of c.
- If $\hat{z} < z^1$:
  - Bank A is trying to get back customers, $\frac{\partial r_t^A}{\partial c} > \frac{1}{2}$
  - $\frac{\partial r_t^A}{\partial c} > \frac{1}{2}$.

back

Robustness 1

z is known since stage 0, and θ is fixed, results:

- if $[r^A_{t-1} - r^B_{t-1}]$ is low than nobody switches in stage zero and hence both MP multipliers are $\frac{1}{2}$.
- if $[r^A_{t-1} - r^B_{t-1}]$ is high than a few people pay the fixed cost θ in stage zero and check r^B_t, turns out both MP multipliers are $> \frac{1}{2}$.

back

Robustness 2

There is no distance z just a switching cost and a refinancing cost

- Then there is a continuum $[0,\bar{\theta}]$ of people with different switching costs.
- Marginal person that is going to switch is $\mathbb{E}[v - r_t^A] > \mathbb{E}[v - r_t^B] - \theta \rightarrow \hat{\theta} = [r_{t-1}^A - r_{t-1}^B] = P$
- If $r_t^A > r_t^B$ then all those people are switching to B
- If $r_t^A < r_t^B$ then all those people are staying with A. **Result:** Again depending on the level of c it might be worth for A to either pursue those customers or not.

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