The Lock-In Effect of Rising Mortgage Rates

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Ross Batzer, Jonah Coste, Will Doerner, Mike Seiler

Division of Research and Statistics
Federal Housing Finance Agency

The Home Buyer's Quandary: Nobody's Selling

Many are ready to move but don't want to lose the low-rate mortgages they locked in a few years ago, crimping the supply of homes and keeping prices high

'I can't afford to sell because I don't want to lose that rate': 3% mortgage rates will loom large over the U.S. housing market for years to come

Rate 'lock-in' effect is hurting housing and mortgage markets, Powell says

The Lock-in Effect: 89% of People With Mortgages Have an Interest Rate Below 6%, Down From a Record 93% in 2022

1. How "locked-in" are borrowers?
2. How sensitive are sales to lock-in?
3. What is the aggregate effect on sales?
4. What effect has lock-in had on prices?

Literature Review

- ▶ Lock-in in capital markets:
    - ▶ Capital gains/dividend taxes: Eilbot and Hersh (1976), Holt and Shelton (1962), Klein (2001)
    - ▶ Other: Keifer (1990), Senchack and Starks (1993), Landsman and Shackelford (1995)

- ▶ Other lock-in in real estate: LaCour-Little, Rosenblatt, and Yao (2010), Ferreira, Gyourko, and Tracy (2011), Farber (2012), Wasi and White (2005), Ihlanfeldt (2011)

- ▶ Mortgage rate lock-in: Quigley (1987, 2002), Libersohn and Rothstein (2023), Fonseca and Liu (2023)

- ▶ Interest rates and house prices: Case and Shiller (2003), McQuinn and O'Reilly (2008)
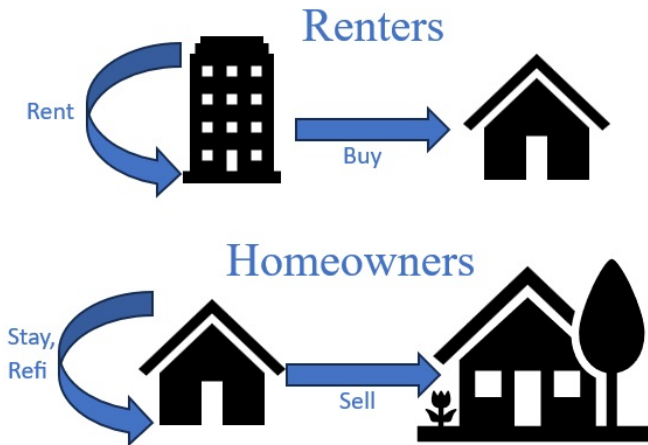
Renters choose $D \in \{\text{rent, buy}\}$ to solve their problem,

$$\max_D U_{rent} = \begin{cases} C_1 + C_2 & , \ D = \text{rent} \\ C_1 + C_2 + \phi & , \ D = \text{buy} \end{cases}$$

subject to their budget constraint

$$\begin{aligned} C_1 + C_2 &= Y - 2R & , \ D = \text{rent} \\ C_1 + C_2 &= Y - R - r_2 PL - \kappa_r - \kappa_m & , \ D = \text{buy} \end{aligned}$$

Since utility is linear, renters will choose to buy if and only if

$$R - r_2 PL + \phi \geq \kappa_r + \kappa_m$$

Modeling: Homeowner Problem

Homeowners with FRMs choose $D \in \{\text{stay, refi, sell}\}$ to solve

$$\max_{D} U_{own} = \begin{cases} C_1 + C_2 & , \ D \in \{\text{stay, refi}\} \\ C_1 + C_2 + \phi & , \ D = \text{sell} \end{cases}$$

subject to

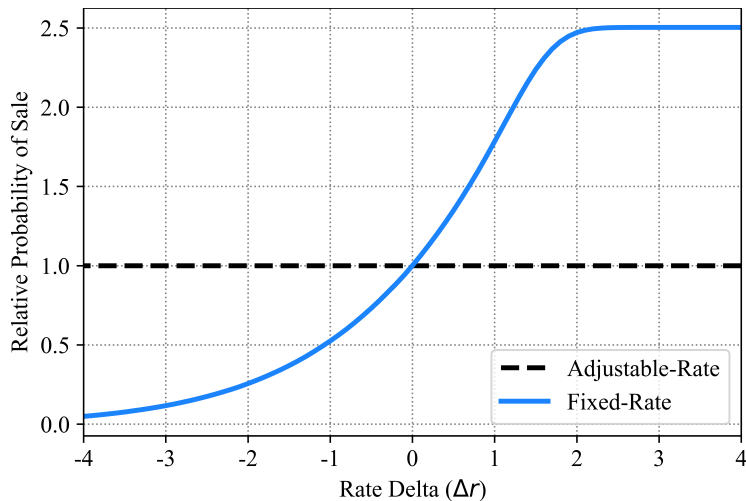$$\begin{aligned} C_1 + C_2 &= Y - 2r_1 L & , \ D = \text{stay} \\ C_1 + C_2 &= Y - (r_1 + r_2)L - \kappa_r & , \ D = \text{refi} \\ C_1 + C_2 &= Y - (r_1 + r_2)L - \kappa_r - \kappa_m & , \ D = \text{sell} \end{aligned}$$
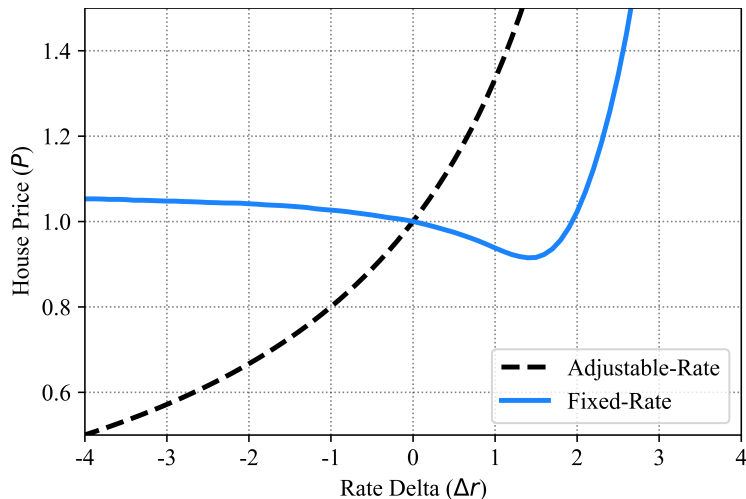
Let $\Delta r \equiv r_1 - r_2$. A homeowner with a FRM will choose to sell if

$$\Delta r L + \phi \geq \kappa_r + \kappa_m \text{ and } \phi \geq \kappa_m$$

If not selling and $\Delta r L \geq \kappa_r$, they will refinance. Otherwise, they will stay.

1. National Mortgage Database$^{®}$ (NMDB)
   - ▶ Nationally representative 5% sample of U.S. mortgages
   - ▶ Loans active 1998-2023
   - ▶ Maintained jointly by the FHFA and the CFPB.
   - ▶ More information can be found at:
     fhfa.gov/PolicyProgramsResearch/Programs/Pages/National-Mortgage-Database.aspx

2. Proprietary GSE loan data joined with assessor and deed data provided by CoreLogic
   - ▶ All loans originated since 2000 acquired by Fannie Mae or Freddie Mac
   - ▶ 91.0% of loans matched to CoreLogic properties
   - ▶ Sale: arms-length transaction within two months of the close date
   - ▶ 24.0% of closed loans end with a sale

Summary Statistics   Active Fixed-Rate Mortgages Over Time   Sale Rate vs. NAR$^{®}$ Existing Home Sales

A borrower's rate delta, Δr, is the difference between their fixed rate $r_{i,o}^f$ and the market rate for the same loan at time t $r_{i,t}$

$$\Delta r_{i,t} = r_{i,o}^f - r_{i,t} \qquad (1)$$

To estimate $r_{i,t}$, we first predict $r_{i,o}^f$ using quarter of origination fixed effects and a vector of borrower and loan characteristics X_i.
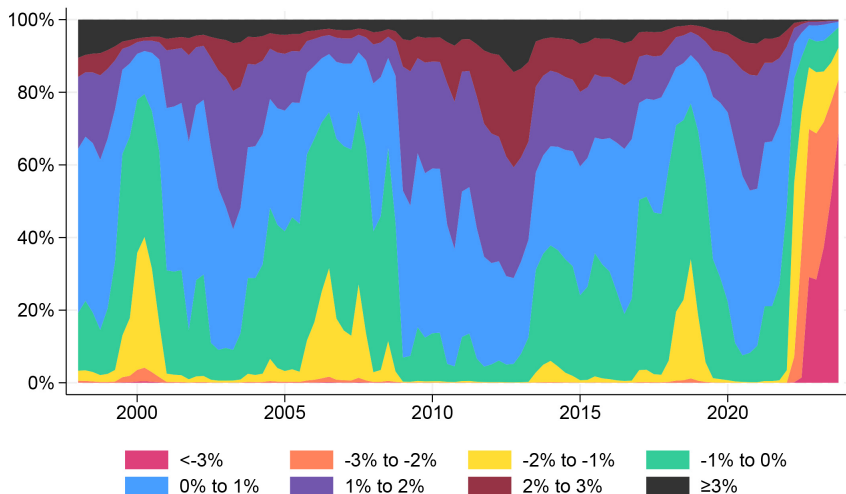
$$r_{i,o}^f = \gamma_o + \beta X_i + \varepsilon_i \qquad (2)$$

Estimated γ and β parameters are used to estimate $r_{i,t}$ and $\Delta r_{i,t}$.
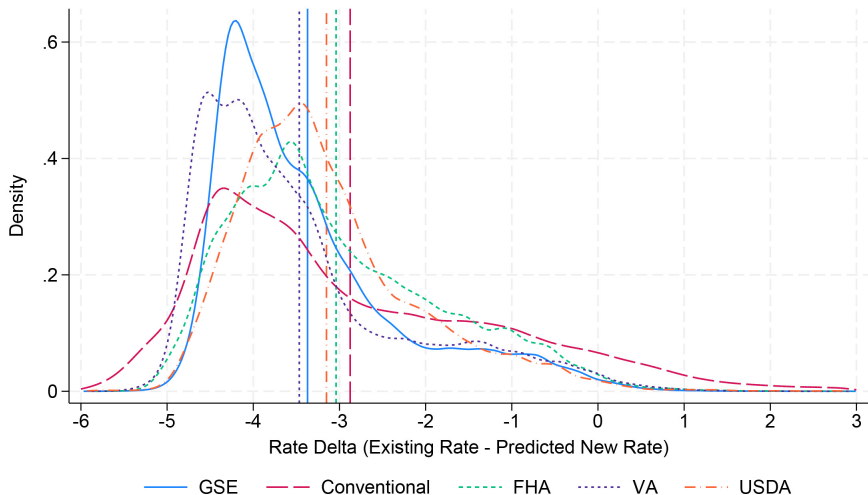
$$\hat{r}_{i,t} = \hat{\gamma}_t + \hat{\beta} X_i \qquad (3)$$

$$\Delta r_{i,t} = r_{i,o}^f - \hat{r}_{i,t} \qquad (4)$$

Rate Delta Distribution Over Time

Legend:
- <-3%
- -3% to -2%
- -2% to -1%
- -1% to 0%
- 0% to 1%
- 1% to 2%
- 2% to 3%
- ≥3%

2023Q4 Rate Delta Distribution by Loan Type

We model the probability of sale using a linear probability model with a flexible function $f(\Delta r)$.

$$\mathbb{1}(Sale_{i,t}) = \theta_t + \beta X_{i,t} + f(\Delta r_{i,t}) + \varepsilon_{i,t} \quad (5)$$

The non-parametric results show that the probability of sale is increasing and approximately linear for $\Delta r \leq 1$. Therefore, we parameterize $f(\Delta r)$ as a linear function for $\Delta r \leq 1$ and add a dummy variable for $\Delta r > 1$.
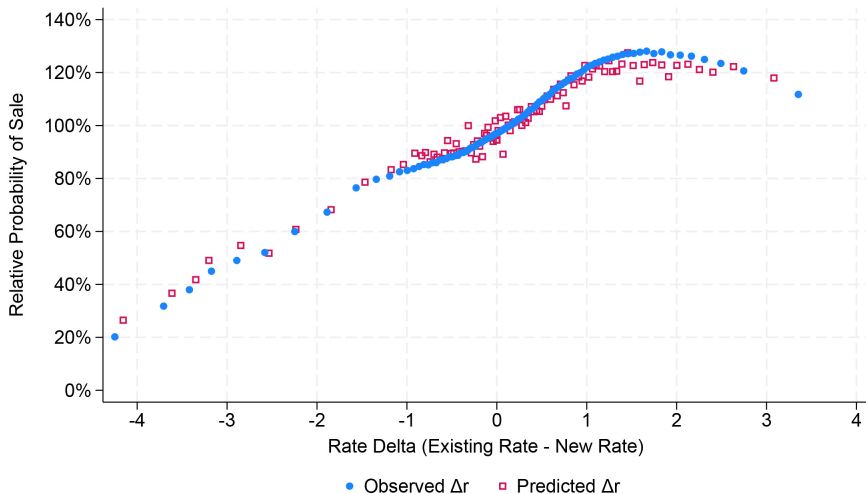
$$\mathbb{1}(Sale_{i,t}) = \theta_t + \beta_X X_{i,t} + \beta_{r1}\mathbb{1}(\Delta r_{i,t} \leq 1)\Delta r_{i,t} + \beta_{r2}\mathbb{1}(\Delta r_{i,t} > 1) + \varepsilon_{i,t} \quad (6)$$

Estimate models using both observed rate deltas, $\Delta r_{i,t}$, and predicted rate deltas $\widehat{\Delta r_{i,t}} = \hat{r}_{i,o} - \hat{r}_{i,t}$, to account for endogeneity.

Fixed-Rate Mortgages

Relative Probability of Sale vs. Rate Delta (Existing Rate - New Rate)

- Observed Δr
- Predicted Δr

Fixed-Rate Mortgages

Slope = 18.1% (SE: 1.6%)

Slope = 19.5% (SE: 1.3%)

Relative Probability of Sale

Rate Delta (Existing Rate - New Rate)

● Observed Δr   □ Predicted Δr
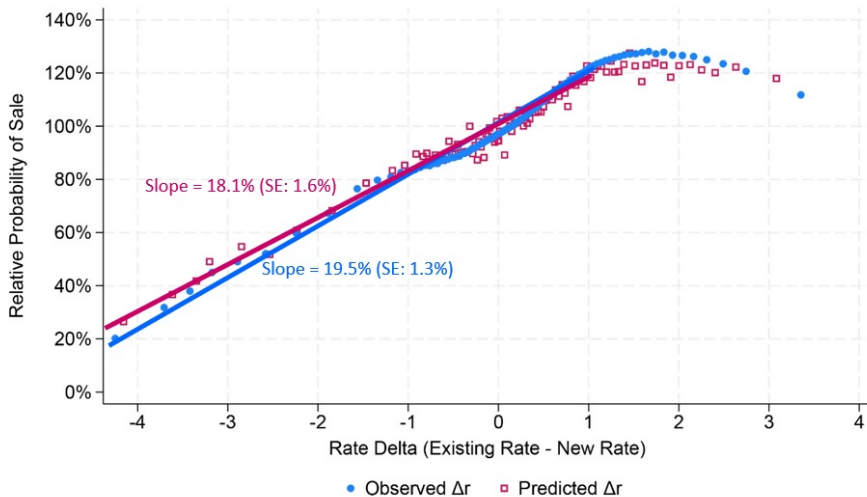
A Placebo Test using Adjustable-Rate Mortgages
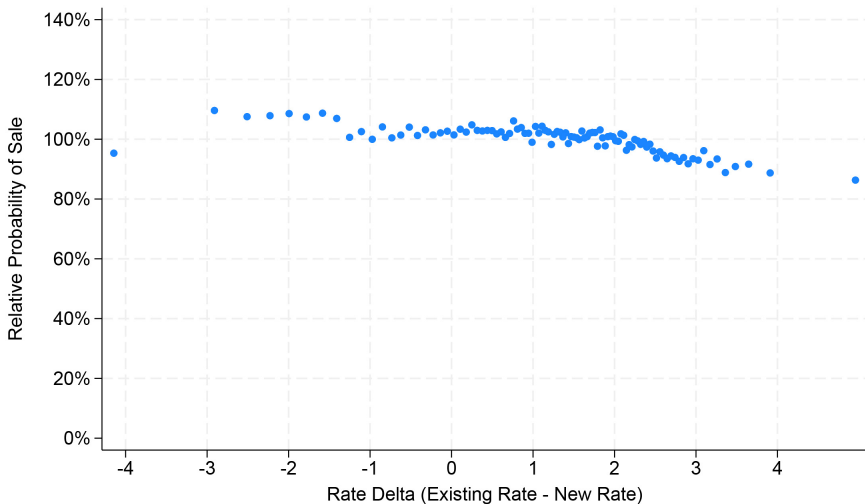
Two notable sources of heterogeneity

1. More affluent borrowers are more sensitive to lock-in.
   Particularly borrowers with high (absolute) home values. `Link`

   ▶
	Average sensitivity
Value<$300K	13.0%
$300K≤Value<$600K	19.4%
Value≥$600K	22.6%

   ▶ Positive: Less affluent are less affected.
   Negative: Less ability to strategically time transactions.

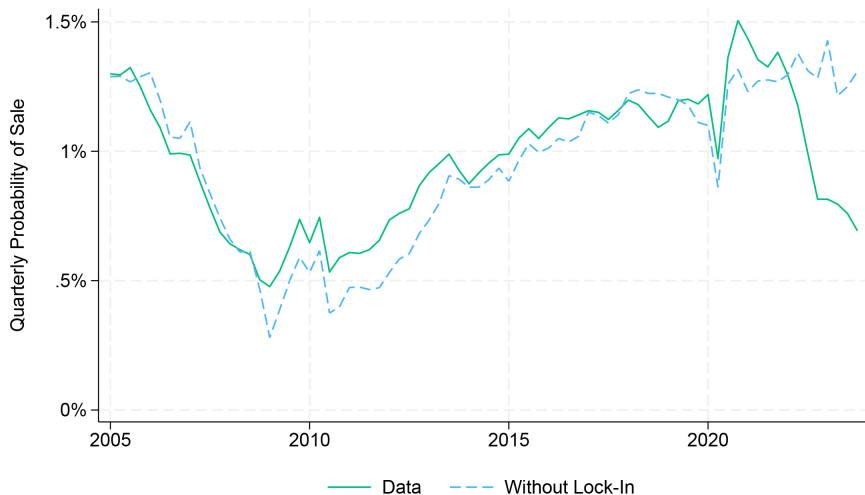2. Controlling for other variables, non-white borrowers are more
   sensitive. `Link`

   ▶ White average sensitivity: 16.4%
   ▶ Otherwise similar borrower sensitivities
   Black: 22.2%
   Hispanic (of any race): 21.9%
   Asian: 22.3%
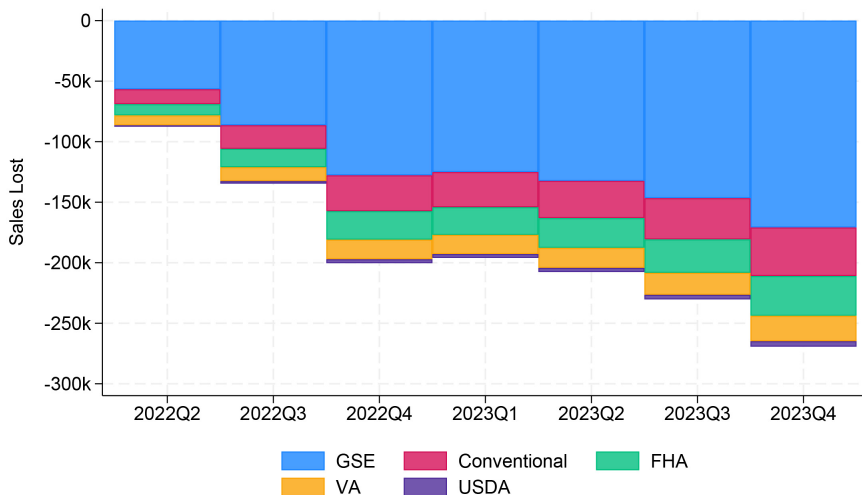
Modeled Effects Over Time
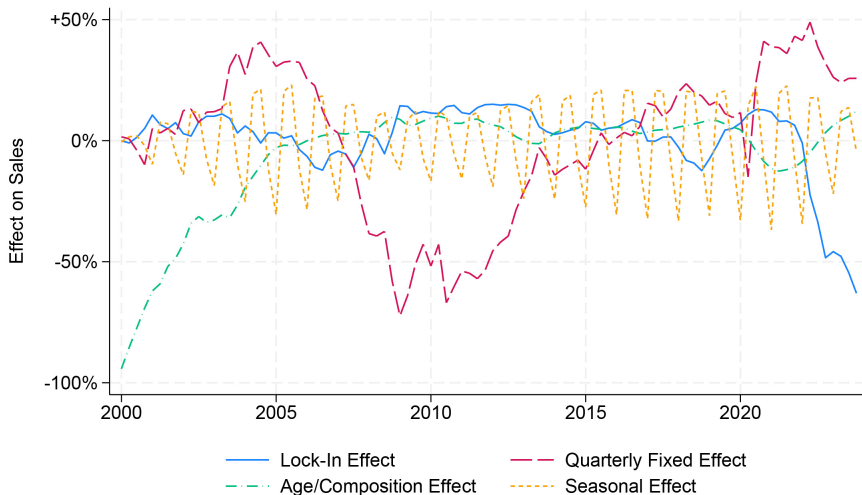
## Counterfactual Analysis

Sales Lost to Lock-In by Quarter

Effects on Real Estate Price Appreciation

	OLS			2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
Rate Delta	-0.220*		-0.351**	-0.306**		-0.375**
	(0.129)		(0.145)	(0.135)		(0.149)
Interest Rate		-0.096	-0.168*		-0.101	-0.177*
		(0.085)	(0.092)		(0.085)	(0.094)
MSA FE	✓	✓	✓	✓	✓	✓
Seasonal FE	✓	✓	✓	✓	✓	✓
Number of MSAs	397	397	397	397	397	397
Number of Quarters	104	104	104	104	104	104
$\beta_{Interest\ Rate} - \beta_{\Delta r}$			0.183			0.198
			(0.135)			(0.136)

Notes: The coefficients represent the percentage point effect on quarter-over-quarter price appreciation. Robust standard errors, double-clustered at the quarter and MSA levels, are shown in parentheses. *=p<0.1, **=p<0.05, ***=p<0.01. Source: Author calculations using NMDB and FHFA HPI data 1998–2023.

Modeled Cumulative Effects on Home Prices

Robustness Checks and Additional Analyses
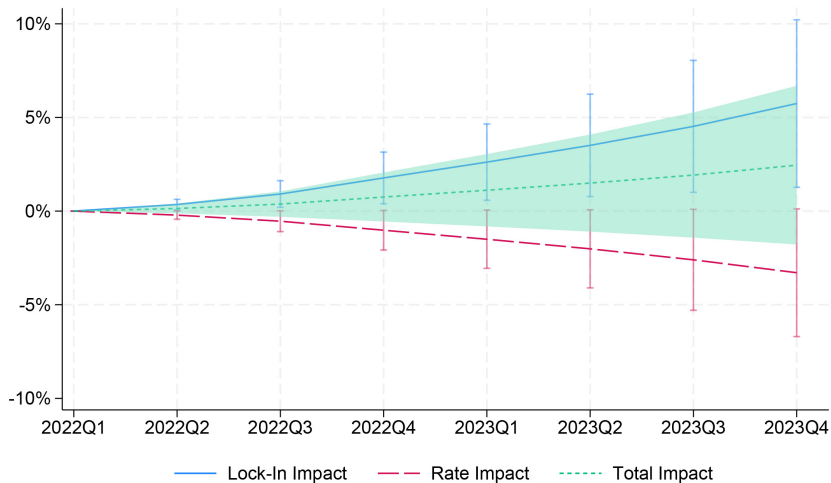
▶ Restricted Subsample Link

▶ Pre-2020 Sample Link

▶ Proportional Hazard Model Link

▶ Sales Vs. Other Prepayments Link

▶ Modeling Persistence of the Current Lock-In Episode Link

▶ Are Sales Lost or Just Delayed? Link

Two datasets are available at fhfa.gov/papers/wp2403.aspx

1. Data for recreating figures

2. Supplemental quarterly aggregate data 1998-2023
   - ▶ Metrics: existing rate, predicted new rate, Δr, Δr distribution, payment change ($ and %), lock-in sensitivity, lock-in effect, and lost sales.
   - ▶ Groupings: state, MSA, county, loan type, home value, income, age, race/ethnicity, ltv, and credit score.

Conclusions: Research Questions

1. How "locked-in" are borrowers?
   As of 2023Q4, the average $\Delta r = $ -3.24
   This corresponds to a \$511 or 40.1% increase in P&I payments, and $\approx$\$60,000 in NPV.

2. How sensitive are sales to lock-in? For every percentage point that market mortgage rates exceed the origination interest rate, the probability of sale is decreased by 18.1%.
   Non-white borrowers and those in high-value homes are more sensitive.

3. What is the aggregate effect on sales?
   Lock-in led to a 57% reduction in home sales with fixed-rate mortgages in 2023Q4 and prevented 1.33 million sales between 2022Q2 and 2023Q4.

4. What effect has lock-in had on prices?
   The supply reduction increased home prices by 5.7%, outweighing the direct impact of elevated rates, which decreased prices by 3.3%.

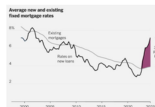Several policies and market structures have been proposed or used internationally.

1. Assumability
2. Portability
3. Borrower repurchase
4. Tax credits

Our paper and other existing literature give policymakers many of the tools needed to assess these options. Still, many open questions remain, such as the equilibrium effect on offered rates and the reasons for historically low take-up rates.
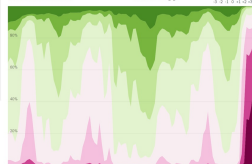
A Huge Number of Homeowners Have Mortgage Rates Too Good to Give Up

On a scale not seen in decades, many Americans are stuck in homes they would rather leave.

By EMILY BADGER and FRANCESCA PARIS

High Mortgage Rates Have Prevented the Sale of More Than a Million Homes in the U.S.

The lock-in effect has cost the housing market 1.3 million home sales and affected home prices, finds FHFA

"It looks like lock-in could be with us for a long time," write FHFA researchers.

Mortgage rate 'lock-in effect' in Bay Area is more dramatic than anywhere else. These charts show the striking trend

Email Jonah.Coste@fhfa.gov with any questions or comments.

Appendix Slides

Data: Summary Statistics

	GSE Data	NMDB	NMDB Orig≥2000
Number of Loans	95,324,027	11,321,667	8,930,197
Borrower Attributes			
Borrower Age (at origination)	46	44	45
Borrower Credit Score	741	715	719
DTI	34	34	35
Home Value (2022 Prices)	$542,550	$489,800	$507,650
Annual Income (2022$)	$135,450	$126,050	$128,900
Loan Characteristics			
Loan Amount (2022$)	$274,550	$252,850	$271,700
Origination LTV	71	74	74
Loan Term (months)	312	312	315
Interest Rate	4.84%	5.70%	5.06%
Purchase-Only Mortgage	37.7%	47.1%	42.6%
Owner Occupied	91.4%	94.0%	93.4%
Active	27.3%	19.5%	24.6%
Loan Type			
GSE	100%	57.2%	60.4%
Conventional	—	23.1%	19.5%
FHA	—	12.9%	12.9%
VA	—	5.9%	6.1%
Race and Ethnicity			
White	62.0%	79.0%	77.9%
Black	3.0%	6.4%	6.4%
Asian	5.6%	5.1%	5.6%
Hispanic (of any race)	6.0%	8.6%	9.1%

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Data: Active Fixed-Rate Mortgages Over Time

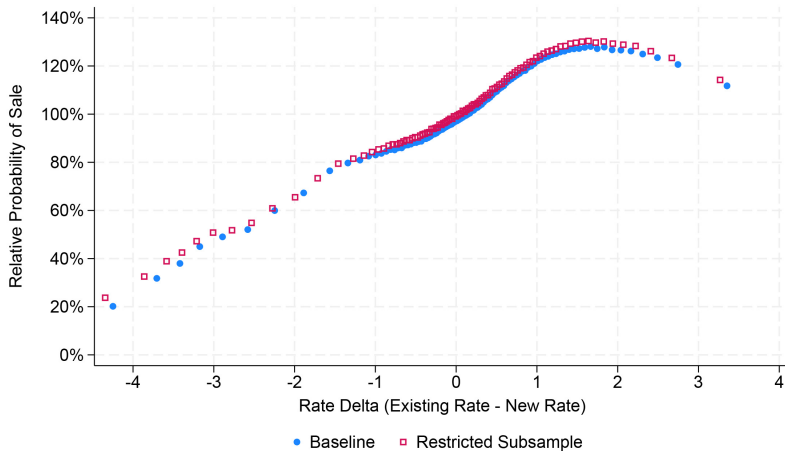# Data: Sale Rate vs. NAR® Existing Home Sales

Legend: GSE/CoreLogic Data — Existing Home Sales (Right Axis)
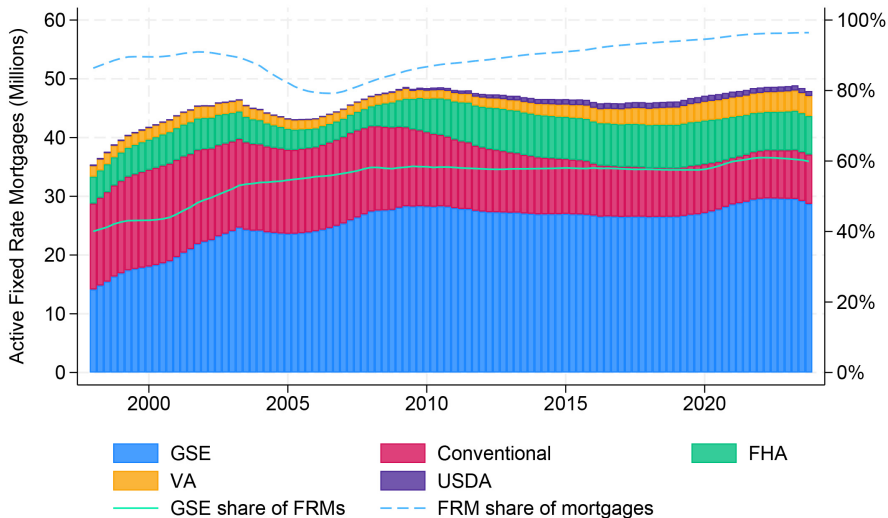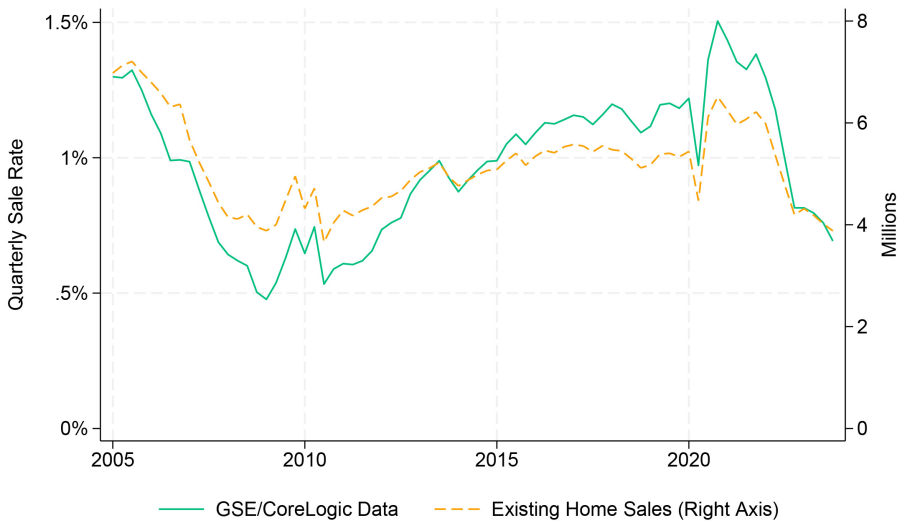
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Home Value
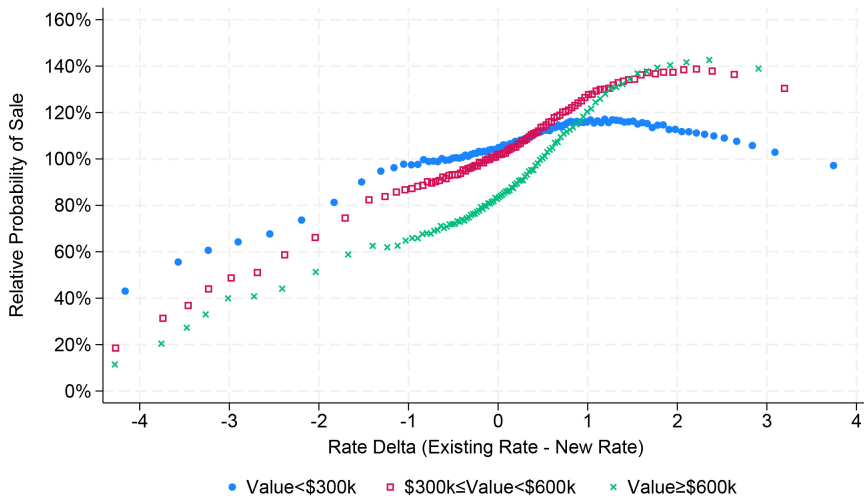
Race and Ethnicity
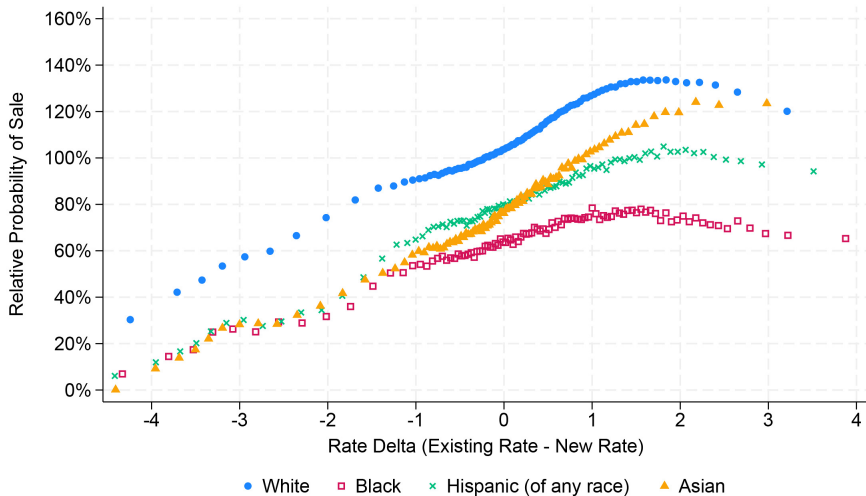
Robustness Test: Restricted Subsample

Relative Probability of Sale vs. Rate Delta (Existing Rate - New Rate)

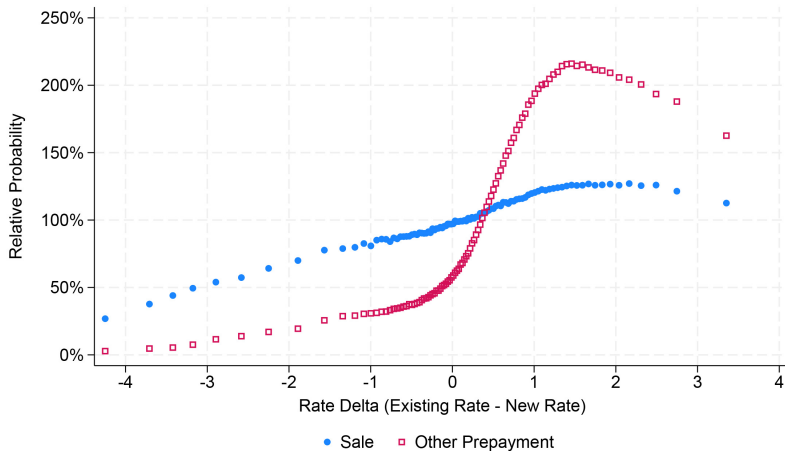Legend: • Baseline   □ Restricted Subsample

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Robustness Test: Proportional Hazard Model
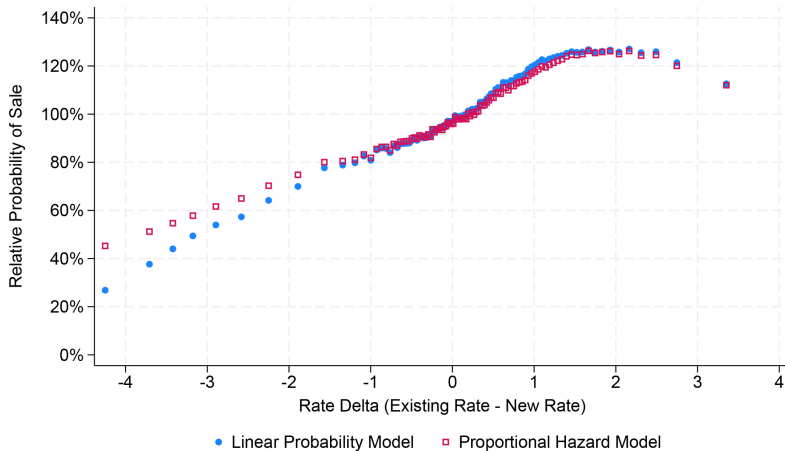
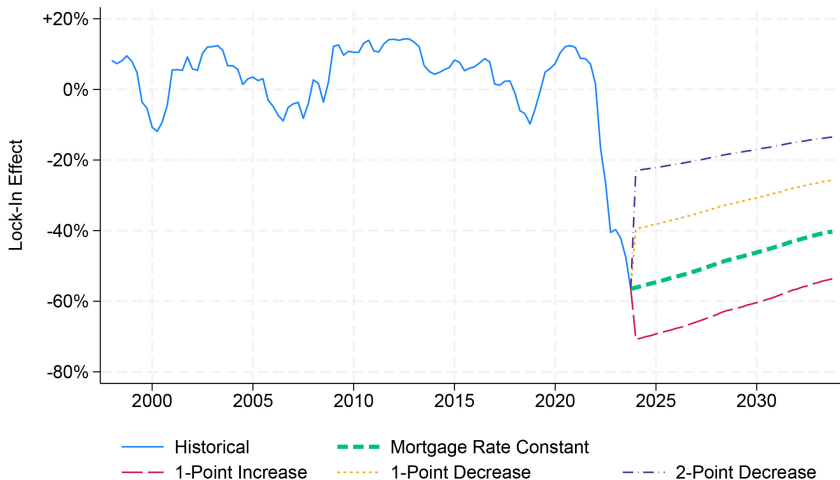# Sales Vs. Other Prepayments

Modeling Persistence of the Current Lock-In Episode

Simulated Future Lock-In Effect on Sales

Are Sales Lost or Just Delayed?

	Baseline	Decay	Pent-Up Supply
$\mathbb{1}(\widehat{\Delta r}_t \leq 1)\widehat{\Delta r}_t$	0.177***	0.186***	0.179***
	(0.016)	(0.017)	(0.021)
$\mathbb{1}(\widehat{\Delta r}_t > 1)$	0.217***	0.220***	0.221***
	(0.030)	(0.030)	(0.037)
$\mathbb{1}(\widehat{\Delta r}_t \leq 1)\widehat{\Delta r}_t \times \sum_{i=2}^{\infty} \mathbb{1}(\widehat{\Delta r}_{t-i} < 0)$		-0.0012***	
		(0.0004)	
$\sum_{i=2}^{\infty} (\widehat{\Delta r}_{t-i}\|\widehat{\Delta r}_{t-i} < 0)$			-0.0008
			(0.0019)
Borrower & Loan Characteristics	✓	✓	✓
Loan Age x Term FE	✓	✓	✓
Loan Age x Purpose FE	✓	✓	✓
Quarter FE	✓	✓	✓

Notes: The coefficients represent the percentage point effect on the quarterly likelihood of sale. The population average likelihood is 0.976%/quarter during the sample period. Robust standard errors, clustered at the quarter level, are in parentheses. *=p<0.1, **=p<0.05, ***=p<0.01. Source: Author calculations using GSE and CoreLogic data from 2000–2023.

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