

# 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 and in the related paper are those of the author and do not necessarily reflect the views of the Bank of Italy.

## 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. ⇒ **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. ⇒ **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. ⇒ **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. ⇒ **Pronounced Skewness**.
- 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 lender imperfect competition

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

} 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:  $I_t = r_{t-1}^i$ )
- } 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**
- } Price Dispersion (absent any shock)
- Customers' **search friction**  
(Incomplete Information:  $I_t = r_{t-1}^i$ )
- } 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:  $I_t = r_{t-1}^i$ )
- } 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:  $I_t = r_{t-1}^i$ )
- } 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:  $I_t = r_{t-1}^i$ )
- } 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.

# Outline

1 Introduction

2 **Data**

3 **Empirical Analysis**

4 **Theoretical Framework**

5 **Conclusions**

### **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...).

### **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

1 Introduction

2 Data

3 Empirical Analysis

- **Advertised Lending Rates**
- **Unemployment** ▶ on request

4 Theoretical Framework

5 Conclusions

## Local projection specification

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

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

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

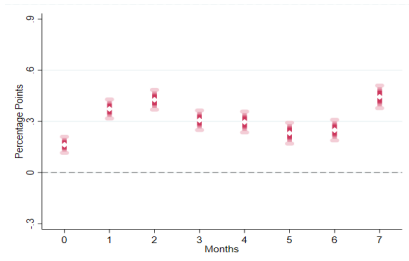
**Controls:** National GDP, Defl, Stock Market, Excess Bond Premium, county: wage growth, unemployment, home prices, Herfindal Index, ROA, Cost of Funds, Loan Loss Provisions, lags of the outcome variable, Product/County FE.

**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

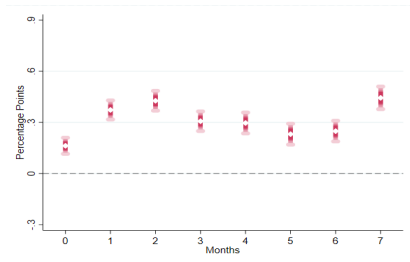


(a) Response with skewness at long-run mean ( $\beta_0$ ).

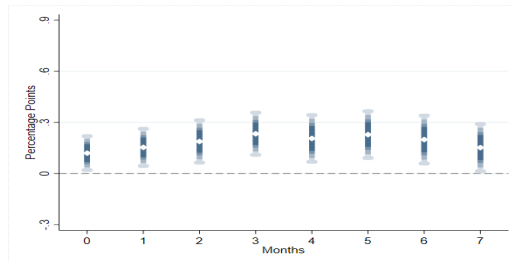
- **Result 1:** Pass-Through significantly higher when ex-ante skewness is high.

## Coefficient Plots: Lending Rates

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



(a) Response with skewness at long-run mean ( $\beta_0$ ).

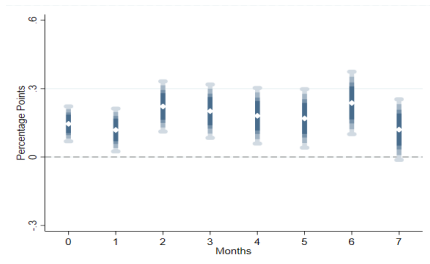


(b) Additional impact with skewness 1 s.d. above mean ( $\beta_1$ )

- **Result 1:** 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

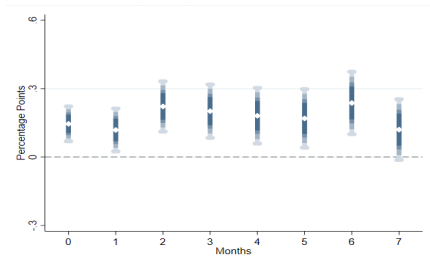


(b) Additional impact: skewness 1 s.d. above mean ( $\beta_1$ )

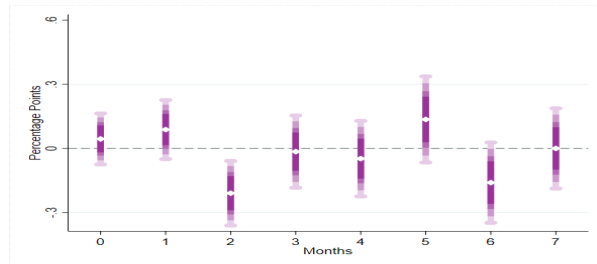
- **Result 2:** Skewness remains highly significant. Variance is NOT significant.

## 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 ( $\beta_1$ )



(c) Additional impact: variance 1 s.d. above mean ( $\beta_3$ )

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

## 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:

1 Introduction

2 Data

3 Empirical Analysis

4 **Theoretical Framework**

5 Conclusions

## 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:  $\lambda_1$  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:  $\lambda_1$  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:  $\lambda_1$  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  $\phi_j$  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:  $\lambda_1$  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  $\phi_j$  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:  $\lambda_1$  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  $\phi_j$  to apply for quotes at both lenders.
    - apply for a free quote from the default lender.
- $\Rightarrow$  Mass of searching customers:  $S = f(r_{H,t-1}, r_{L,t-1})$
- 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:  $\lambda_1$  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  $\phi_j$  to apply for quotes at both lenders.
  - apply for a free quote from the default lender.
- $\Rightarrow$  Mass of searching customers:  $S = f(r_{H,t-1}, r_{L,t-1})$
- 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:  $\lambda_1$  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  $\phi_j$  to apply for quotes at both lenders.
  - apply for a free quote from the default lender.
- $\Rightarrow$  Mass of searching customers:  $S = f(r_{H,t-1}, r_{L,t-1})$
- 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:  $\lambda_1$  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  $\phi_j$  to apply for quotes at both lenders.
  - apply for a free quote from the default lender.
- ⇒ Mass of searching customers:  $S = f(r_{H,t-1}, r_{L,t-1})$
- 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:

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

#### Bank L:

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

## Where the fun happens: demand and profit functions

### Demand Functions:

Bank H:

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

Bank L:

$$X_L(r_H, r_L) = \left[ \begin{array}{c} \bar{Q}_L - \underbrace{\beta_L r_L}_{\left[ \lambda_2 + \frac{1}{2} \lambda_1 (1 - S) \right]} \quad \underbrace{+ \kappa r_H}_{\left[ \frac{1}{2} \lambda_1 (1 - S) \right]} \end{array} \right]$$

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

## Where the fun happens: demand and profit functions

### Profit Functions:

#### Bank H:

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

#### Bank L:

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

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

## Where the fun happens: demand and profit functions

### Profit Functions:

#### Bank H:

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

#### Bank L:

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

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

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

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

- 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

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

- 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

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

- 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  $\lambda_1$ . [▶ 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

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

- 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  $\lambda_1$ . [▶ 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

## 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

1 Introduction

2 Data

3 **Skewness Zoom-in** ▶ On Request

4 Empirical Analysis

5 Theoretical Framework

6 Conclusions

## 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):

- 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)

# Outline

1 Introduction

2 Data

3 Skewness Zoom-in

4 Empirical Analysis

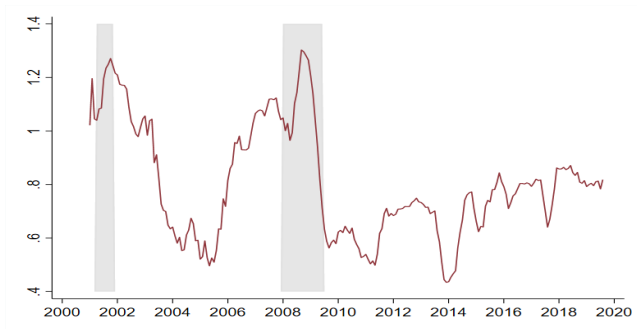
- **Advertised Lending Rates**
- **Unemployment** ▶ on request

5 Theoretical Framework

6 Conclusions

## Branch-Level Data: variation over time and space

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

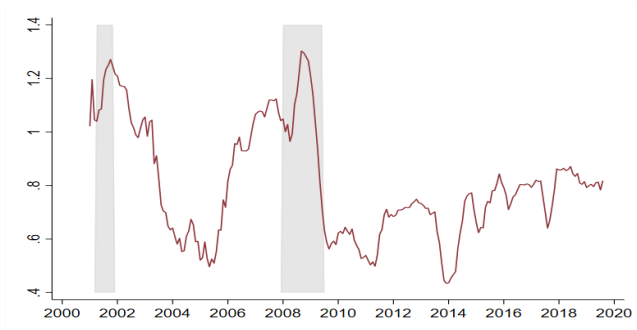


Lending rates skewness, US overall distribution.



## 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

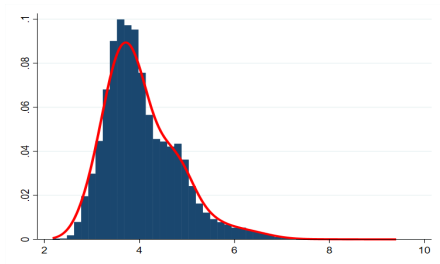
► Cross-County Mean

► Realized Rates

► More Product Types

► back

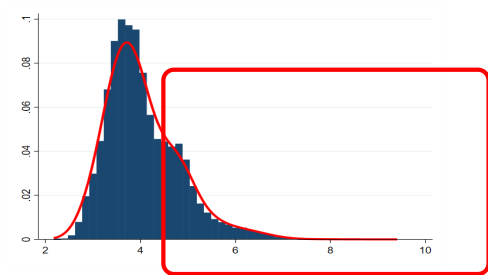
Facts: The curious shapes of the lending rate distributions.



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

- Pronounced Asymmetric shape, market concentration but...

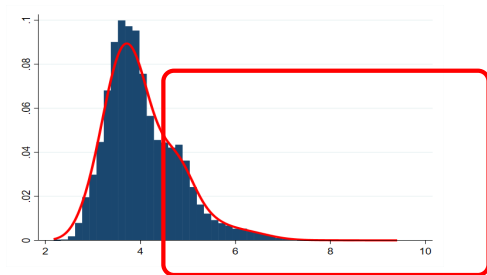
Facts: The curious shapes of the lending rate distributions.



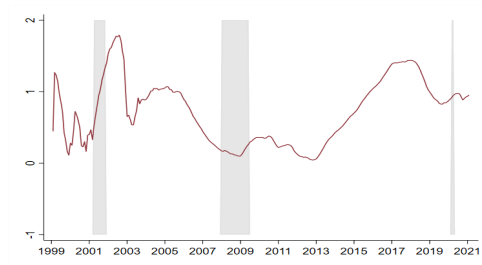
(a) 30Y Mortgage Rates. Minneapolis-MSA. 2019-M1.

- Pronounced Asymmetric shape, market concentration but...

## Facts: The curious shapes of the lending rate distributions.



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

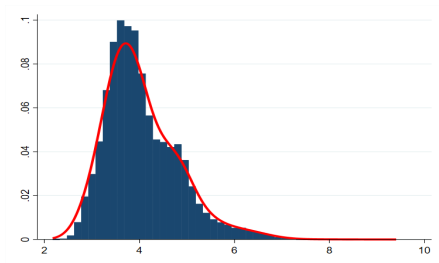


(b) Skewness Time-Series. Minneapolis-MSA

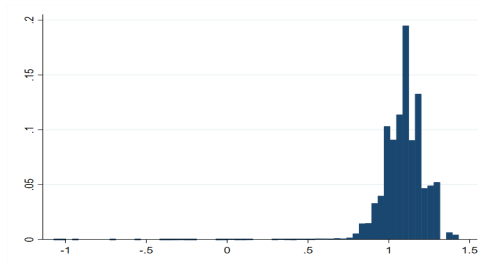
- Pronounced Asymmetric shape, market concentration but...
- Asymmetry is time-varying (next slides)

## 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.

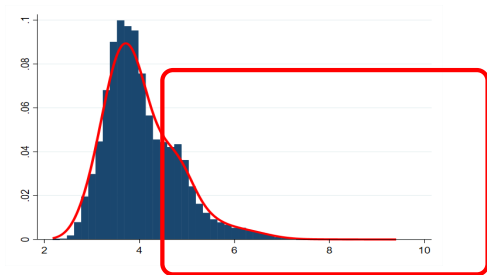


(b) Skewness Distribution Over MSAs. (Recessions in grey)

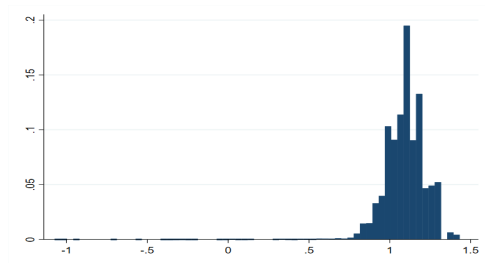
- Pronounced Asymmetric shape, market concentration but...
- Skewness cross-section MSA distribution centered around 1 and positive.

## 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.

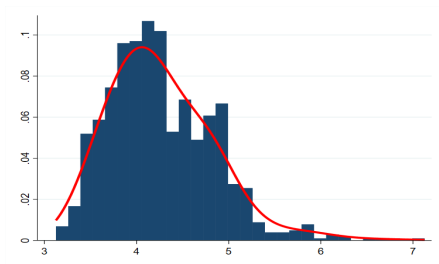


(b) Skewness Distribution Over MSAs. (Recessions in grey)

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

Facts: The curious shapes of the lending rate distributions.

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

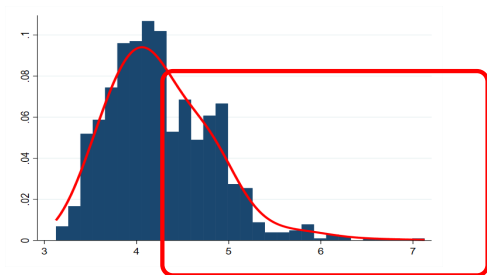


(a) Distribution in 2019-M1.

- Pronounced Asymmetric shape, market concentration but...

Facts: The curious shapes of the lending rate distributions.

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



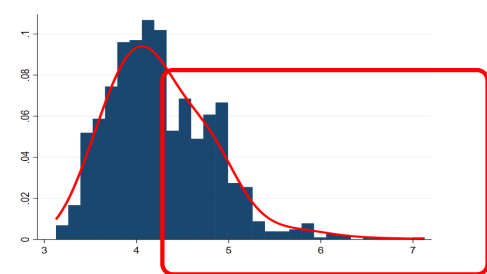
(a) Distribution in 2019-M1.

- Pronounced Asymmetric shape, market concentration but...

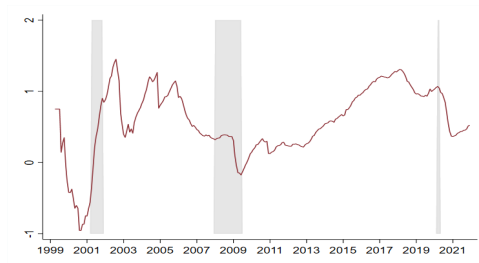


## Facts: The curious shapes of the lending rate distributions.

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



(a) Distribution in 2019-M1.

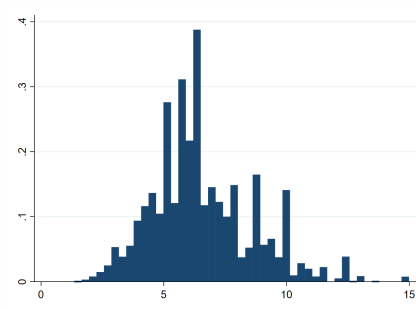


(b) Skewness over time. (Recessions in grey)

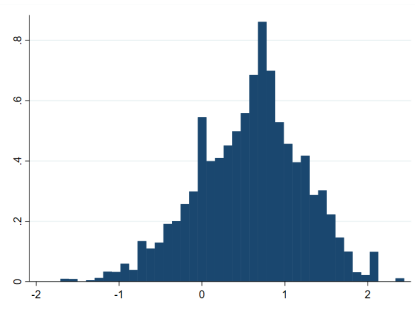
- Pronounced Asymmetric shape, market concentration but...
- Asymmetry is time-varying (next slides)

# 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.

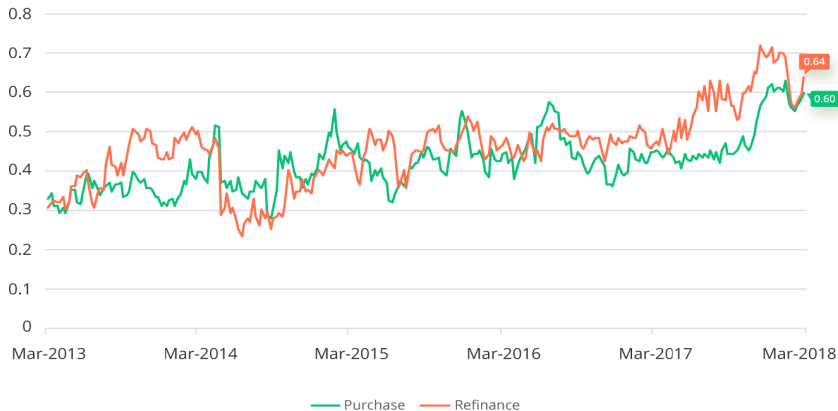
► Skewness Time-Series

► Robustness Freddie Mac

► Online Dispersion

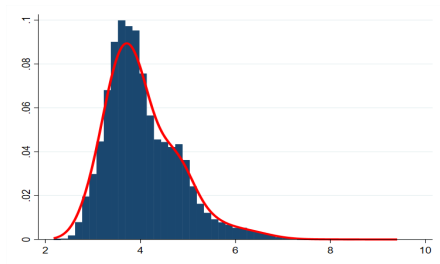
► back

## Facts: The lending rate dispersion on Online Marketplaces



Interest Rate Dispersion on LendingTree.com

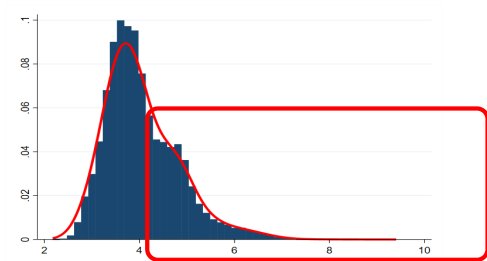
## Freddie Mac Data on Realized House Mortgage Rates



(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,

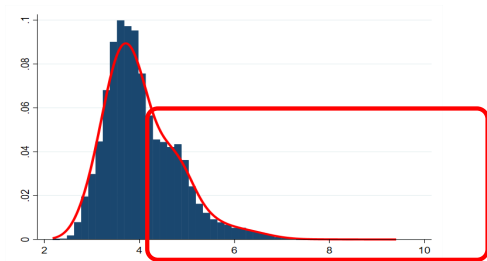
## Freddie Mac Data on Realized House Mortgage Rates



(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,

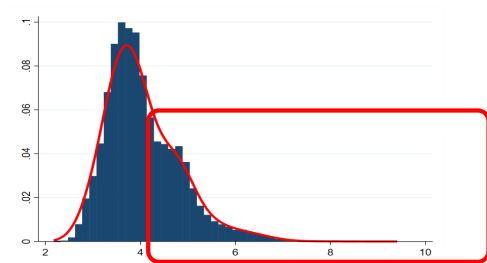
## Freddie Mac Data on Realized House Mortgage Rates



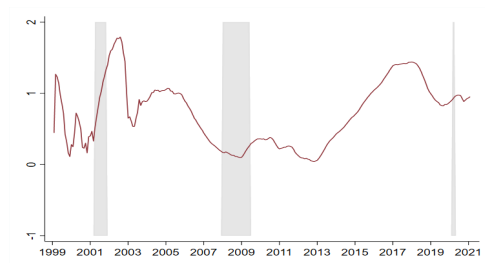
(a) 30Y Mortgage Rates. Minneapolis-MSA. 2019-M1.

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

## Freddie Mac Data on Realized House Mortgage Rates



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

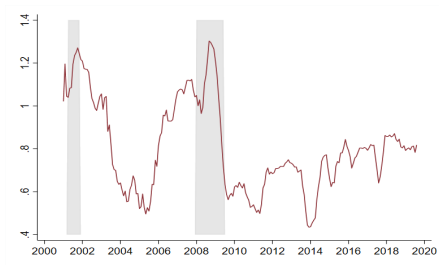


(b) Skewness Time-Series. Minneapolis-MSA

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

## 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

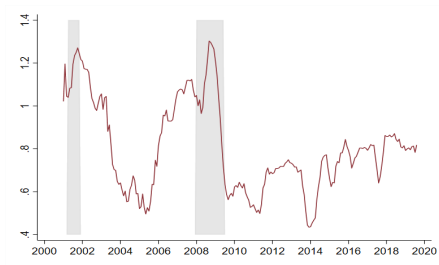
► Loan-level Distribution

► Syndicated Loans

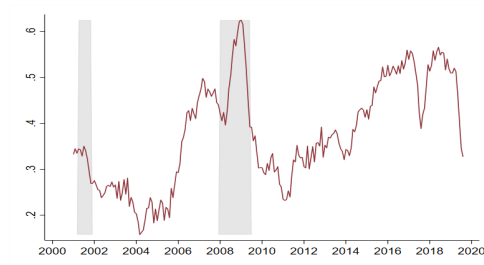


## Branch-Level Data: cross-sectional skewness over time

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



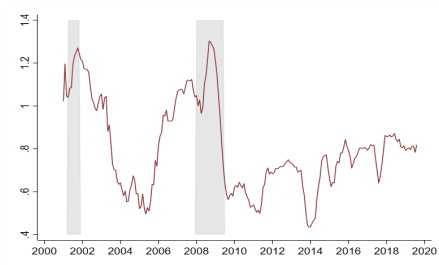
(a) Lending rates skewness, US overall distribution.



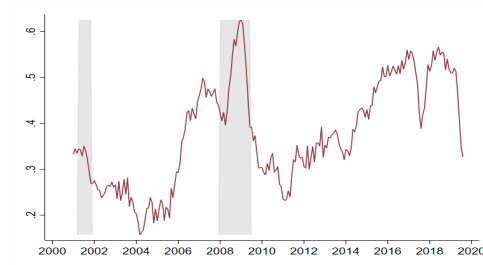
(b) Mean of within-county skewness measures.

## 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

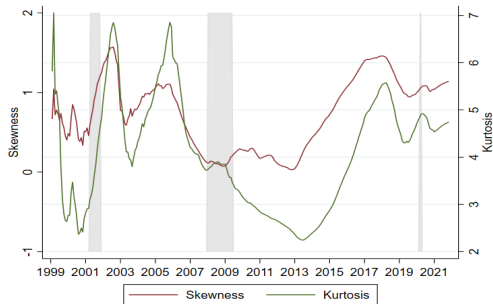
► Loan-level Distribution

► Syndicated Loans

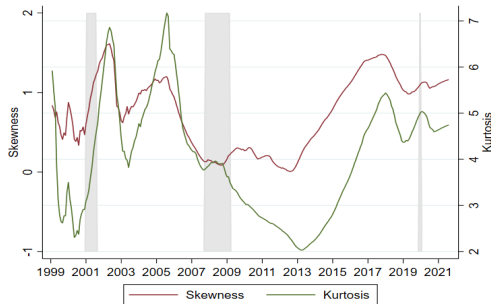
## Loan-Level Distribution: higher order moments non-trivial dynamics

### Freddie Mac Mortgage Rates. Purged. Moments over time.

Skewness and Kurtosis, County-Level Mean



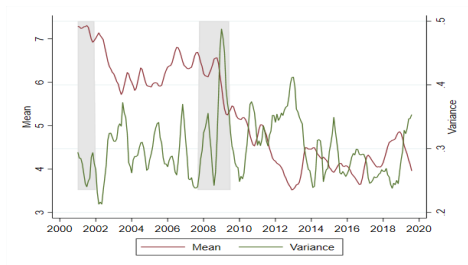
Skewness and Kurtosis, pooled-US Mean



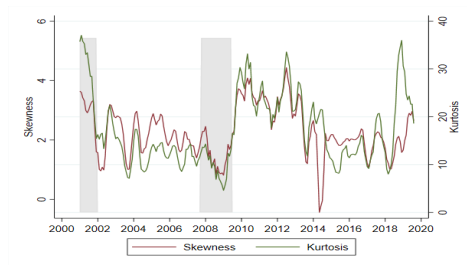
# Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

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

Mean and Variance



Skewness and Kurtosis

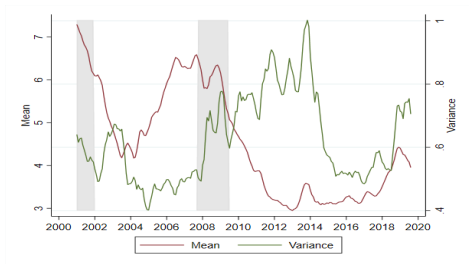


Interest rates at monthly frequency.

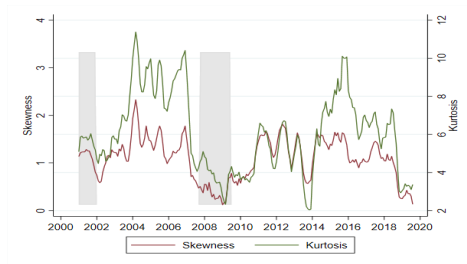
# Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

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

Mean and Variance



Skewness and Kurtosis

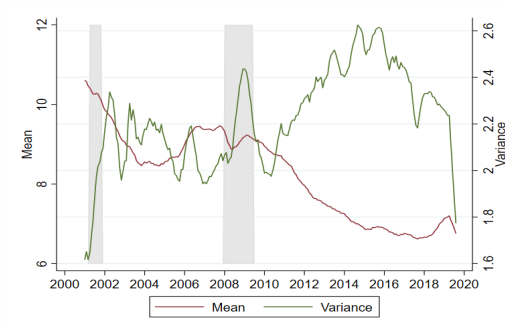


Interest rates at monthly frequency.

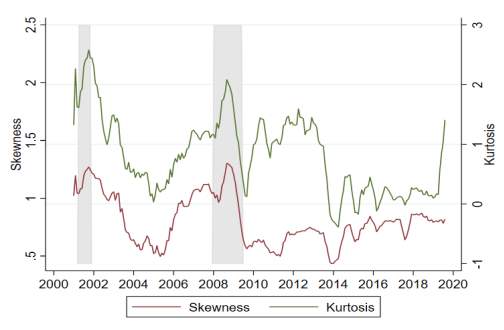
## Branch-Level Distribution: higher order moments non-trivial dynamics

### Personal Recreational Vehicle Advertised Loan Rates.

Mean and Variance



Skewness and Kurtosis

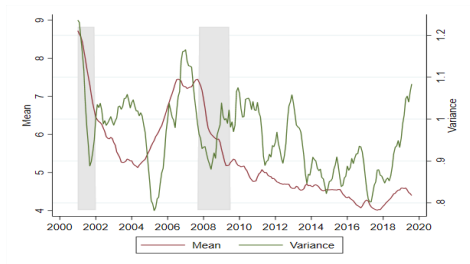


[Back to Outline](#)

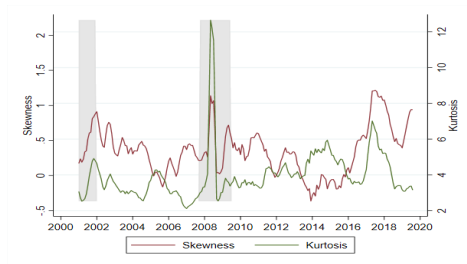
## Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

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

Mean and Variance



Skewness and Kurtosis

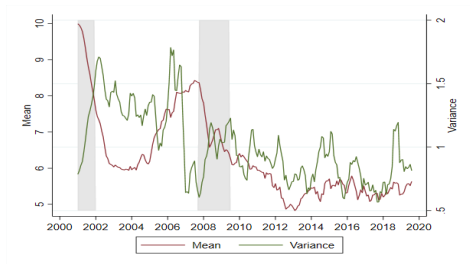


Interest rates at monthly frequency.

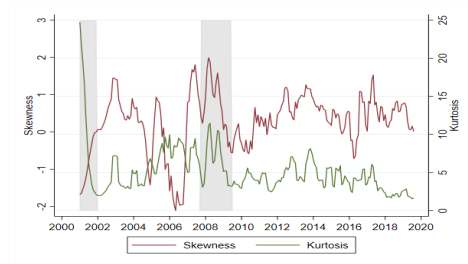
# Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

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

Mean and Variance



Skewness and Kurtosis



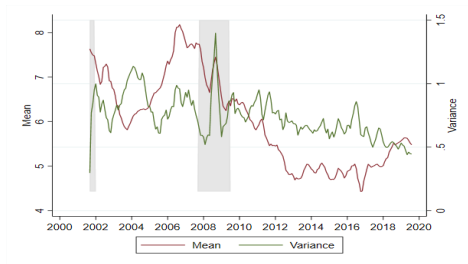
Interest rates at monthly frequency.



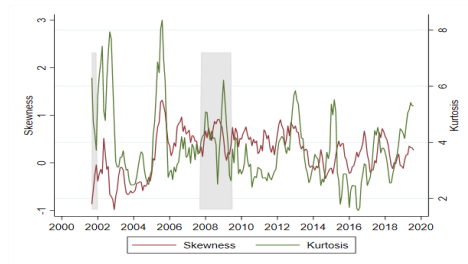
# Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

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

Mean and Variance



Skewness and Kurtosis

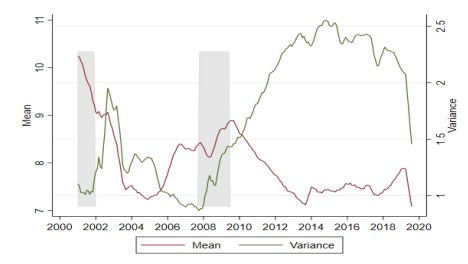


Interest rates at monthly frequency.

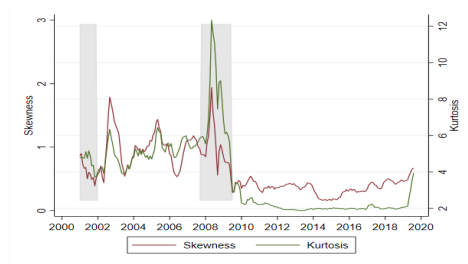
# Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

## Ratewatch interest rate spreads moments over time (Boat New)

Mean and Variance



Skewness and Kurtosis

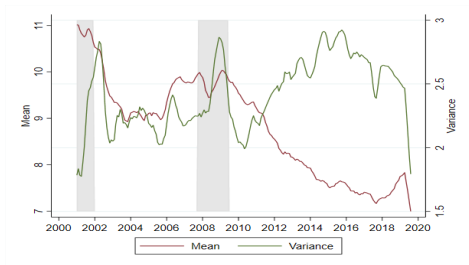


Interest rates at monthly frequency.

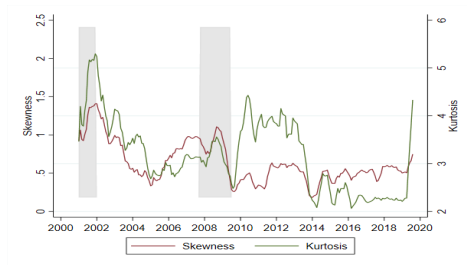
## Evolution of Interest Rate Distribution 1st to 4th Moment. Ratewatch

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

Mean and Variance



Skewness and Kurtosis

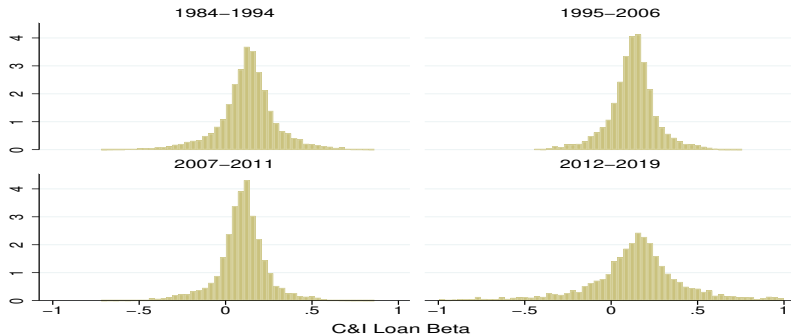


Interest rates at monthly frequency.

# 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))

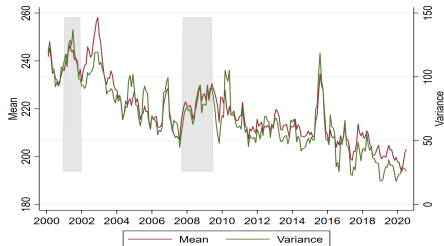
$$\Delta \text{Rate}_{bank,t} = \alpha_{bank} + \alpha_t + \sum_{k=1}^4 \beta_{bank,k} \Delta FFR_t + \varepsilon_{bank,t} \quad \mathbf{BETA} = \sum_{k=1}^4 \beta_k$$



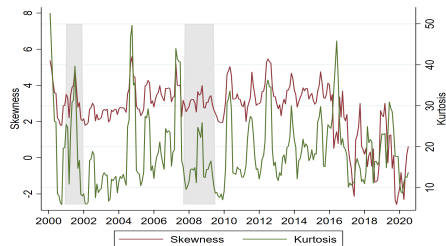
## Evolution of Interest Rate Distribution 1st to 4th Moment. Dealscan

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

Mean and Variance



Skewness and Kurtosis



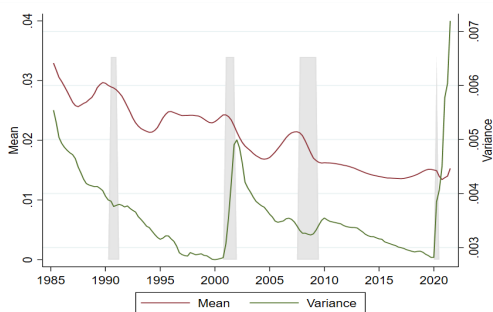
Interest rates spread on base rate from Dealscan Data at monthly frequency.

► Back

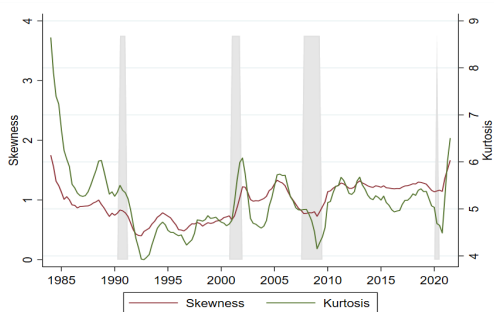
## Lender-Level Distribution: higher order moments non-trivial dynamics

### C&I Loan average interest rates

Mean and Variance



Skewness and Kurtosis



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

## MP Pass-Through heterogeneity Across-States

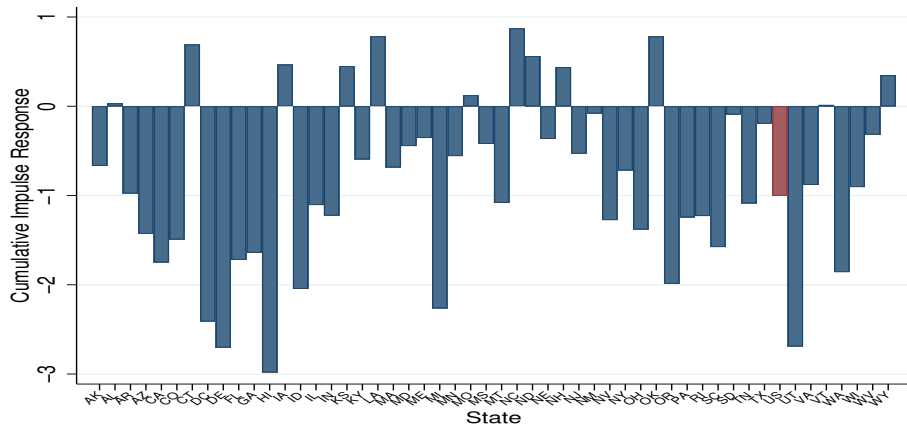


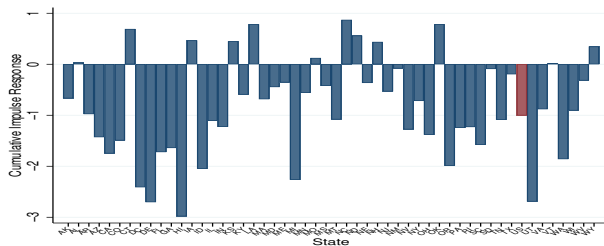
Figure: IRF to 1% MP Shock. IV Local Projections.

## MP Heterogeneity Across States

**Methodology:** IV Local Projections with High-Frequency Proxy by State.<sup>1</sup>

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

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



<sup>2</sup> Proxy Identification as in Jarociński and Karadi (2020)



## US States/Bank Panel: Real Personal Income

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

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

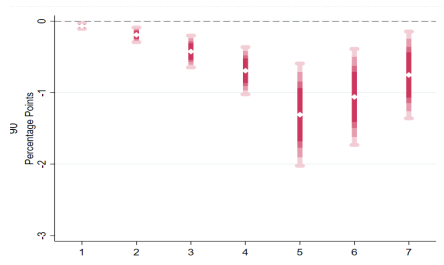
**Outcome Variables:** State Real Personal Income.

**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.

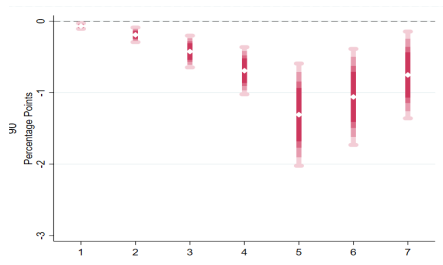
## Coefficient Plots



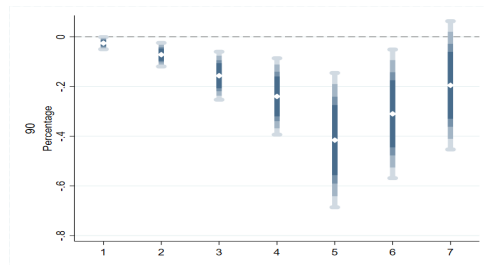
(a) Standard MP response ( $\beta_0$ ).

- Response to 100 b.p. MP shock.

## Coefficient Plots



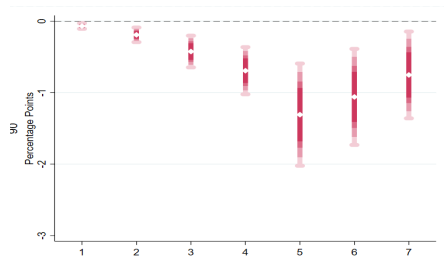
(a) Standard MP response ( $\beta_0$ ).



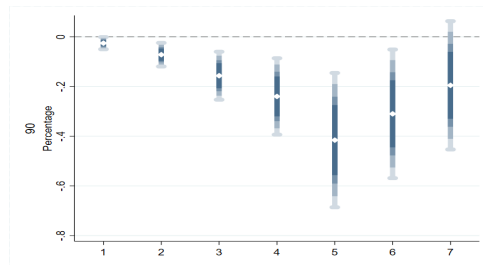
(b) Difference in MP response with high skewness ( $\beta_1$ )

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

## Coefficient Plots



(a) Standard MP response ( $\beta_0$ ).



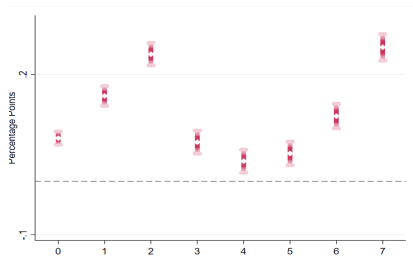
(b) Difference in MP response with high skewness ( $\beta_1$ )

- 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

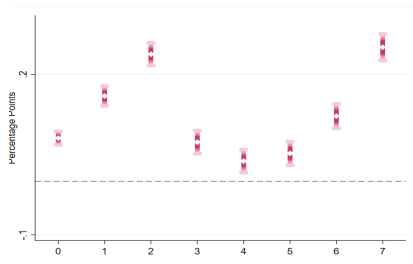


(a) Response with skewness at long-run mean ( $\beta_0$ ).

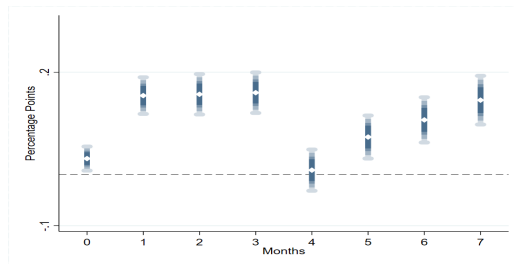
- Efficacy significantly higher when skewness is high.

## Coefficient Plots: Unemployment Rate

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



(a) Response with skewness at long-run mean ( $\beta_0$ ).



(b) Additional impact with skewness 1 s.d. above mean ( $\beta_1$ )

- Efficacy significantly 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*** (8.44)	0.34*** (10.84)	0.48*** (13.62)	0.44*** (11.87)	0.37*** (8.95)	0.23*** (5.55)	0.29*** (6.67)	0.55*** (12.54)	0.38*** (8.62)	0.44*** (8.87)	0.52*** (10.12)
Skew.	0.15*** (3.73)	0.12** (2.48)	0.22*** (3.95)	0.20*** (3.37)	0.18*** (2.91)	0.17*** (2.59)	0.24*** (3.40)	0.12* (1.77)	0.16** (2.34)	0.00 (0.06)	-0.00 (-0.03)
Mean	-0.13*** (-6.14)	-0.04** (-2.03)	-0.17*** (-6.72)	-0.28*** (-9.33)	-0.31*** (-9.16)	-0.15*** (-4.01)	-0.27*** (-7.27)	-0.22*** (-5.38)	-0.18*** (-4.67)	-0.30*** (-7.56)	-0.32*** (-7.90)
Var.	0.04 (0.73)	0.09 (1.25)	-0.21*** (-2.73)	-0.02 (-0.18)	-0.05 (-0.53)	0.14 (1.32)	-0.16* (-1.67)	-0.00 (-0.00)	-0.23** (-2.45)	-0.34*** (-3.29)	-0.13 (-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

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

## 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*** (4.96)	0.28*** (20.15)	0.36*** (24.02)	0.26*** (17.23)	0.21*** (13.41)	0.23*** (14.27)	0.37*** (21.92)	0.49*** (26.25)	0.56*** (29.86)	0.57*** (31.73)	0.19*** (11.42)
Skew.	0.04*** (3.12)	0.12*** (6.67)	0.11*** (5.50)	0.09*** (4.58)	-0.05** (-2.38)	0.02 (0.91)	0.04* (1.91)	0.09*** (3.54)	0.05** (2.00)	0.02 (0.67)	0.02 (1.01)
Mean	0.09*** (14.53)	-0.04*** (-4.12)	-0.11*** (-10.29)	-0.02* (-1.71)	-0.03** (-2.44)	-0.00 (-0.26)	-0.18*** (-14.68)	-0.18*** (-13.21)	-0.17*** (-12.38)	-0.28*** (-21.11)	-0.05*** (-3.81)
Var.	-0.00 (-0.12)	0.04* (1.70)	-0.02 (-0.65)	-0.11*** (-3.80)	-0.03 (-1.06)	-0.11*** (-3.77)	0.07** (2.39)	-0.05 (-1.38)	0.02 (0.53)	0.08** (2.45)	-0.04 (-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

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



## 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).

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

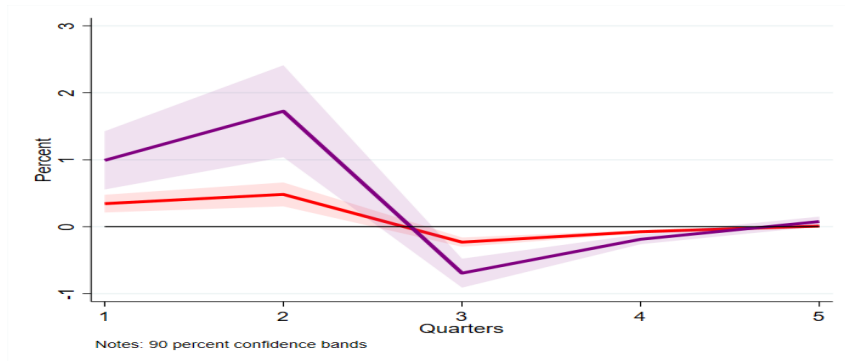
**Methodology:** IV Local Projections with High Frequency Proxy.

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

**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 Rate to 50 b.p. exogenous decrease in MP rate.

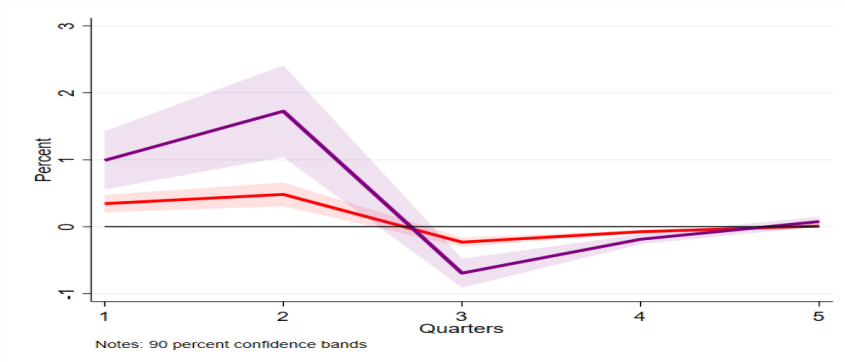


Red line: Standard Pass-Through. Purple Line: High Skewness Pass-Through. SE clustered at the county level.

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

## 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 Mortgage 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

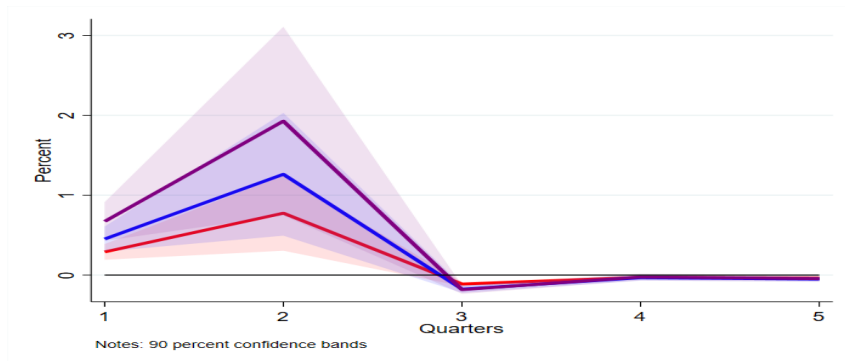
**Methodology:** IV Local Projections with High Frequency Proxy.

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

**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.

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

## (Very) Simple Conceptual Framework

	Bank	Borrower
Type A	high market power	high switching cost $\phi$
Type B	low market power	low switching cost $\phi$

### 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:

$$\max_{r_{t,A}, S} \quad \pi = [r_{t,A} - c] \mathbf{1}_{S=\text{Lend}}$$

$$(IC1) \quad r_{t,A} \leq r_{t,B} + \phi_A \quad \text{if } r_{t,A} = r_{t-1,A}$$

$$(IC2) \quad r_{t,A} + \psi \leq r_{t,B} + \phi_A \quad \text{if } r_{t,A} \neq r_{t-1,A}$$



## (Very) Simple Conceptual Framework

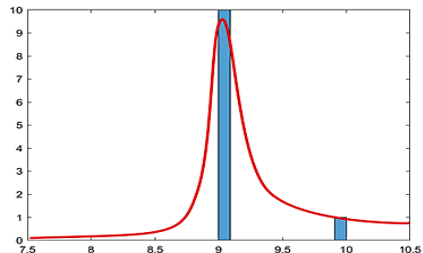
### Assume:

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

## (Very) Simple Conceptual Framework

One quarter later FED eases by 0.5%:

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

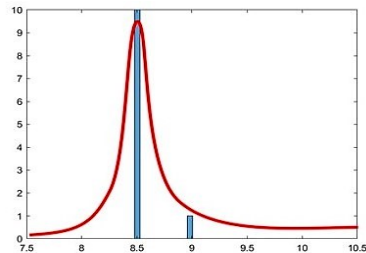
Assume:

1  $\phi_A = 1\%$

2  $\psi_A = 0.5\%$

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

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



Quarter 2: Bank Rates Distribution

► Back

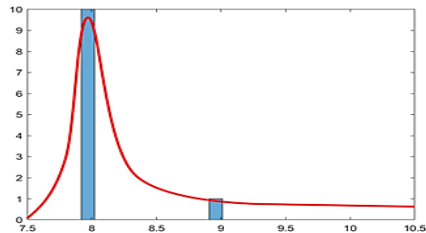
## (Very) Simple Conceptual Framework

One quarter later FED eases again by 0.5%:

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

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

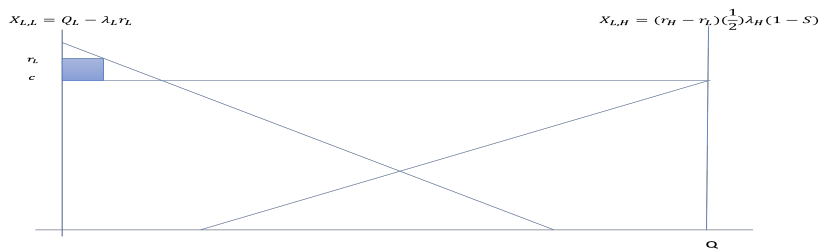
$$\text{Pass-Through: } \frac{(n-x)*(8.5\%-8\%)+x*(9\%-9\%)}{0.5\%} < 1$$



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.

## Graphic Intuition, Strategic L fixed H



Low skewness.

► back

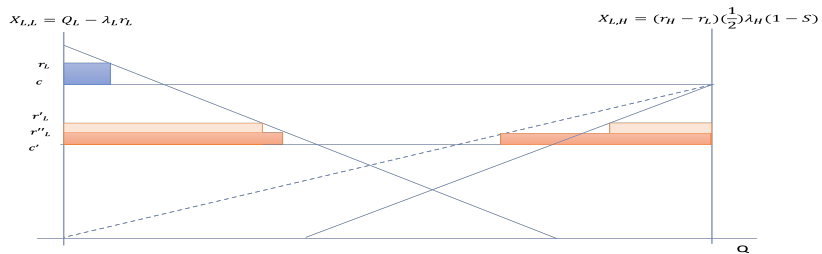
## Graphic Intuition



Lower skewness. MP easing.

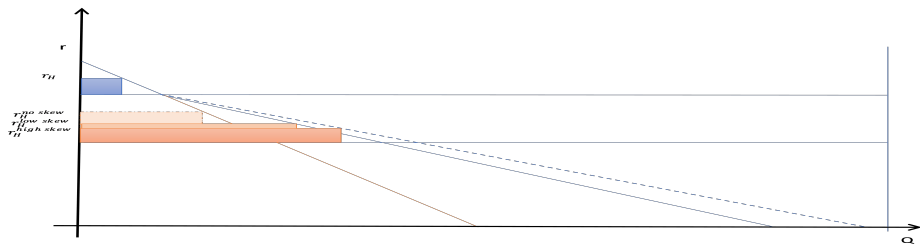
► back

## Graphic Intuition



Higher skewness. Same MP easing.

## Graphic Intuition



No/Low/High Skewness. MP Easing.

## Best Responses:

### Best Responses for Duopoly with Bank H:

Bank H:

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

Bank L:

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

Substituting  $r_H$  into  $r_L$ : Bank L:

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

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



## Results about the Pass-Through.

### Proposition 2

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

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

## Results about the Pass-Through.

### Proposition 2

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

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

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

## Results about the Pass-Through.

### Proposition 2

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

## Results about the Pass-Through.

### Proposition 2

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

## Results about the Pass-Through.

### Proposition 2

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

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

## 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.

<sup>1</sup> Technical Condition  $\lambda_2 > \lambda_1 S$

## 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.

<sup>1</sup> Technical Condition  $\lambda_2 > \lambda_1 S$

## 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.

<sup>1</sup> Technical Condition  $\lambda_2 > \lambda_1 S$



### 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.

<sup>1</sup> Technical Condition  $\lambda_2 > \lambda_1 S$

## Empirical Test of Proposition 3

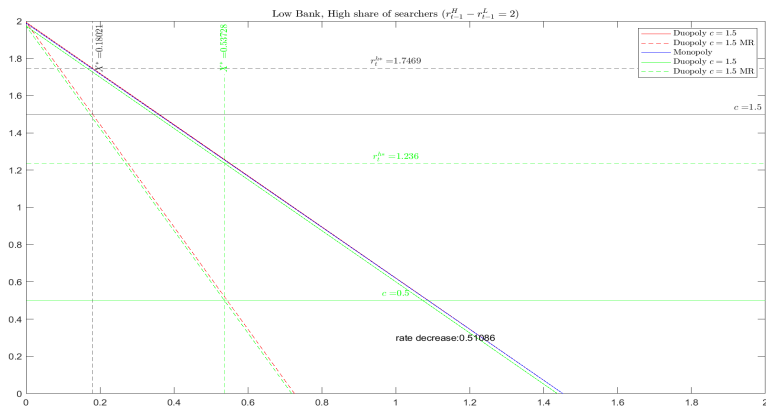
**Table:** Responsiveness of High vs Low Rate lender to a 100 b.p. monetary policy shock when skewness is high

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

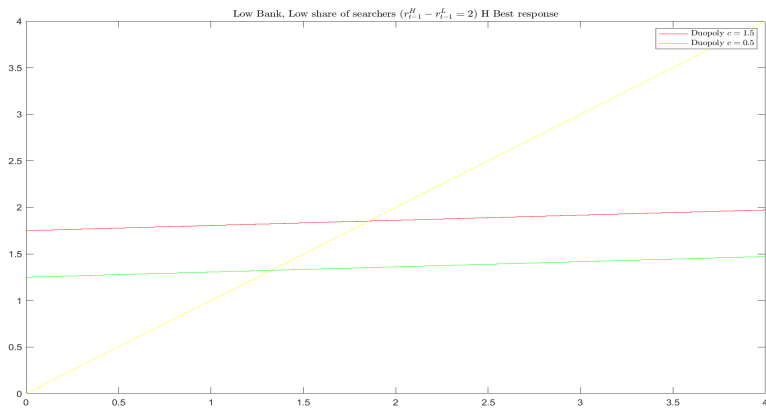
*t* statistics in parentheses

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

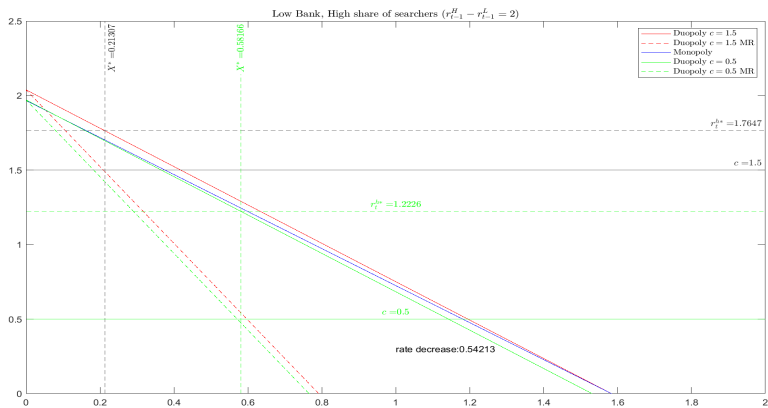
# Graphical Intuition



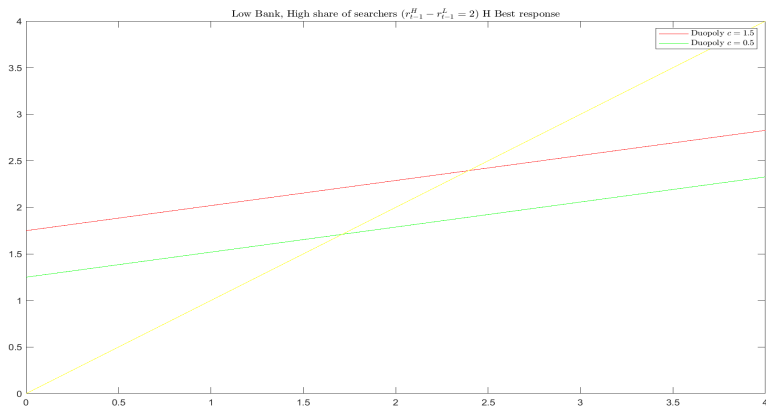
## Graphical Intuition



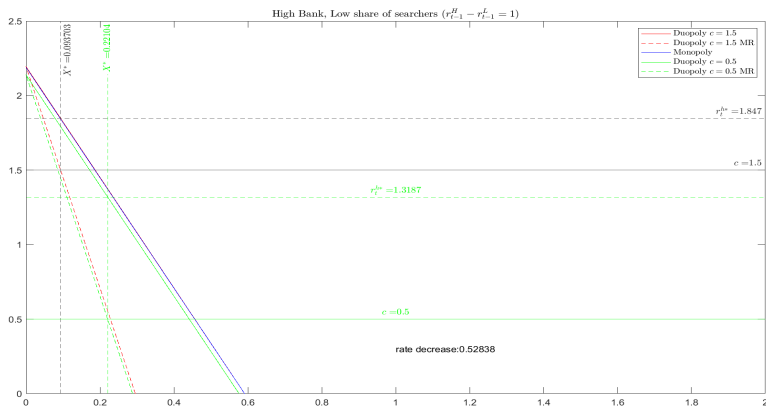
# Graphical Intuition



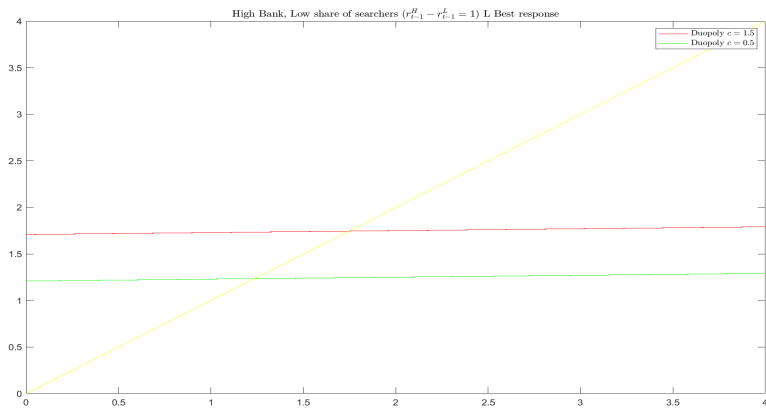
## Graphical Intuition



# Graphical Intuition

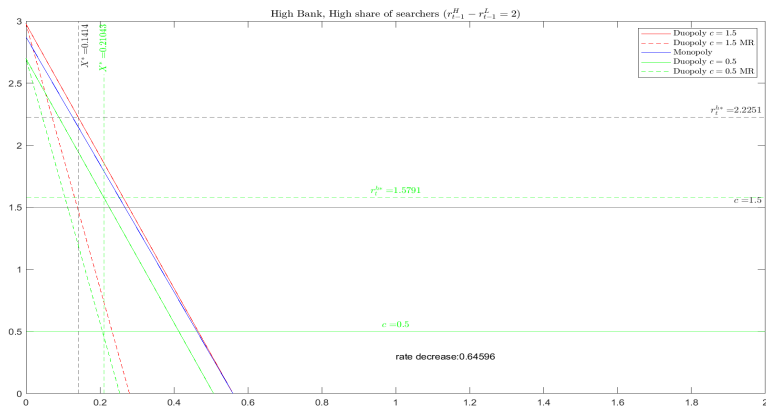


## Graphical Intuition

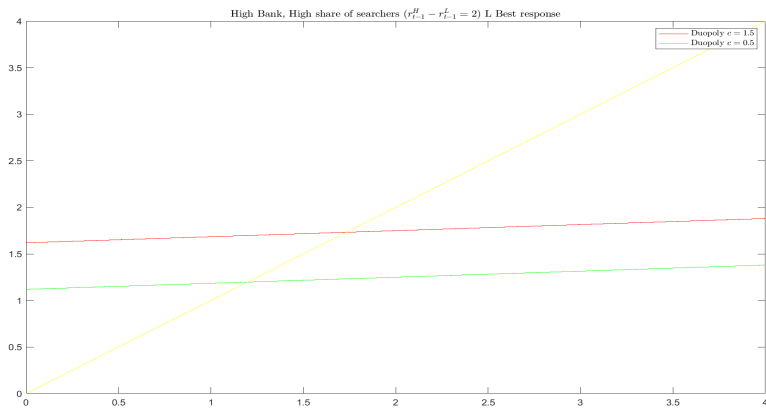




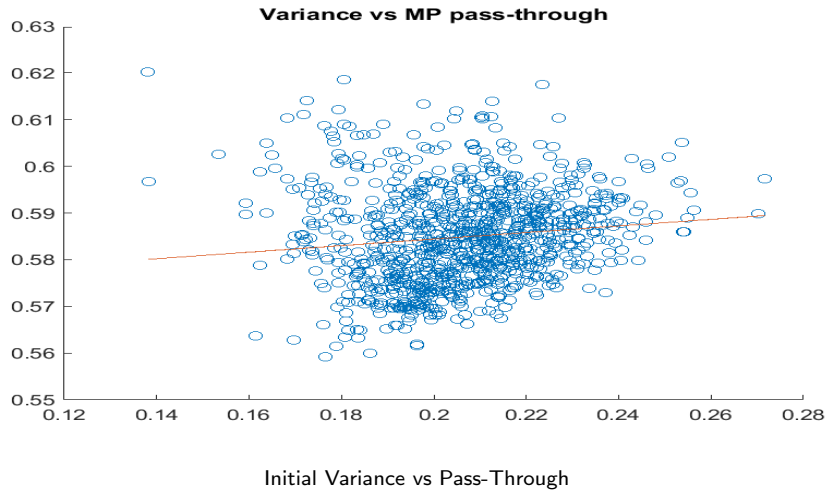
# Graphical Intuition



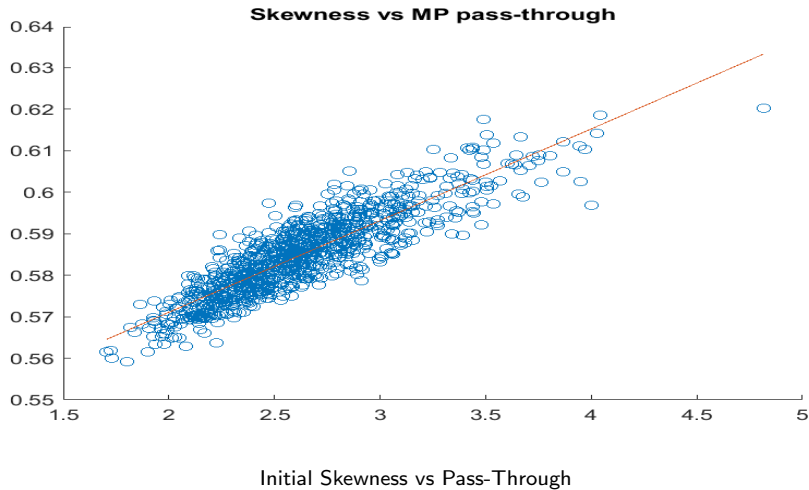
## Graphical Intuition



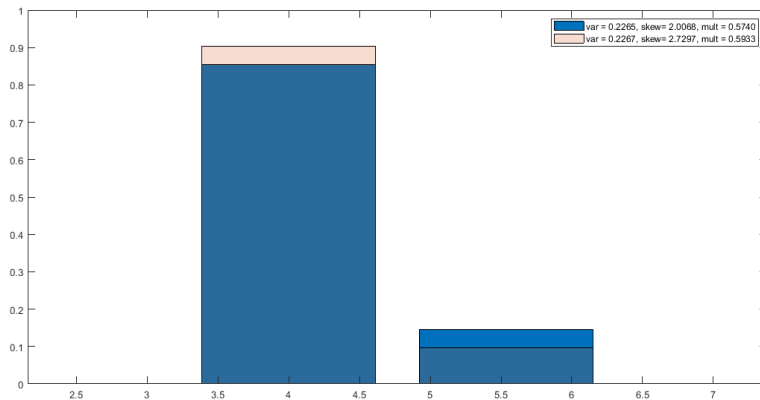
## Model Simulation: Variance vs Skewness



## Model Simulation: Variance vs Skewness



## Model Simulation: Variance vs Skewness



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

## Consumer Problem: stage 0 to 3

- Consider the case  $r_{t-1}^A > r_{t-1}^B$  then:
- For each  $z$  only consumers with  $\theta: v - \mathbb{E}[r_t^A - z] \geq v - \mathbb{E}[r_t^B - (2 - z) - \theta]$  will stay Type 1.
- Hence  $v - r_{t-1}^A - 1 \geq v - r_{t-1}^B - 1 - \theta \leftrightarrow \theta \geq [r_{t-1}^A - r_{t-1}^B]$
- 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:

$$\begin{aligned} X_A^1(r_t^A) &= \int_0^2 \lambda_1 \int_0^{\bar{\theta}} \frac{1}{\bar{\theta}} \mathbb{1}_{\{v - z - r_t^A > 0 \mid \text{Type 1 choice}\}} \mathbb{1}_{\{\theta > gap_{t-1}\}} d\theta dz \\ &= \lambda_1 (v - r_t^A) \mathbb{P}(gap_{t-1}) \end{aligned}$$

- Demand of type 3 to Bank A should hence be:  $X_A^3(r_t^A, r_t^B) = \lambda_1 (1 - \mathbb{P}) \left( \frac{r_t^B - r_t^A}{2} + 1 \right)$
- Finally Total demand of type 2 and 3 to Bank B should be:  
 $X_B(r_t^A, r_t^B) = X_B^2(r_t^B) + X_B^3(r_t^A, r_t^B) = \lambda_2 (v - r_t^B) + \lambda_1 (1 - \mathbb{P}) \left( \frac{r_t^A - r_t^B}{2} + 1 \right)$

## 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*.