Real effects of nominal interest rates

Joshua K. Hausman
University of Michigan
& NBER

John Leahy
Deceased, formerly University of Michigan
& NBER

John Mondragon
Federal Reserve Bank of
San Francisco*

Johannes F. Wieland
Federal Reserve Bank of San Francisco*
& University of California, San Diego
& NBER

NBER Summer Institute
Monetary Economics
14 July 2026

*The views expressed here are those of the authors and do not necessarily reflect those of the Federal Reserve Bank of San Francisco or the Federal Reserve System.

Summary

- Most economics: The real (inflation-adjusted) interest rate matters, not the nominal (posted) interest rate (e.g., Galí 2026).
- Our paper and ordinary people: Good reasons to think that the nominal interest rate matters, possibly even more than the real interest rate.
- Why: The structure of loan contracts, particularly mortgages.
- Evidence: Michigan survey of consumers and mortgage origination volume across cities.
- Model: Standard new Keynesian model with a payment-to-income constraint.
- Result: An increase in nominal interest rates will be contractionary even if real interest rates are unchanged.

Previous Literature

- Economists during and in the aftermath of inflation in the 1970s looked at how nominal interest rates interacted with mortgage contracts, e.g. Lessard and Modigliani (1975).
- Wilcox (1989, 1990) looks at the correlation of consumption with nominal and real interest rates.
- MacGee and Yao (2025, 2026) look at the long-run effects of steady-state inflation on the housing market.
- Lots of recent work on mortgage market institutions, e.g., Bhutta and Ringo (2021); Bosshardt, Di Maggio, Kakhbod, and Kermani (2024); Greenwald (2026).
- Little work in related theory; closest are Drechsel (2023) and Garriga, Kydland, Šustek (2017, 2021).

Outline

Outline

Debt contracts

- Models usually have one-period debt: You borrow money today and repay it all with interest at some future date. e.g. Borrow \$1,500,000 for a house today, repay the entire \$1,500,000 plus interest in 30 years.
- But real world debt contracts in the U.S., specifically mortgages, often have the following features:
  1. Debt is multi-period, it requires multiple payments during the life of the debt contract.
  2. One repays debt with a constant nominal payment each period. e.g., A homebuyer who obtains a 30-year fixed-rate mortgage in July 2026 will make 360 identical nominal payments from July 2026 through June 2056.
  3. Lenders resist making loans in which debt payments (mortgage plus other) are above 45 or 50 percent of income.
     - ⋆ Called a payment-to-income or, more commonly, a debt-to-income (DTI) constraint.
     - ⋆ Need not be institutional: consumers may have other consumption commitments that make it difficult to devote a large fraction of income to housing.

EXAMPLE

Suppose a household earns \$100,000 a year and faces a debt-to-income constraint of 1/2: mortgage payments must be $\leq$ \$50,000 per year. What size mortgage can it obtain?

Case 1: $\pi^e = 0$, $r = 0 \implies i = 0$

- Annual payment on a 30-year fixed rate mortgage is one-thirtieth of the principal.
- Maximum mortgage: \$50,000 x 30 = **\$1.5 million**.

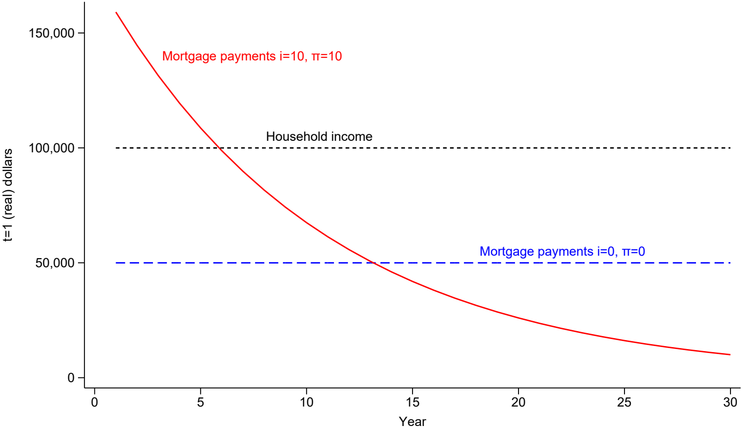
Case 2: $\pi^e = 10$, $r = 0 \implies i = 10$

- A \$1.5 million loan would require a first-year payment above \$150,000.
- To keep the first-year payment under \$50,000, the household can borrow only **\$470,000**.

- Rising wages shrink the payment as a share of income over time – but do not affect how the constraint binds at origination.

Same real rate; maximum mortgage falls from \$1.5 million to \$470,000.

The tilt: real payments on a $1.5 million mortgage



Outline

Consumer survey evidence

First empirical test: See whether the nominal or real interest rate drives home-buying sentiment in the Michigan Survey of Consumers.

- The Michigan Survey of Consumers asks: "Generally speaking, do you think now is a good time or a bad time to buy a home?"
- It also asks about expected inflation over the next 5-10 years.
- So we have a survey-respondent level measure of the real interest rate.
- And the survey asks about house price expectations. We can see how expectations of the general price level versus expectations of house prices affect home buying sentiment.
- The survey also asks people *why* they say it's a good time to buy a house. Many respondents say because interest rates are low. We see if they mean nominal or real rates.

Specification: survey

$$\text{Home buy attitude}_{j,t} = \beta_0 + \beta_1 i_t + \beta_2 r_{j,t} + \varepsilon_{j,t}$$

- Home buy attitude is a dummy variable equal to 1 if a survey respondent j in month t says that it is a good time to buy a home.
- i_t is the actual nominal interest rate on 30-year fixed rate mortgages.
- $r_{j,t}$ is the respondent-specific real interest rate equal to i_t minus the respondent's expected annual inflation rate over the next five to ten years.

Michigan survey regressions

	Buy home	Buy home	Buy home	Low int. rate	Buy home
Mortgage rate (%)	−0.11***	−0.11***	−0.11***	−0.071***	
	(0.0021)	(0.0022)	(0.0060)	(0.0025)	
Real mortgage rate (%)	0.0039***	0.0039***	0.0049***	0.0027***	
	(0.00031)	(0.00032)	(0.00049)	(0.00040)	
Exp. house price infl. (%)			0.0075***		0.0075***
			(0.00047)		(0.00047)
Exp. 5-10 year infl. (%)					−0.0044***
					(0.00042)
Unemployment rate (%)		−0.0022			
		(0.0021)			
Time trend (monthly)	−0.0021***	−0.0021***	−0.0025***	−0.0015***	
	(0.000043)	(0.000051)	(0.000090)	(0.000065)	
Survey mth fixed effects					X
R^2	0.20	0.20	0.27	0.11	0.30
Sample period	2/79-2/26	2/79-2/26	3/07-2/26	2/79-2/26	3/07-2/26
Observations	236,987	235,923	91,940	232,666	91,940

Notes: In columns (1), (2), (3), and (5) the dependent variable is a dummy variable for whether or not the respondent says that it is a good time to buy a home. In column (4), the dependent variable is a dummy variable for whether or not the respondent says that low interest rates are a reason why it is a good time to buy a home. Standard errors are clustered by survey month.

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

▸ With demographic controls

Outline

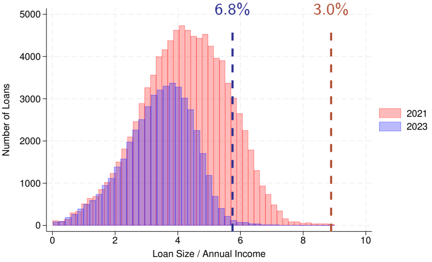
DTI constraints and geography

- We want to look at actual mortgage market outcomes.
- We use geographic variation: the nominal interest rate does not vary within the U.S., but its effects likely do.
- A higher nominal interest rate will reduce the volume of mortgage originations as it tightens DTI (payment-to-income) constraints.
- More (potential) borrowers will be affected in cities where loans are large relative to incomes.
- DTI data are unavailable pre-2018, but the DTI ratio is strongly correlated with the loan-to-income (LTI) ratio, the ratio of the mortgage loan size to the borrower's income.
  - We have mortgage-level LTI data starting in 1995.

▸ DTI and LTI across cities

Intuition: LTI distribution, Houston and Los Angeles

Houston, 2021 and 2023



Los Angeles, 2021 and 2023.

Dashed lines: maximum LTI consistent with a 45 percent mortgage-payment-to-income ratio on a 30-year loan at each year's mortgage rate (3.0% in 2021; 6.8% in 2023). Loans between the lines were feasible in 2021, infeasible in 2023. Illustrative: ignores other debt payments and property taxes.

Mortgage volume fell 27 percent in Houston, 50 percent in Los Angeles.

Specification: mortgage volume

$$\Delta \ln \text{Loans}_{jt} = \beta_0 \Delta i_t + \sum_{k=1}^{3} \gamma_k \text{Tercile } k\text{: LTI}_j + \sum_{k=1}^{3} \theta_k [\Delta i_t \times \text{Tercile } k\text{: LTI}_j]$$
$$+ \delta_0 \Delta r_t + \sum_{k=1}^{3} \zeta_k [\Delta r_t \times \text{Tercile } k\text{: LTI}_j] + \varepsilon_{jt}.$$

- $\Delta \ln \text{Loans}_{jt}$ is the 4-quarter log change in the number of mortgages originated in CBSA (metro area) j and quarter t.
- i_t and r_t are the nominal and real mortgage interest rate.
- $\text{Tercile } k\text{: LTI}_j$ is a dummy variable for the loan-to-income (LTI) bin containing CBSA j. Bin 3 is the tercile of CBSAs with the highest average LTI (e.g., Los Angeles is in bin 3).

Hypothesis: $\theta_3 < 0$; where mortgages are large relative to income, an increase in i will depress mortgage lending more.

Directly tests for a DTI constraint channel. Money illusion would not lead to a negative θ_3.

Data

- Number of mortgages originated and LTI: Confidential home mortgage disclosure act (cHMDA) data.
  - Sample: 1996-2023, 704 cities.
  - Data cover at least 80 percent of the mortgage market.
  - Restrict to loans for purchases of owner-occupied homes.
- The mortgage rate (i_t) is the 30-year fixed rate mortgage rate.
- The real rate (r_t) equals $i_t - \pi_t^e$, with inflation expectations (π_t^e) measured as Michigan survey mean 5-10 year expected inflation.

Mortgage loan count regressions

	(1)	(2)	(3)	(4)
Δ Mortgage rate	-4.36***	-13.93***	-15.69***	
	(0.39)	(0.42)	(0.46)	
Mid LTI x Δ Mortgage rate	-2.40***	-2.97***	-2.87***	-2.87***
	(0.54)	(0.58)	(0.63)	(0.64)
High LTI x Δ Mortgage rate	-5.51***	-5.50***	-3.90***	-3.90***
	(0.60)	(0.64)	(0.70)	(0.70)
Δ Real rate (Michigan mean)	2.31***	10.24***	10.73***	
	(0.41)	(0.43)	(0.44)	
Mid LTI x Δ Real rate (Michigan mean)	1.23**	1.71***	1.68***	1.68***
	(0.57)	(0.61)	(0.62)	(0.62)
High LTI x Δ Real rate (Michigan mean)	2.90***	2.89***	2.44***	2.44***
	(0.62)	(0.66)	(0.67)	(0.67)
House price growth control		X	X	X
Fed funds rate control			X	X
City and date fixed effects				X
R^2	0.03	0.14	0.14	0.55
Number of cities	704	704	704	704
Number of years	28	28	28	28
Number of observations	78,848	78,848	78,848	78,848

▸ Alternative inflation expectation measures ▸ Double-clustered standard errors

Outline

Summary

Goal: illustrate how the nominal interest rate might directly impact the economy, consistent with the above empirical evidence.

- Simple model as close as possible to Galí (2015).
- In the spirit of Lucas and Stokey (1987): a cash good and a credit good.
- Purchases of the credit good are subject to a payment-to-income constraint as in Drechsel (2023) and the real world.
- The payment-to-income constraint means that changes in the nominal rate have real effects.

Cash good and credit good

- Representative household derives utility from the consumption of two non-durable goods, a cash good indexed by n, and a credit good indexed by d.
- P^n and P^d are the prices of the two goods.
- C^n and C^d are consumption of the two goods.
- The consumer chooses consumption of the two goods and labor supply (N) to maximize the present value of utility

$$\sum_t \beta^t U_t \text{ with } U_t = \frac{(C_t^n)^{1-\sigma}}{1-\sigma} + \lambda \frac{(C_t^d)^{1-\sigma}}{1-\sigma} - \frac{1}{1+\gamma} N_t^{1+\gamma}.$$

  $1/\sigma$ is the elasticity of intertemporal substitution, γ is the inverse Frisch elasticity of labor supply, and λ is a parameter that determines the relative importance of the two goods in utility.

Borrowing constraint

To purchase the credit good, the consumer pays the price plus interest in the next period. Faces the payment-to-income constraint:

$$(1+i_t)P_t^d C_t^d \leq \theta P_t Y_t.$$

- P is the aggregate price level, so PY is nominal income.

- θ is the share of income that a consumer can commit to spending on the credit good. $0 < \theta < 1$.

Budget constraint

The Euler equation and the forward guidance puzzle

The Euler equation solved forward:

$$y_t = -\frac{1}{\sigma} \lim_{T\to\infty} \sum_{k=0}^{T} [(i_{t+k} - \pi_{t+k+1})] - \frac{\bar{C}^d}{\bar{C}^n} i_t + \underbrace{\lim_{T\to\infty} y_{t+T}}_{=0}$$

- The first term is the long-term real interest rate, as in the standard Euler equation.
- The second term shows that a higher nominal interest rate reduces demand by tightening the payment-to-income constraint.
- The effect of the nominal rate depends on the size of the d sector relative to the n sector, $\frac{\bar{C}^d}{\bar{C}^n}$.
- What matters are current not future nominal rates. Helps to resolve the forward guidance puzzle.

LONG-TERM DEBT

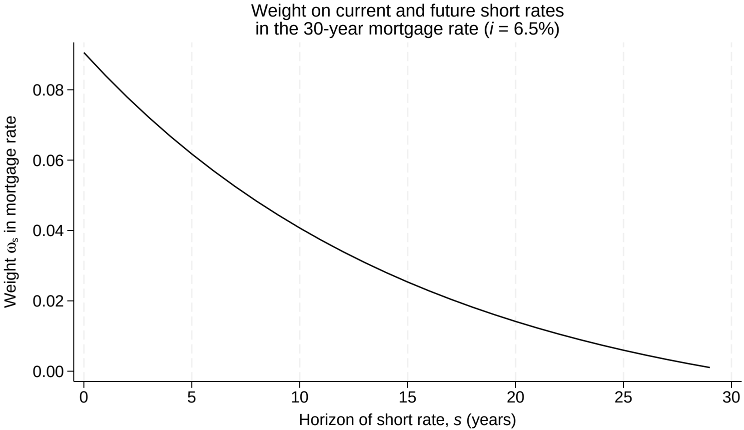
Longer-term mortgage contracts: future short-term nominal rates still affect demand less than do current short-term nominal rates.

$$y_t = -\frac{1}{\sigma}\sum_{j=0}^{\infty}\left(i_{t+j} - \pi_{t+j+1}\right) - \frac{\bar{C}^d}{\bar{C}^n}\underbrace{\sum_{s=0}^{M-1}\omega_s i_{t+s}}_{\rho_t};$$

- ω_s are positive weights that are decreasing in s (time).
- The payment-to-income constraint depends on the long-term mortgage rate $\rho_t = \sum_{s=0}^{M-1}\omega_s i_{t+s}$.
  - e.g., The expected one-year interest rate 29 years in the future affects the 30-year mortgage rate less than the expected one-year interest rate one year in the future.

Lender profit maximization

Declining weights on future i_t in the Euler equation



Conclusion: policy implications

1. Data and model provide a rationale for the focus of the Fed on nominal interest rates.
2. They help to explain how increases in nominal rates can be contractionary even if unaccompanied by increases in real rates.
3. They explain why conditional on the real rate, decreases in the nominal rate are more expansionary than are increases in expected inflation.
    - An implication is that the effect of monetary policy shocks will be a poor guide to the effect of higher expected inflation.
    - Monetary policy shocks are nominal rate shocks that change how payment-to-income constraints bind; changes in expected inflation do not affect such constraints.
    - Helps to explain the empirical result that lower real interest rates resulting from higher expected inflation are not expansionary (Wieland 2019; Cohen-Setton, Hausman, and Wieland 2017).

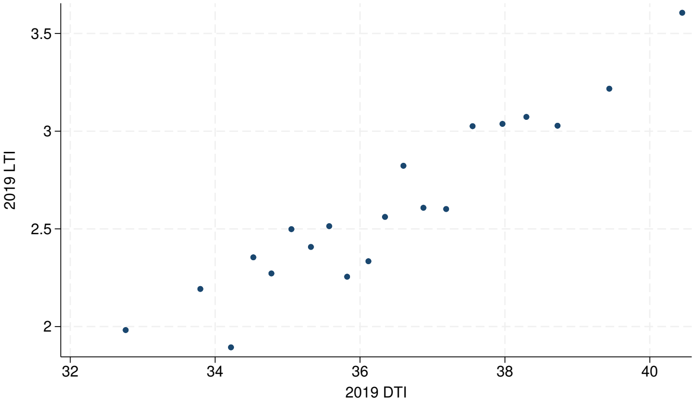
Michigan survey regressions (with demographic controls)

	Buy home	Buy home	Buy home	Low int. rate	Buy home
Mortgage rate (%)	-0.11^{***}	-0.11^{***}	-0.11^{***}	-0.072^{***}	
	(0.0022)	(0.0023)	(0.0060)	(0.0025)	
Real mortgage rate (%)	0.0034^{***}	0.0034^{***}	0.0046^{***}	0.0023^{***}	
	(0.00032)	(0.00033)	(0.00050)	(0.00042)	
Exp. house price infl. (%)			0.0074^{***}		0.0075^{***}
			(0.00046)		(0.00046)
Exp. 5-10 year infl. (%)					-0.0040^{***}
					(0.00043)
Unemployment rate (%)		-0.0022			
		(0.0022)			
Time trend (monthly)	-0.0022^{***}	-0.0023^{***}	-0.0027^{***}	-0.0016^{***}	
	(0.000047)	(0.000055)	(0.000090)	(0.000069)	
Survey mth fixed effects					X
R^2	0.21	0.21	0.28	0.12	0.31
Sample period	2/79-2/26	2/79-2/26	3/07-2/26	2/79-2/26	3/07-2/26
Observations	219,790	218,860	86,088	216,227	86,088

Notes: Demographic controls: age (cubic), gender, marital status, college graduation, census region, number of children, number of adults in household, and income. In columns (1), (2), (3), and (5) the dependent variable is a dummy for whether the respondent says it is a good time to buy a home. In column (4), the dependent variable is a dummy for whether the respondent says that low interest rates are a reason it is a good time to buy a home. Standard errors are clustered by survey month. $^{*}\,p<0.1$, $^{**}\,p<0.05$, $^{***}\,p<0.01$

Back

DTI AND LTI ACROSS U.S. CITIES



BINSCATTER OF DEBT-TO-INCOME (DTI) AND LOAN-TO-INCOME (LTI) RATIOS IN 2019 ACROSS CITIES.
SOURCE: HMDA DATA AND AUTHORS' CALCULATIONS.

Back

Mortgage loan count regressions: Alternative inflation expectation measures

	(1) Michigan median	(2) Cleveland fed	(3) TIPS breakeven
Mid LTI x Δ Mortgage rate	-5.62***	-1.07*	-0.97**
	(1.15)	(0.56)	(0.43)
High LTI x Δ Mortgage rate	-9.46***	-1.81***	-1.85***
	(1.34)	(0.57)	(0.44)
Mid LTI x Δ Real rate	4.44***	-0.38	-0.54*
	(1.16)	(0.71)	(0.30)
High LTI x Δ Real rate	8.08***	0.21	0.26
	(1.32)	(0.75)	(0.34)
House price growth control	X	X	X
Fed funds rate control	X	X	X
City and date fixed effects	X	X	X
R^2	0.55	0.55	0.55
Number of cities	704	704	704
Number of years	28	28	28
Number of observations	78,848	78,848	56,320

Double-clustered standard errors
Back

Mortgage loan count regressions: double clustered standard errors

	(1)	(2)	(3)	(4)
Δ Mortgage rate	-4.36	-13.93***	-15.69***	
	(5.76)	(4.67)	(4.19)	
Mid LTI x Δ Mortgage rate	-2.40***	-2.97***	-2.87***	-2.87***
	(0.63)	(0.76)	(0.84)	(0.94)
High LTI x Δ Mortgage rate	-5.51***	-5.50***	-3.90***	-3.90***
	(1.15)	(1.19)	(1.38)	(1.45)
Δ Real rate (Michigan mean)	2.31	10.24**	10.73**	
	(6.09)	(5.10)	(4.80)	
Mid LTI x Δ Real rate (Michigan mean)	1.23*	1.71**	1.68*	1.68*
	(0.70)	(0.83)	(0.86)	(0.99)
High LTI x Δ Real rate (Michigan mean)	2.90**	2.89**	2.44*	2.44
	(1.28)	(1.31)	(1.41)	(1.50)
House price growth control		X	X	X
Fed funds rate control			X	X
City and date fixed effects				X
R^2	0.03	0.14	0.14	0.55
Number of cities	704	704	704	704
Number of years	28	28	28	28
Number of observations	78,848	78,848	78,848	78,848

▸ Alternative inflation expectation measures ▸ Back

Mortgage loan count regressions: Alternative inflation expectation measures, double clustered standard errors

	(1) Michigan median	(2) Cleveland fed	(3) TIPS breakeven
Mid LTI x Δ Mortgage rate	-5.62***	-1.07	-0.97
	(1.74)	(0.83)	(0.76)
High LTI x Δ Mortgage rate	-9.46***	-1.81	-1.85*
	(2.76)	(1.24)	(0.94)
Mid LTI x Δ Real rate	4.44**	-0.38	-0.54
	(1.81)	(1.19)	(0.63)
High LTI x Δ Real rate	8.08***	0.21	0.26
	(2.84)	(1.55)	(0.63)
House price growth control	X	X	X
Fed funds rate control	X	X	X
City and date fixed effects	X	X	X
R^2	0.55	0.55	0.55
Number of cities	704	704	704
Number of years	28	28	28
Number of observations	78,848	78,848	56,320

Baseline standard errors Back

Budget constraint

Purchases of both goods are subject to the budget constraint:

$$P_t^n C_t^n + (1+i_{t-1}) P_{t-1}^d C_{t-1}^d + B_t = W_t N_t + \Pi_t + (1+i_{t-1}) B_{t-1}.$$

- B_t is the purchase or issuance of nominal bonds at date t maturing at date $t+1$.
- i_t is the nominal rate of return between t and $t+1$.
- W_t is the nominal wage.
- Π_t is firm profits.

Back

Lender profit maximization

Even with longer-term debt contracts, nominal interest rates will matter less, the further in the future they are.

- Consider a lender choosing between lending X dollars in a fixed rate amortizing mortgage at rate ρ or purchasing a succession of one-year bonds paying interest rates i_1, i_2, . . . i_M, where M is the term of the mortgage (e.g., 30 years).
- The latter strategy will yield $X(1+i_1)(1+i_2)....(1+i_M)$ dollars.
- If the lender lends X dollars for a long-term mortgage, it receives a constant nominal payment of Z every year for 30 years.
- Z is a function of size of the mortgage (Z) and the mortgage interest rate (ρ), with $\partial Z/\partial X > 0$ and $\partial Z/\partial \rho > 0$.
- The lender can reinvest these payments at the prevailing short-run interest rate, so the payoff to giving the mortgage is $Z(\rho)\prod_{t=2}^{M}(1+i_t)+Z(\rho)\prod_{t=3}^{M}(1+i_t)+...+Z(\rho)(1+i_M)+Z(\rho)$.

Lender profit maximization cont.

Lender will set ρ such that

$$X\prod_{t=1}^{M}(1+i_t) = Z(\rho)\prod_{t=2}^{M}(1+i_t) + Z(\rho)\prod_{t=3}^{M}(1+i_t) + \cdots + Z(\rho)(1+i_M) + Z(\rho)$$

- Near-term and future short rates (e.g. i_2 vs i_M) have a symmetric effect on the left-hand side.
- An increase in near-term interest rates (e.g. i_2) increases the right-hand side less than an increase in future rates (e.g., i_M).
- Thus changes in near term short rates have larger effects on the ρ that a lender will charge.
- If ρ (the mortgage rate) affects aggregate demand, then current short rates will affect aggregate demand more than expected future short rates.

Forward guidance