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

Federico Puglisi

Bank of Italy and
Northwestern University

2023 European Winter Meeting of the Econometric Society,
Manchester, December 19, 2023

The views expressed in this presentation are those of the author.

Motivation

- The extent to which changes in the Monetary Policy (MP) rate pass-through to lending rates is a key determinant of MP efficacy.

Motivation

- The extent to which changes in the Monetary Policy (MP) rate pass-through to lending rates is a key determinant of MP efficacy.

- The pass-through of monetary policy to lending rates **varies considerably over time and space**.

Motivation

- The extent to which changes in the Monetary Policy (MP) rate pass-through to lending rates is a key determinant of MP efficacy.

- The pass-through of monetary policy to lending rates **varies considerably over time and space**.

- **The distribution of lending rates exhibits high dispersion** even conditional on borrower/product characteristics. .

Motivation

- The extent to which changes in the Monetary Policy (MP) rate pass-through to lending rates is a key determinant of MP efficacy.

- The pass-through of monetary policy to lending rates **varies considerably over time and space**.

- **The distribution of lending rates exhibits high dispersion** even conditional on borrower/product characteristics. $\Rightarrow$ **Pronounced Skewness**.

Motivation

- The extent to which changes in the Monetary Policy (MP) rate pass-through to lending rates is a key determinant of MP efficacy.

- The pass-through of monetary policy to lending rates **varies considerably over time and space**.

- **The distribution of lending rates exhibits high dispersion** even conditional on borrower/product characteristics. $\Rightarrow$ **Pronounced Skewness**.

- The **lending rates dispersion** (Skewness) **varies considerably over time and space**.

Motivation

- The extent to which changes in the Monetary Policy (MP) rate pass-through to lending rates is a key determinant of MP efficacy.

- The pass-through of monetary policy to lending rates **varies considerably over time and space**.

- **The distribution of lending rates exhibits high dispersion** even conditional on borrower/product characteristics. $\Rightarrow$ **Pronounced Skewness**.

- The **lending rates dispersion** (Skewness) **varies considerably over time and space**.

➢ What is the connection between the two?

Motivation

- The extent to which changes in the Monetary Policy (MP) rate pass-through to lending rates is a key determinant of MP efficacy.

- The pass-through of monetary policy to lending rates **varies considerably over time and space**.

- **The distribution of lending rates exhibits high dispersion** even conditional on borrower/product characteristics. $\Rightarrow$ **<u>Pronounced Skewness</u>**.

- The **lending rates dispersion** (Skewness) **varies considerably over time and space**.

➢ What is the connection between the two?

➢ Understanding the source of pass-through heterogeneity is crucial to assess the real effects of MP on the macroeconomy.

This Paper: Empirical Contribution

Q: Is lending rates dispersion a relevant state-variable for Monetary Policy (MP)? Skewness vs Variance?

- Use county-level dispersion in offered rates by branch and loan product.

This Paper: Empirical Contribution

Q: Is lending rates dispersion a relevant state-variable for Monetary Policy (MP)? Skewness vs Variance?

- Use county-level dispersion in offered rates by branch and loan product.
- **Key Result 1:** Higher initial skewness $\Rightarrow$ stronger MP pass-through to lending rates

This Paper: Empirical Contribution

Q: Is lending rates dispersion a relevant state-variable for Monetary Policy (MP)?
Skewness vs Variance?

- Use county-level dispersion in offered rates by branch and loan product.
- **Key Result 1:** Higher initial skewness $\Rightarrow$ stronger MP pass-through to lending rates
- **Key Result 2:** Higher initial skewness $\Rightarrow$ larger MP efficacy on real economy

This Paper: Empirical Contribution

**Q: Is lending rates dispersion a relevant state-variable for Monetary Policy (MP)?
Skewness vs Variance?**

- Use county-level dispersion in offered rates by branch and loan product.
- **Key Result 1:** Higher initial skewness $\Rightarrow$ stronger MP pass-through to lending rates
- **Key Result 2:** Higher initial skewness $\Rightarrow$ larger MP efficacy on real economy
- **Key Result 3:** Skewness is relevant dimension of dispersion rather than Variance.

This Paper: Empirical Contribution

Q: Is lending rates dispersion a relevant state-variable for Monetary Policy (MP)? Skewness vs Variance?

- Use county-level dispersion in offered rates by branch and loan product.
- **Key Result 1:** Higher initial skewness $\Rightarrow$ stronger MP pass-through to lending rates
- **Key Result 2:** Higher initial skewness $\Rightarrow$ larger MP efficacy on real economy
- **Key Result 3:** Skewness is relevant dimension of dispersion rather than Variance.
- **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 <u>lender imperfect competition</u>

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

This Paper: Theoretical Contribution

Q: How can we explain my empirical findings?

A: Theoretical model of lender imperfect competition

- Bertrand **competition**
- Customers' **switching friction**

} **Price Dispersion (absent any shock)**

- Customers' **search friction** (Incomplete Information: $I_t = r^i_{t-1}$)

} **State-Dependence [new to the literature]**

This Paper: Theoretical Contribution

Q: How can we explain my empirical findings?

A: Theoretical model of lender imperfect competition

- Bertrand **competition**
- Customers' **switching friction**

$\Big\}$ **Price Dispersion (absent any shock)**

- Customers' **search friction** (Incomplete Information: $I_t = r^i_{t-1}$)

$\Big\}$ **State-Dependence [new to the literature]**

1 MP shocks shift lenders' funding costs.

This Paper: Theoretical Contribution

Q: How can we explain my empirical findings?

A: Theoretical model of lender imperfect competition

- Bertrand **competition**
- Customers' **switching friction**

} **Price Dispersion (absent any shock)**

- Customers' **search friction**
  (Incomplete Information: $I_t = r^i_{t-1}$)

} **State-Dependence [new to the literature]**

1 MP shocks shift lenders' funding costs.

2 Higher initial Skewness $\Rightarrow$ Larger borrowers' incentives to search for rates today.

This Paper: Theoretical Contribution

Q: How can we explain my empirical findings?

A: Theoretical model of lender imperfect competition

- Bertrand **competition**
- Customers' **switching friction**

} **Price Dispersion (absent any shock)**

- Customers' **search friction**
  (Incomplete Information: $I_t = r^i_{t-1}$)

} **State-Dependence [new to the literature]**

1 MP shocks shift lenders' funding costs.

2 Higher initial Skewness $\Rightarrow$ Larger borrowers' incentives to search for rates today.

3 Lenders' larger potential for capturing borrowers from competition.

This Paper: Theoretical Contribution

Q: How can we explain my empirical findings?

A: Theoretical model of lender imperfect competition

- Bertrand **competition**
- Customers' **switching friction**

} **Price Dispersion (absent any shock)**

- Customers' **search friction**
  (Incomplete Information: $I_t = r^i_{t-1}$)

} **State-Dependence [new to the literature]**

1 MP shocks shift lenders' funding costs.

2 Higher initial Skewness $\Rightarrow$ Larger borrowers' incentives to search for rates today.

3 Lenders' larger potential for capturing borrowers from competition.

4 Stronger lenders' price complementarity $\Rightarrow$ larger MP pass-through.

Literature Review

Outline

Core Micro-Data

Branch-Level Offered Base Loan Interest Rates from S&P GMI Ratewatch (New to the literature):

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

Core Micro-Data

Branch-Level Offered Base Loan Interest Rates from S&P GMI Ratewatch (New to the literature):

- 30+ Loan Products (House, Consumer Durables, Small Business Loans, Commercial RE).
- Time Span: 2001-2019. Monthly frequency.
- 100,000+ branches (brick-and-mortar offices, cyber offices,...).
- 7500 financial institutions (banks, credit unions, S&L, brokers...).
- Loan product characteristics.
- Branch location, ownership & rate-setting rights.

Other Data

1 **Macro Indicators**:

- National/State-level: GDP, Prices, Excess Bond Premium, House Prices.
- County-Level: Unemployment, Wages, House Prices (Zillow).

Other Data

1 **Macro Indicators**:
- National/State-level: GDP, Prices, Excess Bond Premium, House Prices.
- County-Level: Unemployment, Wages, House Prices (Zillow).

2 **Lender Data**:
- Lender-level: Asset, Liability, Interest Income/Expense by category.
- Branch-level: Location, period of activity, ownership, tot. deposit volume.

Skewness Example Skewness Time-Series

Other Data

1. **Macro Indicators**:
   - National/State-level: GDP, Prices, Excess Bond Premium, House Prices.
   - County-Level: Unemployment, Wages, House Prices (Zillow).
2. **Lender Data**:
   - Lender-level: Asset, Liability, Interest Income/Expense by category.
   - Branch-level: Location, period of activity, ownership, tot. deposit volume.
3. **Robustness Loan-Level Data**:
   - Freddie-Mac Data on Mortgage Loans.
   - Loan Characteristics, Borrower Characteristics, Renegotiation/Cashout Status.

Skewness Example Skewness Time-Series

Outline

Local projection specification

Methodology: Local projections. county(c)/product(p)/month(m) panel.

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

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

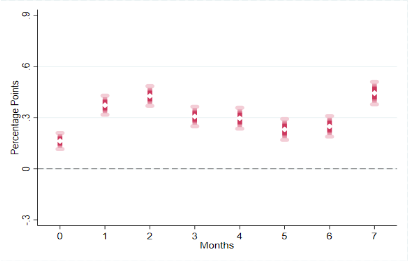
Controls: National GDP, Defl, Stock Market, Excess Bond Premium, county: wage growth, unemployment, home prices, Herfindal Index, ROA, Cost of Funds, Loan Loss Provisions, lags of the outcome variable, Product/County FE.

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

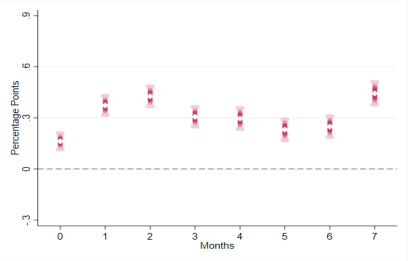


(a) Response with skewness at long-run mean (β_0).

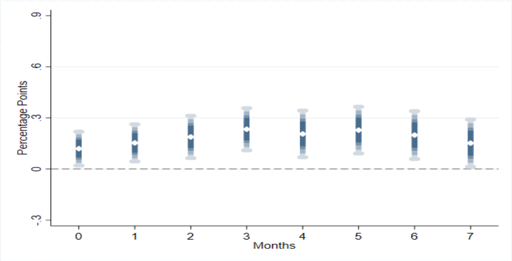
- **Result 1:** Pass-Through significantly higher when ex-ante skewness is high.

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).

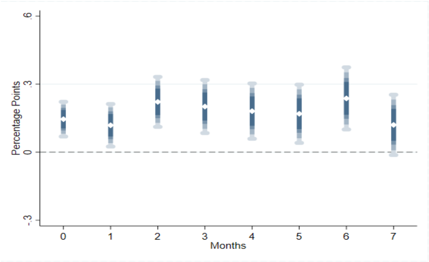


(b) Additional impact with skewness 1 s.d. above mean (β_1)

- **<u>Result 1:</u>** Pass-Through significantly higher when ex-ante skewness is high.

Robust Specification: Lending Rates

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

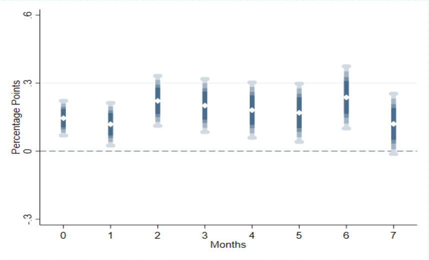


(b) Additional impact: skewness 1 s.d. above mean (β_1)

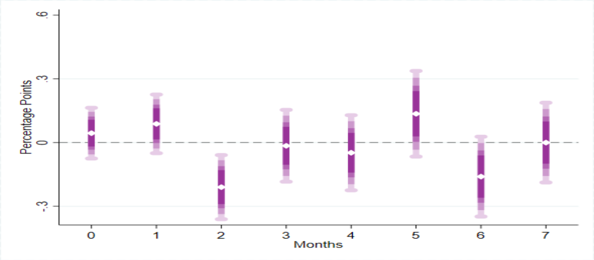
- **Result 2:** Skewness remains highly significant. Variance is NOT significant.

Robust Specification: Lending Rates

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



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



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

- **Result 2:** Skewness remains highly significant. Variance is NOT significant.
- **Result 3: Higher ex-ante Skewness higher MP effects on Unemployment**

Table Results

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: courtyards and brand loyalty

- Structure: Bertrand Duopoly between Bank H and Bank L.

- Each period a new measure one cohort of customers wakes up and knows $r_{H,t-1}, r_{L,t-1}$.

Main Model Ingredients: courtyards and brand loyalty

- Structure: Bertrand Duopoly between Bank H and Bank L.
- Each period a new measure one cohort of customers wakes up and knows $r_{H,t-1}, r_{L,t-1}$.
- S0: λ_1 have their "*home*" lender in H, $1 - \lambda_1$ in L

Main Model Ingredients: courtyards and brand loyalty

- Structure: Bertrand Duopoly between Bank H and Bank L.
- Each period a new measure one cohort of customers wakes up and knows $r_{H,t-1}, r_{L,t-1}$.
- S0: λ_1 have their *"home"* lender in H, $1 - \lambda_1$ in L
- S1: Customers form $\mathbb{E}[r_{i,t} \mid r_{i,t-1}]$ and decide whether to:

Main Model Ingredients: courtyards and brand loyalty

- Structure: Bertrand Duopoly between Bank H and Bank L.

- Each period a new measure one cohort of customers wakes up and knows $r_{H,t-1}, r_{L,t-1}$.

- S0: λ_1 have their *"home"* lender in H, $1 - \lambda_1$ in L

- S1: Customers form $\mathbb{E}[r_{i,t} \mid r_{i,t-1}]$ and decide whether to:
  - pay ϕ_j to apply for quotes at both lenders.

Main Model Ingredients: courtyards and brand loyalty

- Structure: Bertrand Duopoly between Bank H and Bank L.

- Each period a new measure one cohort of customers wakes up and knows $r_{H,t-1}, r_{L,t-1}$.

- S0: λ_1 have their "*home*" lender in H, $1 - \lambda_1$ in L

- S1: Customers form $\mathbb{E}[r_{i,t} \mid r_{i,t-1}]$ and decide whether to:
  - pay ϕ_j to apply for quotes at both lenders.
  - apply for a free quote from the default lender.

Main Model Ingredients: courtyards and brand loyalty

- Structure: Bertrand Duopoly between Bank H and Bank L.

- Each period a new measure one cohort of customers wakes up and knows $r_{H,t-1}, r_{L,t-1}$.

- S0: λ_1 have their *"home"* lender in H, $1 - \lambda_1$ in L

- S1: Customers form $\mathbb{E}[r_{i,t} \mid r_{i,t-1}]$ and decide whether to:
  - pay ϕ_j to apply for quotes at both lenders.
  - apply for a free quote from the default lender.

  $\Rightarrow$ Mass of searching customers: $S = f\left(r_{H,t-1}, r_{L,t-1}\right)$
- S2: Lenders observe MP rate shock and set lending rates.

Main Model Ingredients: courtyards and brand loyalty

- Structure: Bertrand Duopoly between Bank H and Bank L.
- Each period a new measure one cohort of customers wakes up and knows $r_{H,t-1}, r_{L,t-1}$.
- S0: λ_1 have their "*home*" lender in H, $1 - \lambda_1$ in L
- S1: Customers form $\mathbb{E}[r_{i,t} \mid r_{i,t-1}]$ and decide whether to:
    - pay ϕ_j to apply for quotes at both lenders.
    - apply for a free quote from the default lender.

  $\Rightarrow$ Mass of searching customers: $S = f\left(r_{H,t-1}, r_{L,t-1}\right)$
- S2: Lenders observe MP rate shock and set lending rates.
- S3: Customers observe rates and:

Main Model Ingredients: courtyards and brand loyalty

- Structure: Bertrand Duopoly between Bank H and Bank L.

- Each period a new measure one cohort of customers wakes up and knows $r_{H,t-1}, r_{L,t-1}$.

- S0: λ_1 have their *"home"* lender in H, $1 - \lambda_1$ in L

- S1: Customers form $\mathbb{E}[r_{i,t} \mid r_{i,t-1}]$ and decide whether to:
  - pay ϕ_j to apply for quotes at both lenders.
  - apply for a free quote from the default lender.

  $\Rightarrow$ Mass of searching customers: $S = f\left(r_{H,t-1}, r_{L,t-1}\right)$
- S2: Lenders observe MP rate shock and set lending rates.

- S3: Customers observe rates and:
  - If NOT SEARCH: take loan if $v - r_i - z_i \geq 0$.

Main Model Ingredients: courtyards and brand loyalty

- Structure: Bertrand Duopoly between Bank H and Bank L.
- Each period a new measure one cohort of customers wakes up and knows $r_{H,t-1}, r_{L,t-1}$.
- S0: λ_1 have their "*home*" lender in H, $1-\lambda_1$ in L
- S1: Customers form $\mathbb{E}[r_{i,t} \mid r_{i,t-1}]$ and decide whether to:
  - pay ϕ_j to apply for quotes at both lenders.
  - apply for a free quote from the default lender.

  $\Rightarrow$ Mass of searching customers: $S = f\left(r_{H,t-1}, r_{L,t-1}\right)$
- S2: Lenders observe MP rate shock and set lending rates.
- S3: Customers observe rates and:
  - If NOT SEARCH: take loan if $v - r_i - z_i \geq 0$.
  - If SEARCH: take loan if $v - r_i - z_i \geq v - r_{-i} - z_{-i}$.

Where the fun happens: demand and profit functions

Demand Functions:

Bank H:

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

Bank L:

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

Where the fun happens: demand and profit functions

Demand Functions:

Bank H:

$$X_H(r_H, r_L) = \left[\bar{Q}_H - \overbrace{\left[\lambda_1 S + \tfrac{1}{2}\lambda_1(1-S)\right]}^{\beta_H} r_H \quad \overbrace{\left[\tfrac{1}{2}\lambda_1(1-S)\right]}^{+\kappa} r_L \right]$$

Bank L:

$$X_L(r_H, r_L) = \left[\bar{Q}_L - \overbrace{\left[\lambda_2 + \tfrac{1}{2}\lambda_1(1-S)\right]}^{\beta_L} r_L \quad \overbrace{\left[\tfrac{1}{2}\lambda_1(1-S)\right]}^{+\kappa} r_H \right]$$

Where the fun happens: demand and profit functions

Demand Functions:

Bank H:

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

Bank L:

$$X_L(r_H, r_L) = \left[\bar{Q}_L - \overbrace{\beta_L}^{\left[\lambda_2 + \frac{1}{2}\lambda_1(1-S)\right]} r_L \quad \overbrace{+\kappa}^{\left[\frac{1}{2}\lambda_1(1-S)\right]} r_H \right]$$

State Dependency: $S = f\left(r_{H,t-1}, r_{L,t-1}\right)$

Where the fun happens: demand and profit functions

Profit Functions:

Bank H:

$$\pi_H(r_H, r_L, c) = \overbrace{\left[r_H - \underbrace{c}_{MP} \right]}^{\text{Unit Profit}} \times \left[\bar{Q}_H - \overbrace{\left[\lambda_1 S + \tfrac{1}{2}\lambda_1(1-S)\right]}^{\beta_H} r_H \quad \overbrace{\left[\tfrac{1}{2}\lambda_1(1-S)\right]}^{+\,\kappa} r_L \right]$$

Bank L:

$$\pi_L(r_H, r_L, c) = \overbrace{\left[r_L - \underbrace{c}_{MP} \right]}^{\text{Unit Profit}} \times \left[\bar{Q}_L - \overbrace{\left[\lambda_2 + \tfrac{1}{2}\lambda_1(1-S)\right]}^{\beta_L} r_L \quad \overbrace{\left[\tfrac{1}{2}\lambda_1(1-S)\right]}^{+\,\kappa} r_H \right]$$

State Dependency: $S = f\left(r_{H,t-1}, r_{L,t-1}\right)$

Where the fun happens: demand and profit functions

Profit Functions:

Bank H:

$$\pi_H(r_H, r_L, c) = \overbrace{\Big[r_H - \underbrace{c}_{MP}\Big]}^{\text{Unit Profit}} \times \Bigg[\bar{Q}_H - \overbrace{\beta_H \; r_H}^{\left[\lambda_1 S + \frac{1}{2}\lambda_1(1-S)\right]} \quad \overbrace{+\,\kappa \; r_L}^{\left[\frac{1}{2}\lambda_1(1-S)\right]}\Bigg]$$

Bank L:

$$\pi_L(r_H, r_L, c) = \overbrace{\Big[r_L - \underbrace{c}_{MP}\Big]}^{\text{Unit Profit}} \times \Bigg[\bar{Q}_L - \overbrace{\beta_L \; r_L}^{\left[\lambda_2 + \frac{1}{2}\lambda_1(1-S)\right]} \quad \overbrace{+\,\kappa \; r_H}^{\left[\frac{1}{2}\lambda_1(1-S)\right]}\Bigg]$$

State Dependency: $S = f\left(r_{H,t-1}, r_{L,t-1}\right)$

Solution Details: (Best Responses), (Equilibrium Rates), (Pass-Through)

Main Results on Pass-Through

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

Main Results on Pass-Through

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

Proposition 1

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

- If search costs $= \infty \Rightarrow$ NO borrowers search $\Rightarrow$ banks are local monopolists $\Rightarrow$ NO Competition $\Rightarrow$ Pass-Through $= 1/2$.
- If search costs $= 0 \Rightarrow$ ALL borrowers search $\Rightarrow$ banks are perfect Bertrand $\Rightarrow$ High Competition $\Rightarrow$ Pass-Through $= 1$.

Main Results on Pass-Through

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

Proposition 1

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

- If search costs $= \infty \Rightarrow$ NO borrowers search $\Rightarrow$ banks are local monopolists $\Rightarrow$ NO Competition $\Rightarrow$ Pass-Through $= 1/2$.
- If search costs $= 0 \Rightarrow$ ALL borrowers search $\Rightarrow$ banks are perfect Bertrand $\Rightarrow$ High Competition $\Rightarrow$ Pass-Through $= 1$.
- $S = f(r_{H,t-1} - r_{L,t-1})$ pins down **propensity to search & switch** $\Rightarrow$ **competition among lenders**.

Main Results on Pass-Through

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

Proposition 1

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

- ➢ If search costs $= \infty \Rightarrow$ NO borrowers search $\Rightarrow$ banks are local monopolists $\Rightarrow$ NO Competition $\Rightarrow$ Pass-Through $= 1/2$.
- ➢ If search costs $= 0 \Rightarrow$ ALL borrowers search $\Rightarrow$ banks are perfect Bertrand $\Rightarrow$ High Competition $\Rightarrow$ Pass-Through $= 1$.
- ➢ $S = f(r_{H,t-1} - r_{L,t-1})$ pins down **propensity to search & switch** $\Rightarrow$ **competition among lenders**.
- ❖ **Prop 2:** Pass-through Increases in $(r_{H,t-1} - r_{L,t-1})$ and λ_1. details Variance vs Skewness

Main Results on Pass-Through

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

Proposition 1

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

- If search costs $= \infty \Rightarrow$ NO borrowers search $\Rightarrow$ banks are local monopolists $\Rightarrow$ NO Competition $\Rightarrow$ Pass-Through $= 1/2$.
- If search costs $= 0 \Rightarrow$ ALL borrowers search $\Rightarrow$ banks are perfect Bertrand $\Rightarrow$ High Competition $\Rightarrow$ Pass-Through $= 1$.
- $S = f(r_{H,t-1} - r_{L,t-1})$ pins down **propensity to search & switch** $\Rightarrow$ **competition among lenders**.

- **Prop 2:** Pass-through Increases in $(r_{H,t-1} - r_{L,t-1})$ and λ_1. details Variance vs Skewness
- **Prop 3**; Pass-Through(H) > Pass-Through(L). details empirical test

Conclusions

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

Conclusions

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

- 1 s.d. $\Uparrow$ skewness roughly increases MP pass-through by 75%, and efficacy by 25 %.

THANKS!

Conclusions

- **Lending rate skewness** is a **quantitatively** important **state-variable** for MP effects.
- 1 s.d. $\Uparrow$ skewness roughly increases MP pass-through by 75%, and efficacy by 25 %.
- Can account for **heterogeneity** across **space** and **time** of MP effects.

THANKS!

Conclusions

- **Lending rate skewness** is a **quantitatively** important **state-variable** for MP effects.
- 1 s.d. $\Uparrow$ skewness roughly increases MP pass-through by 75%, and efficacy by 25 %.
- Can account for **heterogeneity** across **space** and **time** of MP effects.
- **Search & Switching Frictions** create skewness-based state-dependent responses of lending rates to MP.

THANKS!

Conclusions

- **Lending rate skewness** is a **quantitatively** important **state-variable** for MP effects.
- 1 s.d. $\Uparrow$ skewness roughly increases MP pass-through by 75%, and efficacy by 25 %.
- Can account for **heterogeneity** across **space** and **time** of MP effects.
- **Search & Switching 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

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.**

back

Outline

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)

back

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):

- Location, dates of activity, ownership.
- Total deposits by year.

6 **Other: Loan - level** (Freddie-Mac Data):

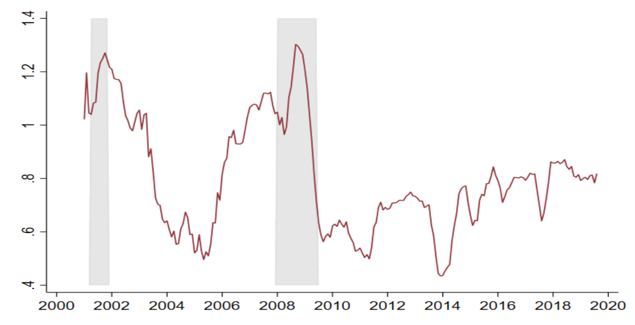
- Loan characteristics. (Location, LTV)
- New/Renegotiation/Cash-out status.
- Borrower characteristics. (FICO)

Skewness On Request

Outline

Branch-Level Data: variation over time and space

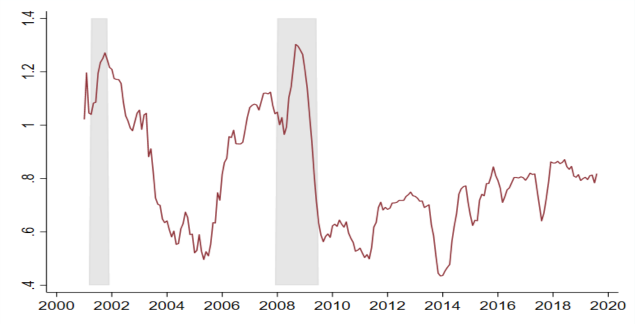
Example: New advertised Loan Rates for Personal Recreational Vehicle purchase.



Lending rates skewness, US overall distribution.

Branch-Level Data: variation over time and space

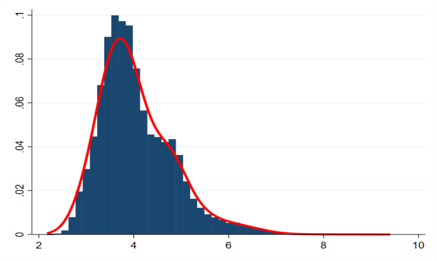
Example: New advertised Loan Rates for Personal Recreational Vehicle purchase.



Lending rates skewness, US overall distribution.

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

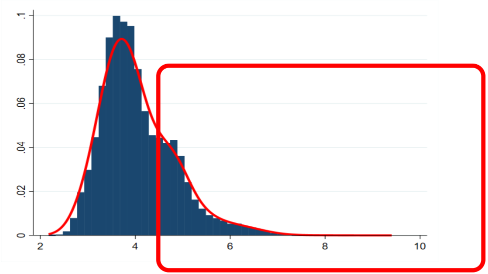
Facts: The curious shapes of the lending rate distributions.



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

- Pronounced Asymmetric shape, market concentration but...

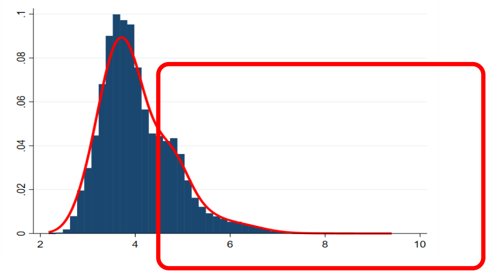
Facts: The curious shapes of the lending rate distributions.



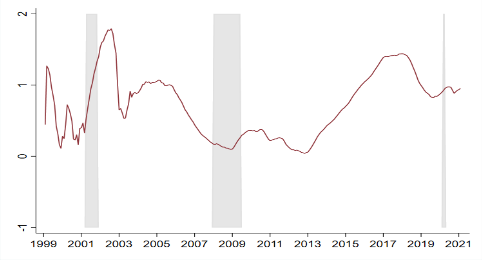
(a) 30Y Mortgage Rates. Minneapolis-MSA. 2019-M1.

- Pronounced Asymmetric shape, market concentration but...

Facts: The curious shapes of the lending rate distributions.



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



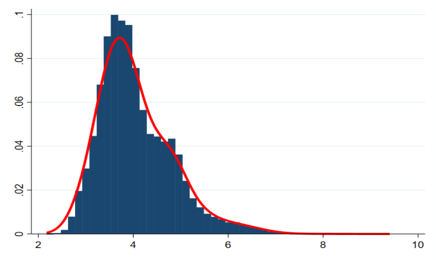
(b) Skewness Time-Series. Minnepolis-MSA

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

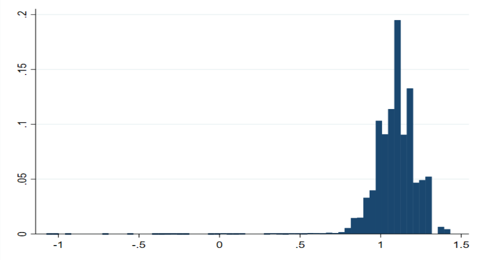
▸ MSA-Cross Distribution ▸ Branch-Level Distribution ▸ Online Marketplace dispersion ▸ Row Rates ▸ MP Pass-Through Heterogeneity ▸ Back

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.



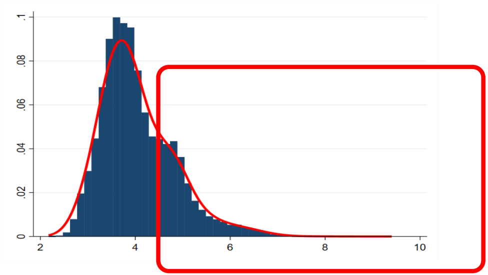
(b) Skewness Distribution Over MSAs. (Recessions in grey)

- Pronounced Asymmetric shape, market concentration but...
- Skewness cross-section MSA distribution centered around 1 and positive.

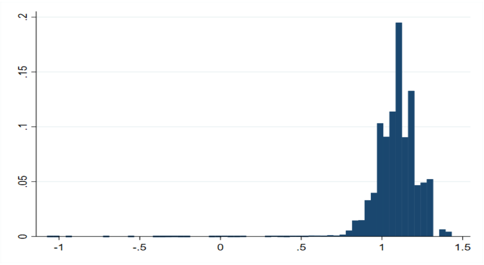
Back

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.



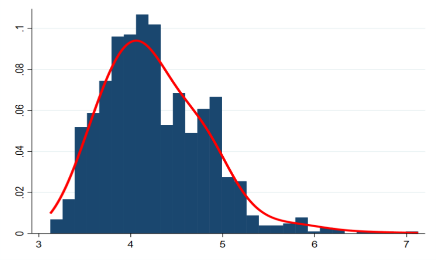
(b) Skewness Distribution Over MSAs. (Recessions in grey)

- Pronounced Asymmetric shape, market concentration but...
- Skewness cross-section MSA distribution centered around 1 and positive.

Back

Facts: The curious shapes of the lending rate distributions.

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



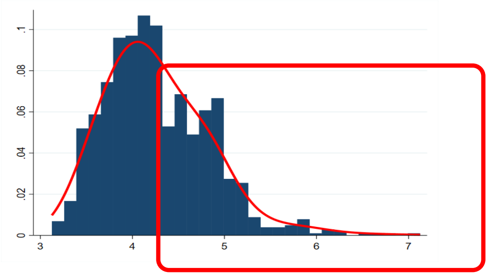
(a) Distribution in 2019-M1.

- Pronounced Asymmetric shape, market concentration but...

Back

Facts: The curious shapes of the lending rate distributions.

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



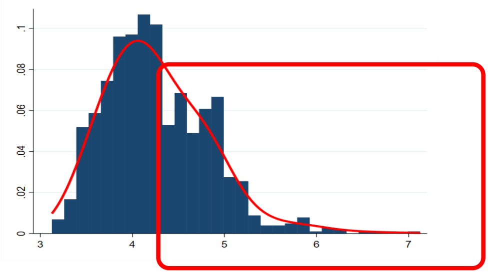
(a) Distribution in 2019-M1.

- Pronounced Asymmetric shape, market concentration but...

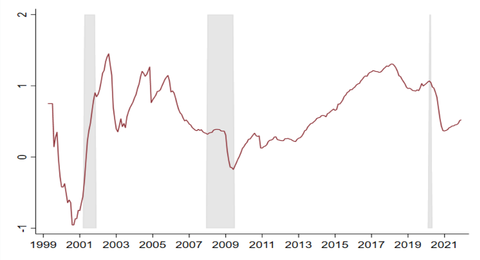
Back

Facts: The curious shapes of the lending rate distributions.

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



(a) Distribution in 2019-M1.



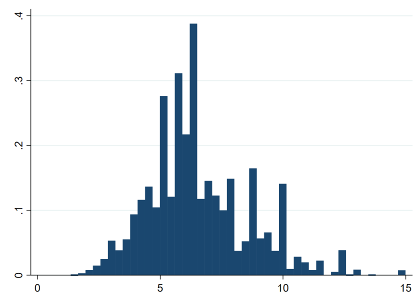
(b) Skewness over time. (Recessions in grey)

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

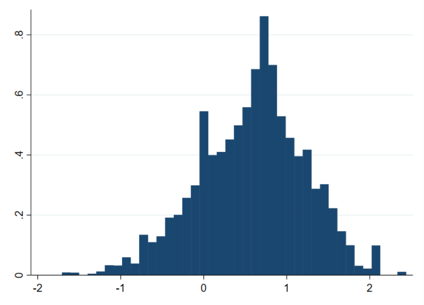
Back

The Distribution of Offered Base Rates by lender branch

Offered Rates on Pers Rec Veichle Loans



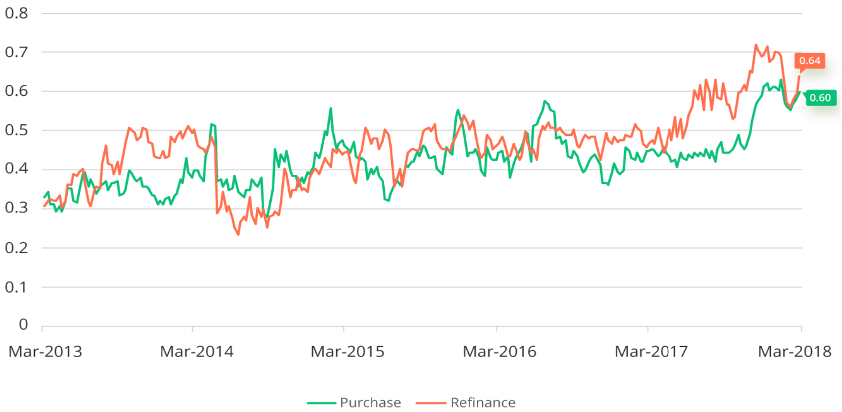
(a) L.A. Cross-sectional Distribution Lending Rates. 2016m1.



(b) National distribution of cross-sectional skewness.

▸ Skewness Time-Series ▸ Robustness Freddie Mac ▸ Online Dispersion ▸ back

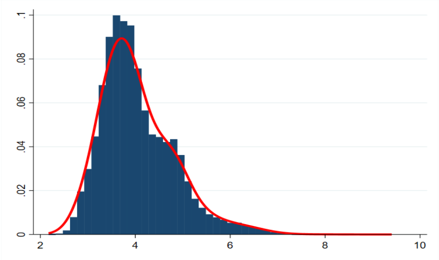
Facts: The lending rate dispersion on Online Marketplaces



Interest Rate Dispersion on LendingTree.com

back

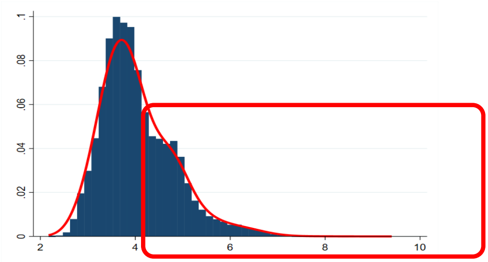
Freddie Mac Data on Realized House Mortgage Rates



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

- Displayed distribution is residualized wrt Borrowers and Loan Observables as in Hurst et al. (2016).
- Pronounced asymmetry,

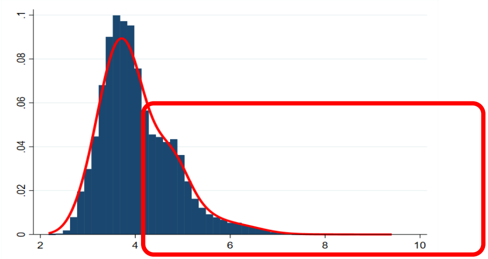
Freddie Mac Data on Realized House Mortgage Rates



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

- Displayed distribution is residualized wrt Borrowers and Loan Observables as in Hurst et al. (2016).
- Pronounced asymmetry,

Freddie Mac Data on Realized House Mortgage Rates

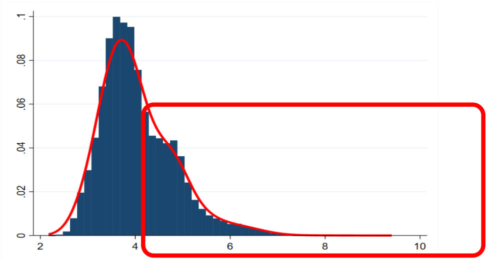


(a) 30Y Mortgage Rates. Minneapolis-MSA. 2019-M1.

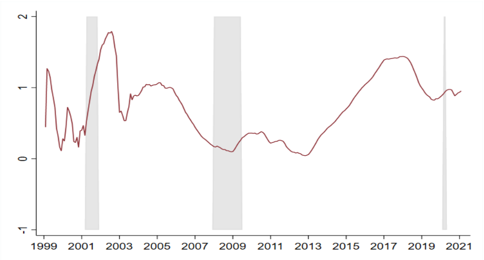
- Displayed distribution is residualized wrt Borrowers and Loan Observables as in Hurst et al. (2016).
- Pronounced asymmetry, market concentration but...

back

Freddie Mac Data on Realized House Mortgage Rates



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



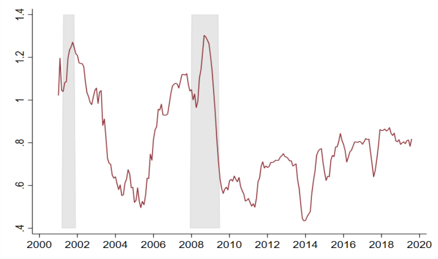
(b) Skewness Time-Series. Minnepolis-MSA

- Displayed distribution is residualized wrt Borrowers and Loan Observables as in Hurst et al. (2016).
- Pronounced asymmetry, market concentration but...
- asymmetry is time-varying.

back

Branch-Level Data: cross-sectional skewness over time

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

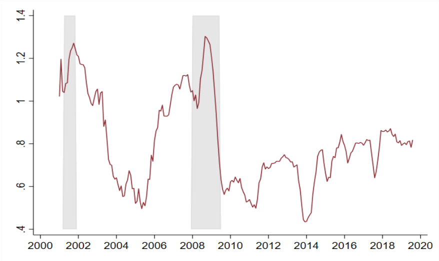


(a) Lending rates skewness, US overall distribution.

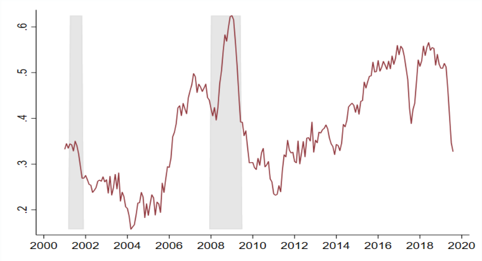
Back
Realized Rates
More Product Types
Loan-level Distribution
Syndacated Loans

Branch-Level Data: cross-sectional skewness over time

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



(a) Lending rates skewness, US overall distribution.

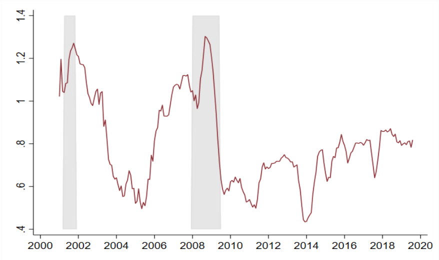


(b) Mean of within-county skewness measures.

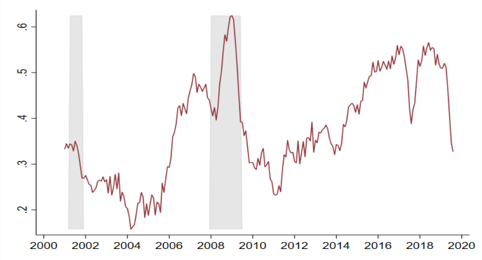
Back
Realized Rates
More Product Types
Loan-level Distribution
Syndicated Loans

Branch-Level Data: cross-sectional skewness over time

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



(a) Lending rates skewness, US overall distribution.



(b) Mean of within-county skewness measures.

⇒ High variation.

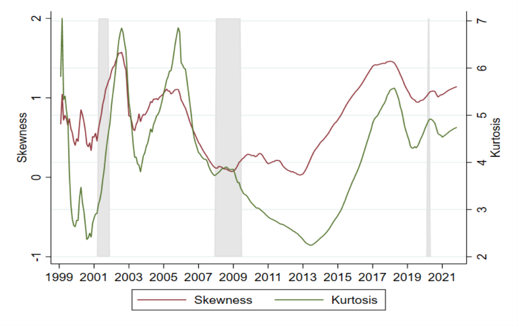
⇒ Distribution of skewness across counties shifts over time.

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

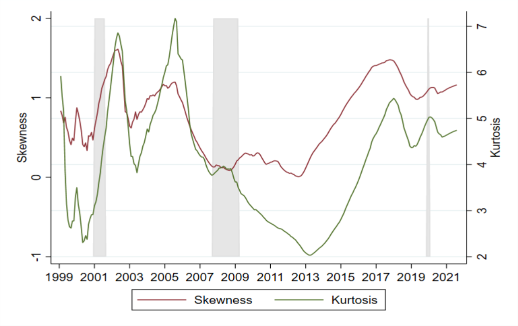
Loan-Level Distribution: higher order moments non-trivial dynamics

Freddie Mac Mortgage Rates. Purged. Moments over time.

Skewness and Kurtosis, County-Level Mean



Skewness and Kurtosis, pooled-US Mean

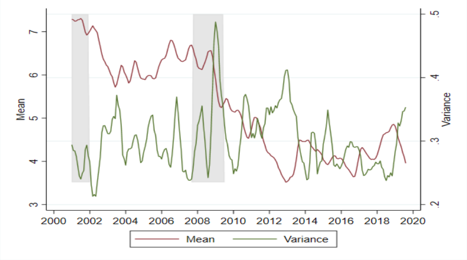


Back

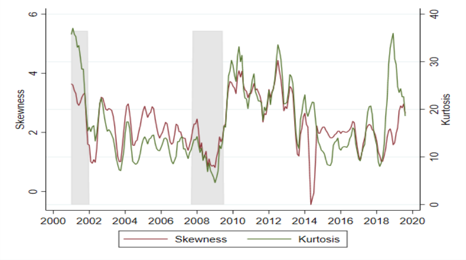
Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

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

Mean and Variance



Skewness and Kurtosis



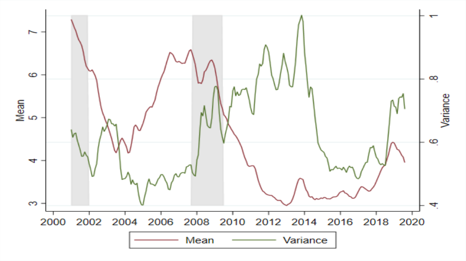
Interest rates at monthly frequency.

Back

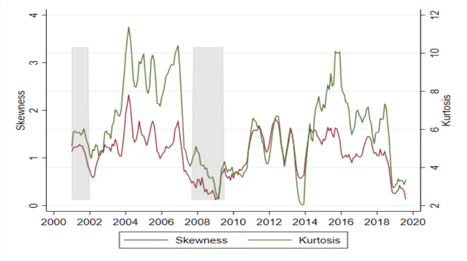
Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

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

Mean and Variance



Skewness and Kurtosis

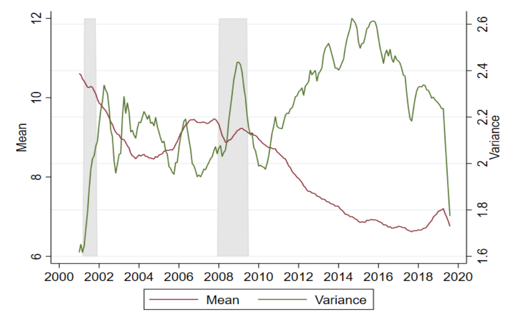


Interest rates at monthly frequency.

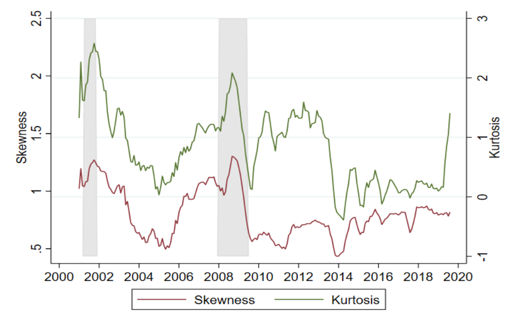
Branch-Level Distribution: higher order moments non-trivial dynamics

Personal Recreational Vehicle Advertised Loan Rates.

Mean and Variance



Skewness and Kurtosis

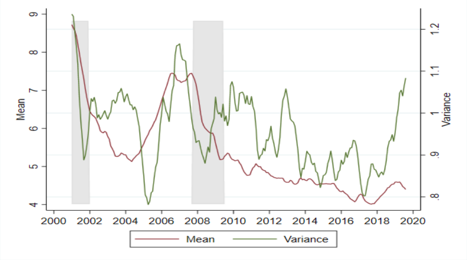


Back to Outline

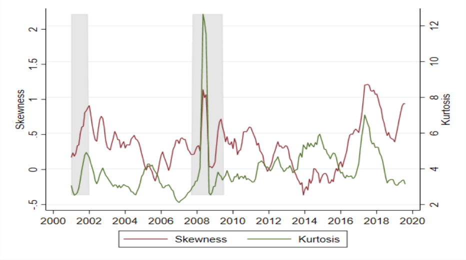
Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

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

Mean and Variance



Skewness and Kurtosis

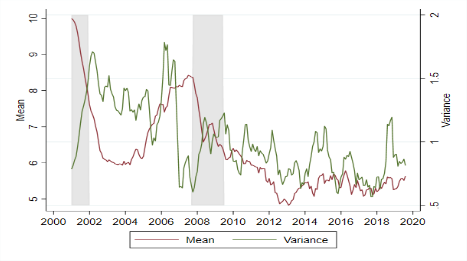


Interest rates at monthly frequency.

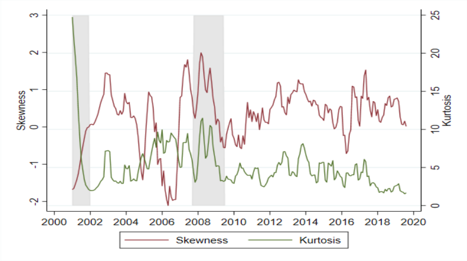
Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

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

Mean and Variance



Skewness and Kurtosis

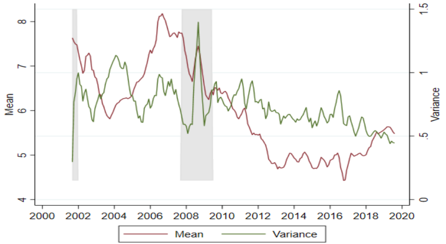


Interest rates at monthly frequency.

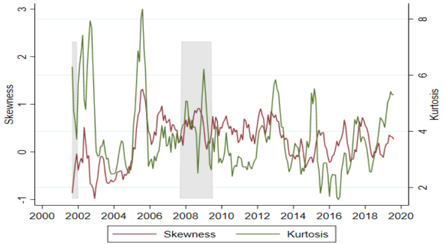
Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

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

Mean and Variance



Skewness and Kurtosis

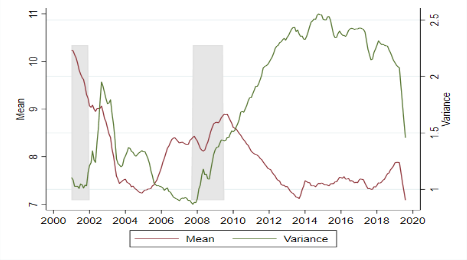


Interest rates at monthly frequency.

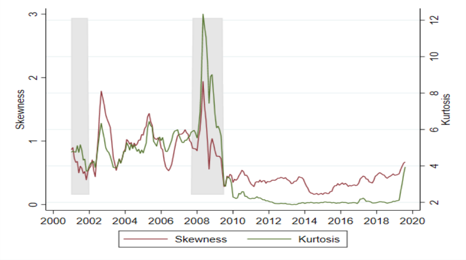
Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

Ratewatch interest rate spreads moments over time (Boat New)

Mean and Variance



Skewness and Kurtosis

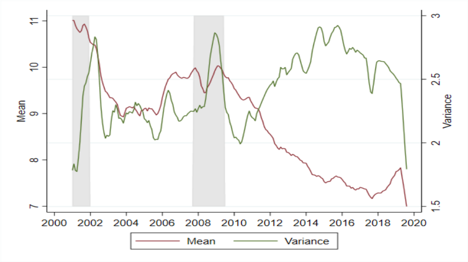


Interest rates at monthly frequency.

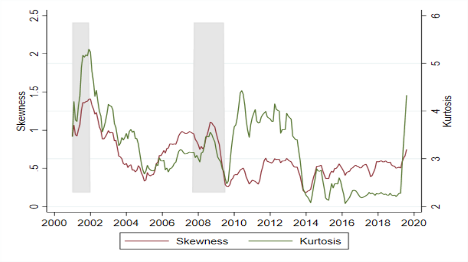
Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

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

Mean and Variance



Skewness and Kurtosis



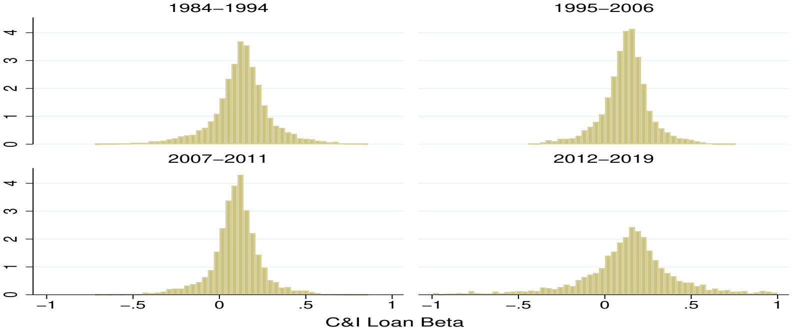
Interest rates at monthly frequency.

Back

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))

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

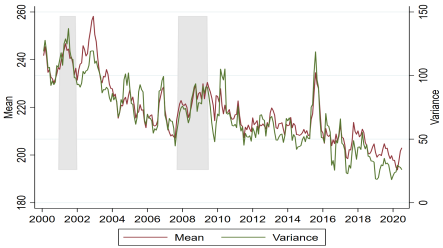


Back

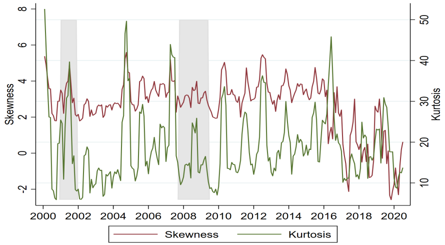
Evolution of Interest Rate Distribution 1st to 4th Moment. Dealscan

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

Mean and Variance



Skewness and Kurtosis

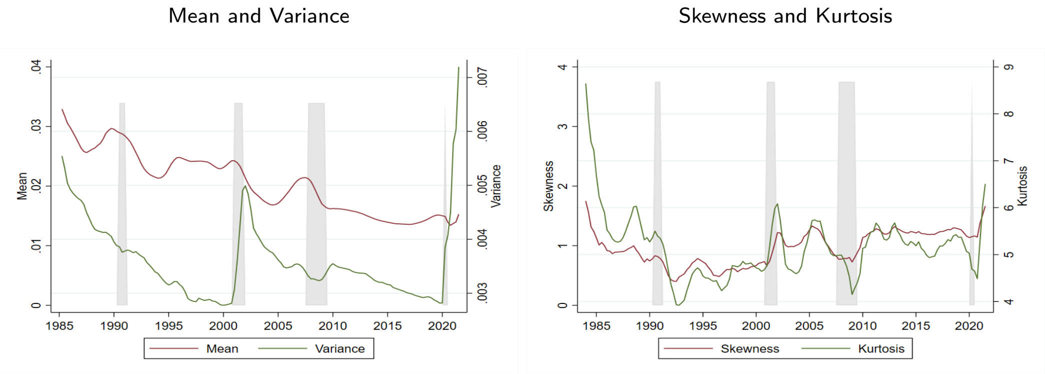


Interest rates spread on base rate from Dealscan Data at monthly frequency.

Back

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.

MP Pass-Through heterogeneity Across-States

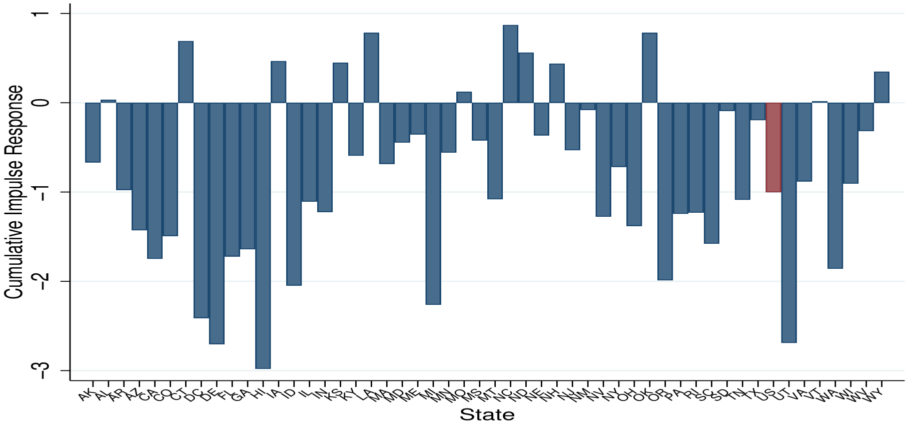


Figure: IRF to 1% MP Shock. IV Local Projections.

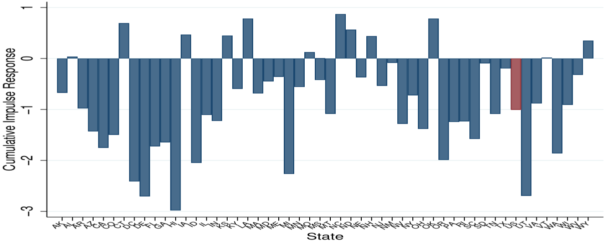
Back

MP Heterogeneity Across States

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

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

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



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

Back

US States/Bank Panel: Real Personal Income

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

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

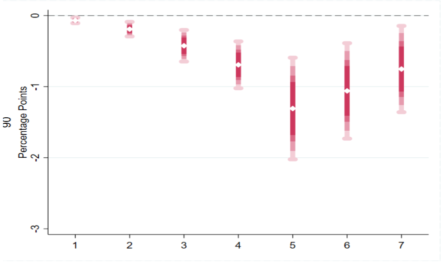
Outcome Variables: State Real Personal Income.

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.

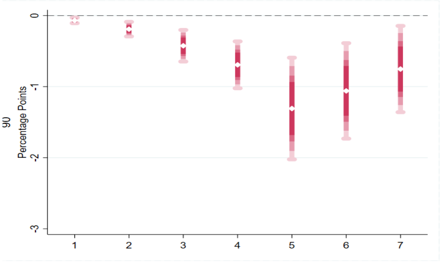
Coefficient Plots



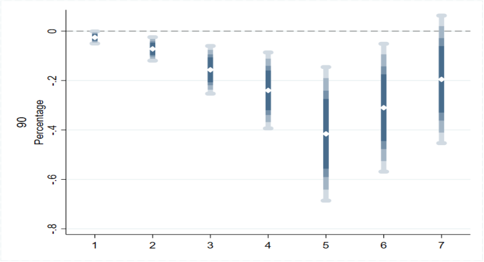
(a) Standard MP response (β_0).

- Response to 100 b.p. MP shock.

Coefficient Plots



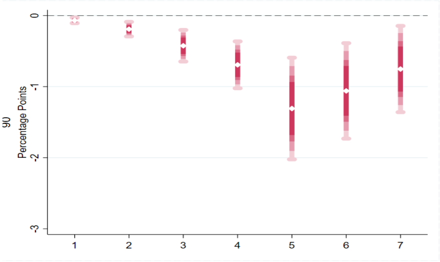
(a) Standard MP response (β_0).



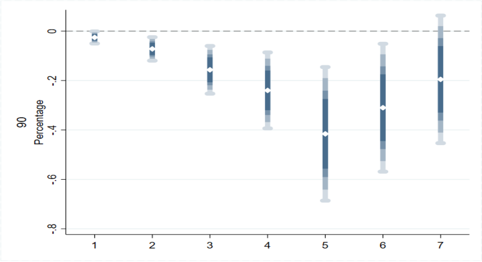
(b) Difference in MP response with high skewness (β_1)

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

Coefficient Plots



(a) Standard MP response (β_0).

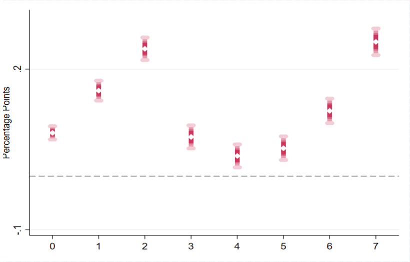


(b) Difference in MP response with high skewness (β_1)

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

Coefficient Plots: Unemployment Rate

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



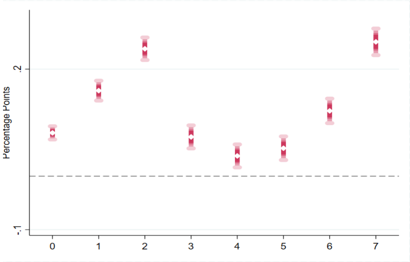
(a) Response with skewness at long-run mean (β_0).

- Efficacy significantly higher when skewness is high.

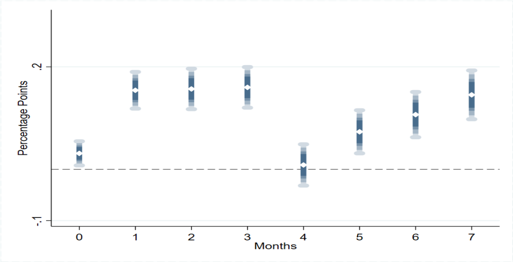
back

Coefficient Plots: Unemployment Rate

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



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



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

- Efficacy significantly higher when skewness is high.

back

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
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Back

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
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Back

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).

Back

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

Methodology: IV Local Projections with High Frequency Proxy.

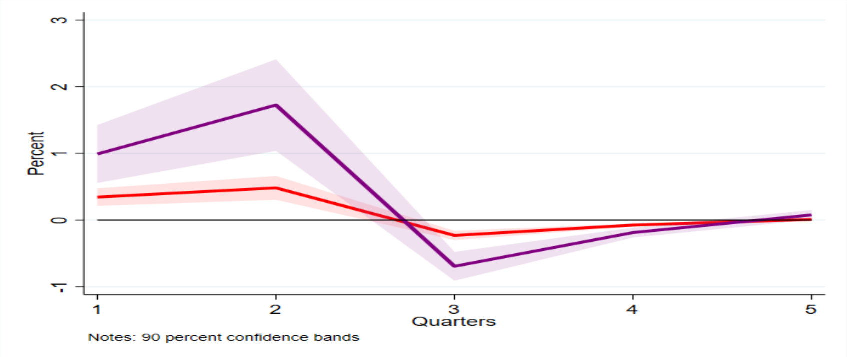
$$\begin{aligned}\text{Refinancing Rates}_{t+h,s} &= \alpha + \underline{\beta_0 \textbf{Treasury Rate}_t} + \underline{\beta_1} \left[\underline{\textbf{Treasury Rate}_t} \times \underline{\textbf{Skewness}}_{t,s}\right] + \\ &+ \sum_{k=1}^{2} \rho_{1,k} \text{Treasury Rate}_{t-k} + \sum_{k=1}^{2} \rho_{2,k}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

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.



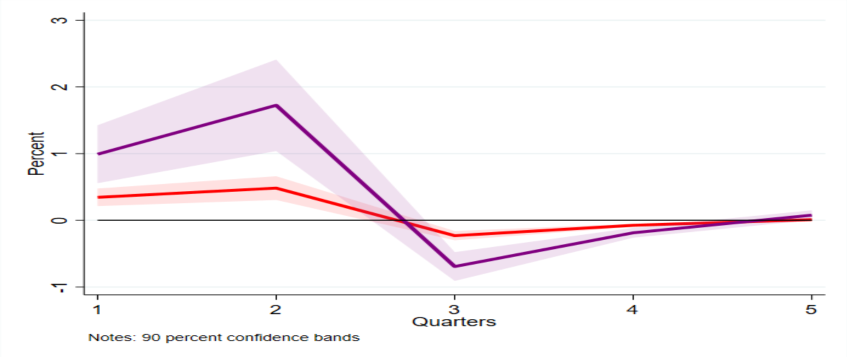
Red line: Standard Pass-Through. Purple Line: High Skewness Pass-Through. SE clustered at the county level.

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

Back

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

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.

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

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

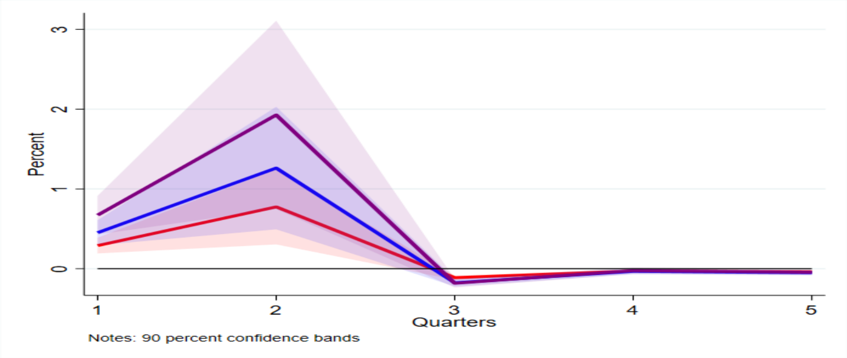
Methodology: IV Local Projections with High Frequency Proxy.

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

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.

Back

Model Appendix

Model Appendix: (Very Simple framework, Graphical Intuitions and Model Details)

(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:

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

Back

(Very) Simple Conceptual Framework

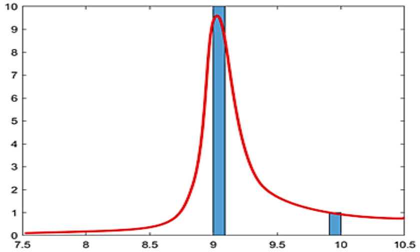
Assume:

- $r_{t,b} = c$
- $c = r_{FED}$
- $n - x$ 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

Back

(Very) Simple Conceptual Framework

One quarter later FED easens by 0.5%**:**

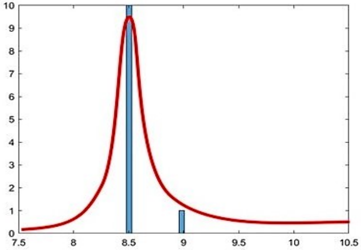
$r_{t,B} = c = 8.5\%$

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

Back

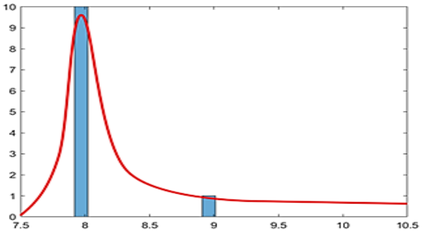
(Very) Simple Conceptual Framework

One quarter later FED easens again by 0.5%**:**

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

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

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

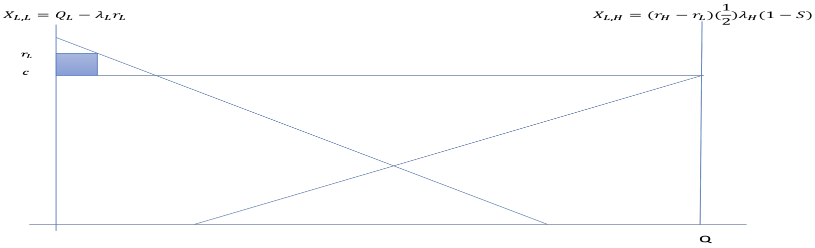


Quarter 3: Bank Rates Distribution

- **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.**

Back

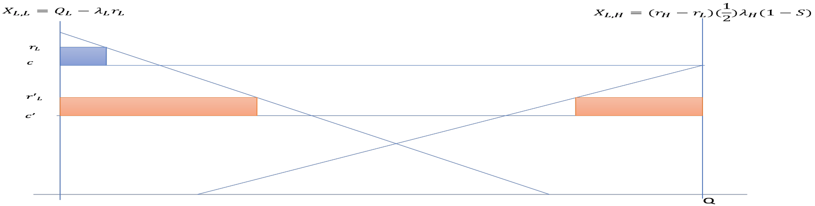
Graphic Intuition, Strategic L fixed H



Low skewness.

back

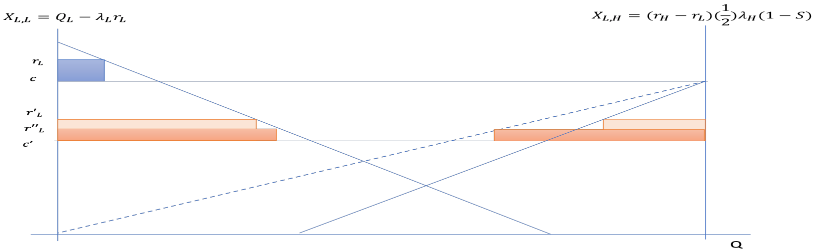
Graphic Intuition



Lower skewness. MP easing.

back

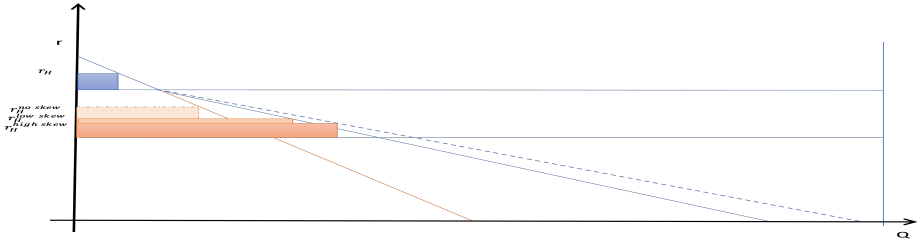
Graphic Intuition



Higher skewness. Same MP easing.

back

Graphic Intuition



No/Low/High Skewness. MP Easing.

back

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:

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

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

Back

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 back

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.

Larger initial mass of Bank H clients $\Rightarrow$ More clients search.

Variance vs Skewness back

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.

Larger initial mass of Bank H clients $\Rightarrow$ More clients search.

More clients on the search $\Rightarrow$ higher pass-through.

Variance vs Skewness back

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.

Larger initial mass of Bank H clients $\Rightarrow$ More clients search.

More clients on the search $\Rightarrow$ higher pass-through.

Note: Skewness increases in $\left(r_{t-1}^H - r_{t-1}^L\right)$ and λ_1.

▸ Variance vs Skewness ▸ back

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.

Larger initial mass of Bank H clients $\Rightarrow$ More clients search.

More clients on the search $\Rightarrow$ higher pass-through.

Note: Skewness increases in $\left(r_{t-1}^H - r_{t-1}^L\right)$ and λ_1.

Take-Away: Larger Skewness $\Rightarrow$ more clients on the search $\Rightarrow$ higher pass-through.

▸ Variance vs Skewness ▸ back

Results about the Pass-Through.

Proposition 3

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

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

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

Variance vs Skewness back

Results about the Pass-Through.

Proposition 3

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

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

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

Variance vs Skewness back

Results about the Pass-Through.

Proposition 3

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

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

Take-Away Bank H responds by more than Bank L to MP.

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

Variance vs Skewness back

Results about the Pass-Through.

Proposition 3

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

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

Take-Away Bank H responds by more than Bank L to MP.

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 back

Empirical Test of Proposition 3

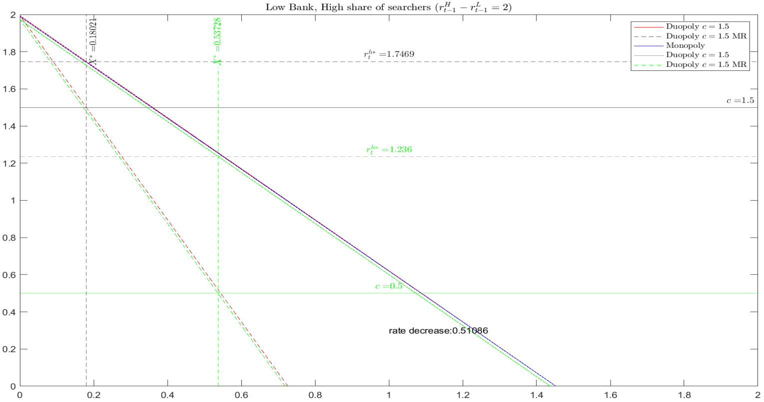
Table: Responsiveness of High vs Low Rate lender to a 100 b.p. monetary policy shock when skewness is high

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

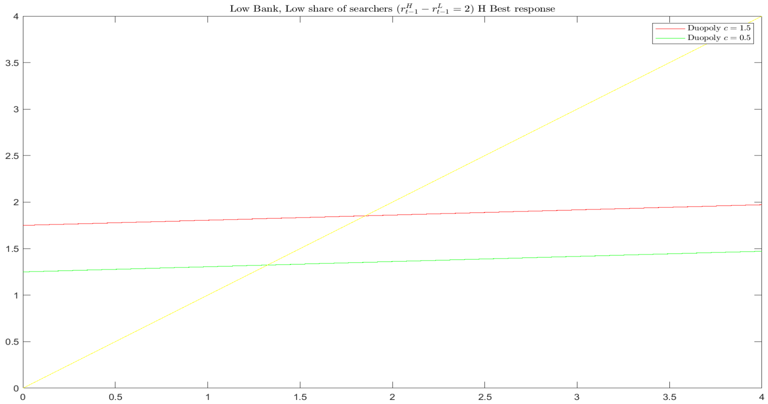
t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

back

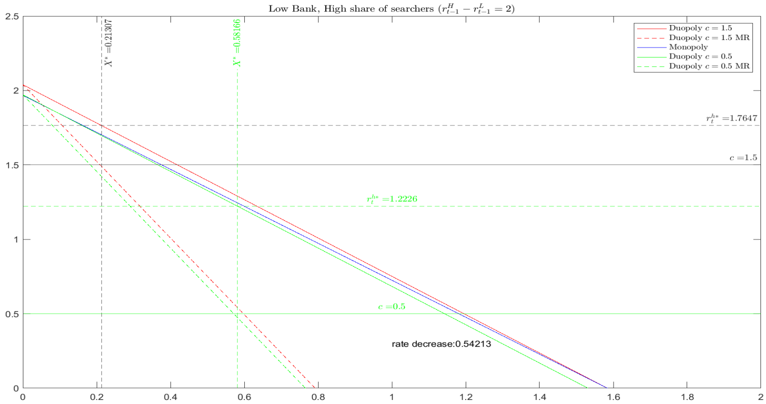
Graphical Intuition



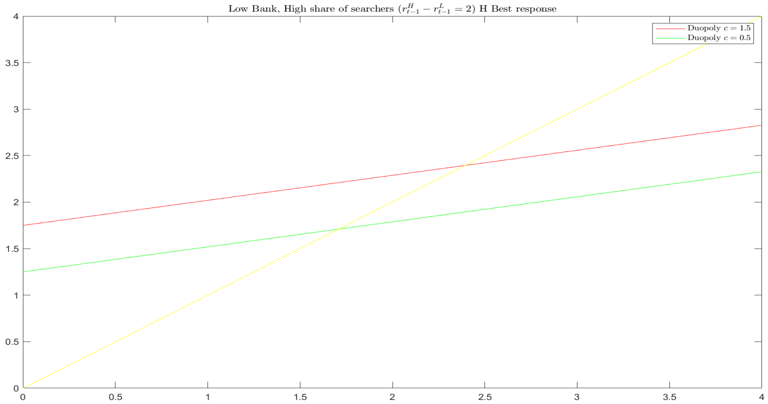
Graphical Intuition



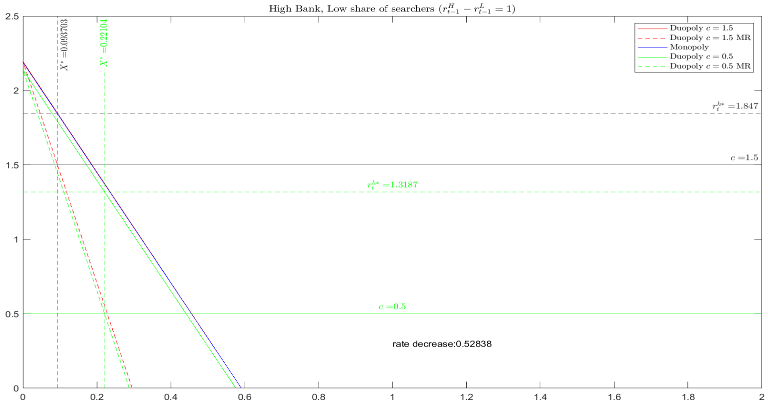
Graphical Intuition



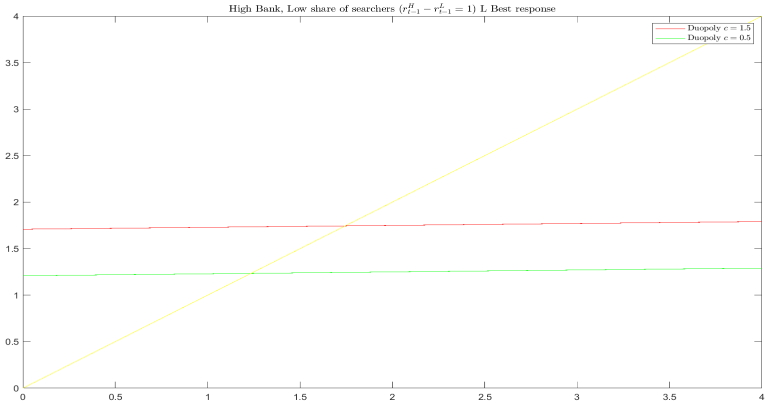
Graphical Intuition



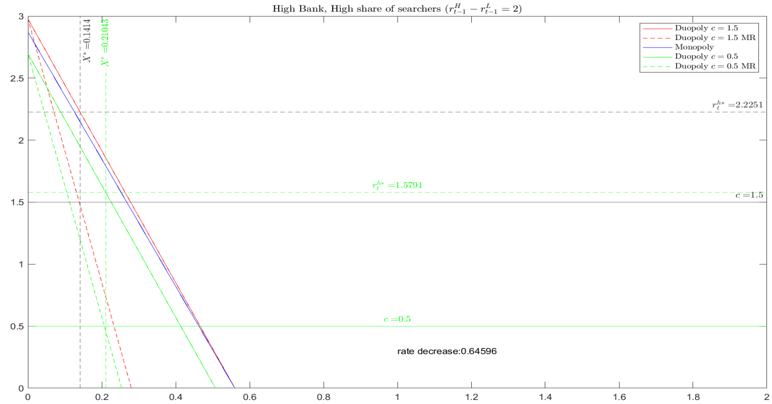
Graphical Intuition



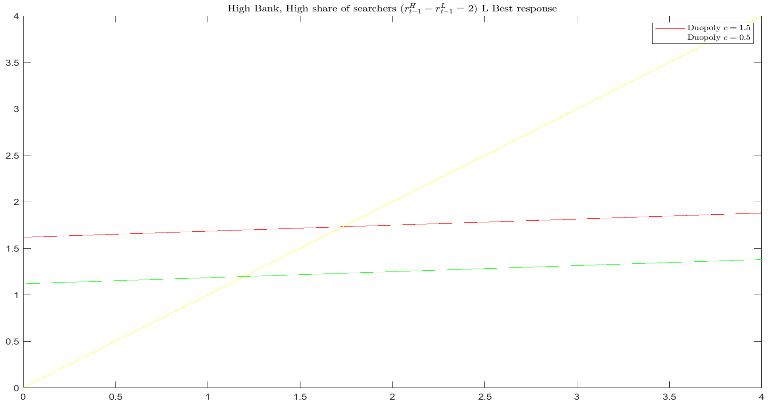
Graphical Intuition



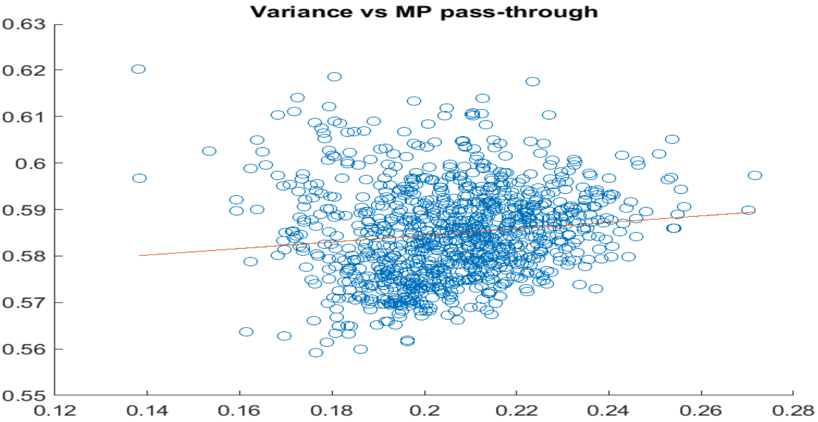
Graphical Intuition



Graphical Intuition



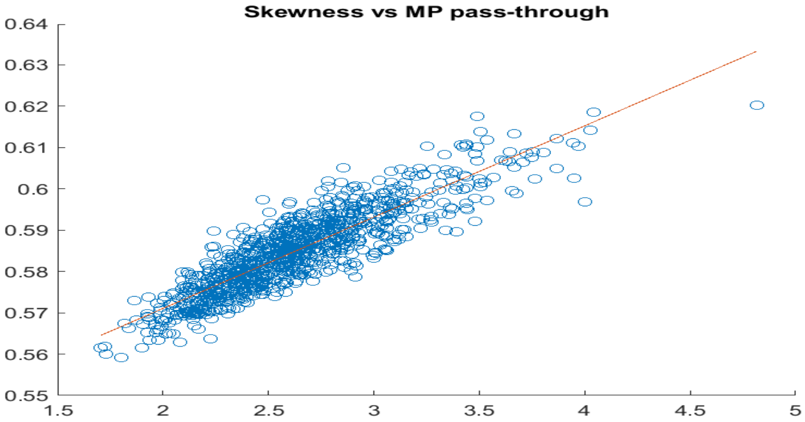
Model Simulation: Variance vs Skewness



Initial Variance vs Pass-Through

▸ Back

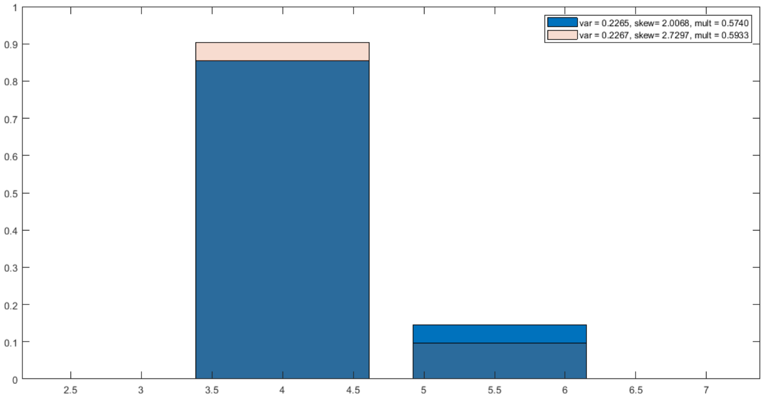
Model Simulation: Variance vs Skewness



Initial Skewness vs Pass-Through

Back

Model Simulation: Variance vs Skewness



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

Back

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

References I

Andersen, S., Campbell, J., Nielsen, K. M., and Ramadorai, T. (2020). Sources of inaction in household finance: Evidence from the danish mortgage market. *American Economic Review*, 110(10):3184–3230.

Bauer, M. D. and Swanson, E. T. (2022). A Reassessment of Monetary Policy Surprises and High-Frequency Identification. NBER Working Papers 29939, National Bureau of Economic Research, Inc.

Berger, D., Milbradt, K., Tourre, F., and Vavra, J. (2021). Mortgage prepayment and path-dependent effects of monetary policy. *American Economic Review*, 111(9):2829–78.

Bernanke, B. S. and Blinder, A. S. (1988). Credit, Money, and Aggregate Demand. *American Economic Review*, 78(2):435–439.

Drechsler, I., Savov, A., and Schnabl, P. (2017). The Deposits Channel of Monetary Policy*. *The Quarterly Journal of Economics*, 132(4):1819–1876.

Eichenbaum, M., Rebelo, S., and Wong, A. (2022). State-dependent effects of monetary policy: The refinancing channel. *American Economic Review*, 112(3):721–61.

Hazell, J., Herreño, J., Nakamura, E., and Steinsson, J. (2020). The slope of the phillips curve: Evidence from u.s. states. Working Paper 28005, National Bureau of Economic Research.

References II

Hurst, E., Keys, B. J., Seru, A., and Vavra, J. (2016). Regional redistribution through the us mortgage market. *American Economic Review*, 106(10):2982–3028.

Jarociński, M. and Karadi, P. (2020). Deconstructing monetary policy surprises-the role of information shocks. *American Economic Journal: Macroeconomics*, 12(2):1–43.

Kashyap, A. and Stein, J. C. (2000). What do a million observations on banks say about the transmission of monetary policy? *American Economic Review*, 90(3):407–428.

Luco, F. (2019). Switching costs and competition in retirement investment. *American Economic Journal: Microeconomics*, 11(2):26–54.

Nagel, S. (2016). The liquidity premium of near-money assets. *The Quarterly Journal of Economics*, 131(4):1927–1971.

Wang, Y., Whited, T., Wu, Y., and Xiao, K. (2020). Bank market power and monetary policy transmission: Evidence from a structural estimation. NBER Working Papers 27258, National Bureau of Economic Research, Inc.

Yankov, V. (2018). In search of a risk-free asset: Search costs and sticky deposit rates. *Available at SSRN 2044882*.