Housing and the Welfare Cost of Inflation

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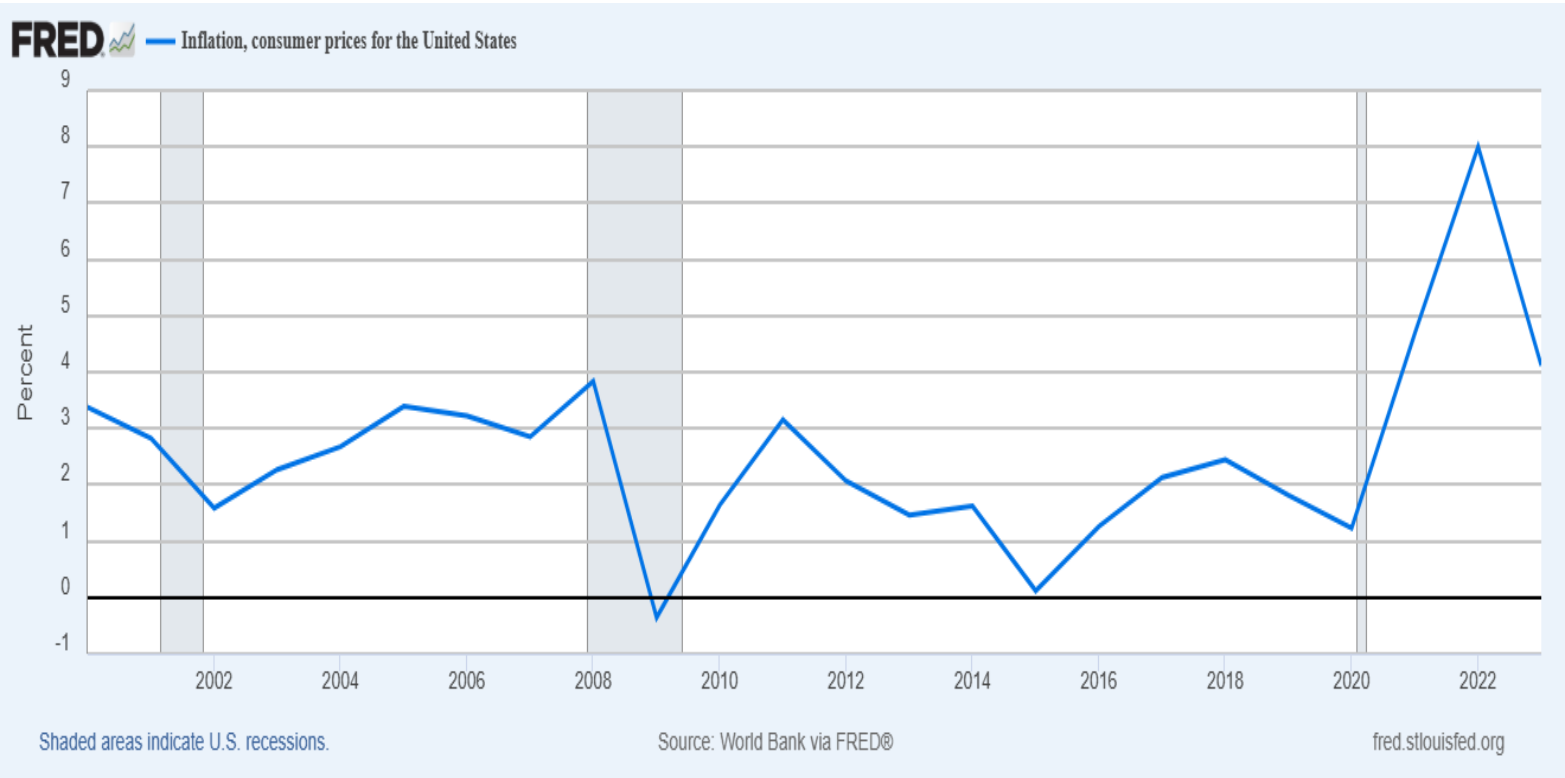
Inflation Rise and Debate over Inflation Target

- Rapid rise of inflation since 2021



Inflation Rise and Debate over Inflation Target

- Rapid rise of inflation since 2021 has rekindled debate over the appropriate target level of inflation

Opinion **US inflation**

It is time to revisit the 2% inflation target

The right goal for central banks in advanced economies such as the US might be 3% a year

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STRATEGIES

The Fed Has Targeted 2% Inflation. Should It Aim Higher?

After raising interest rates again, the Federal Reserve will soon have to consider how much pain it is willing to inflict in its fight against inflation, our columnist says.

Welfare Cost of Inflation

- Cost of inflation is typically evaluated in money-demand models (see e.g. Bailey 1965, Friedman 1969 and, Lucas 2000)
  - Rising inflation increases costs of holding (non-interest) bearing money
  - distorts relative price of consumption over time $\rightarrow$ Welfare loss

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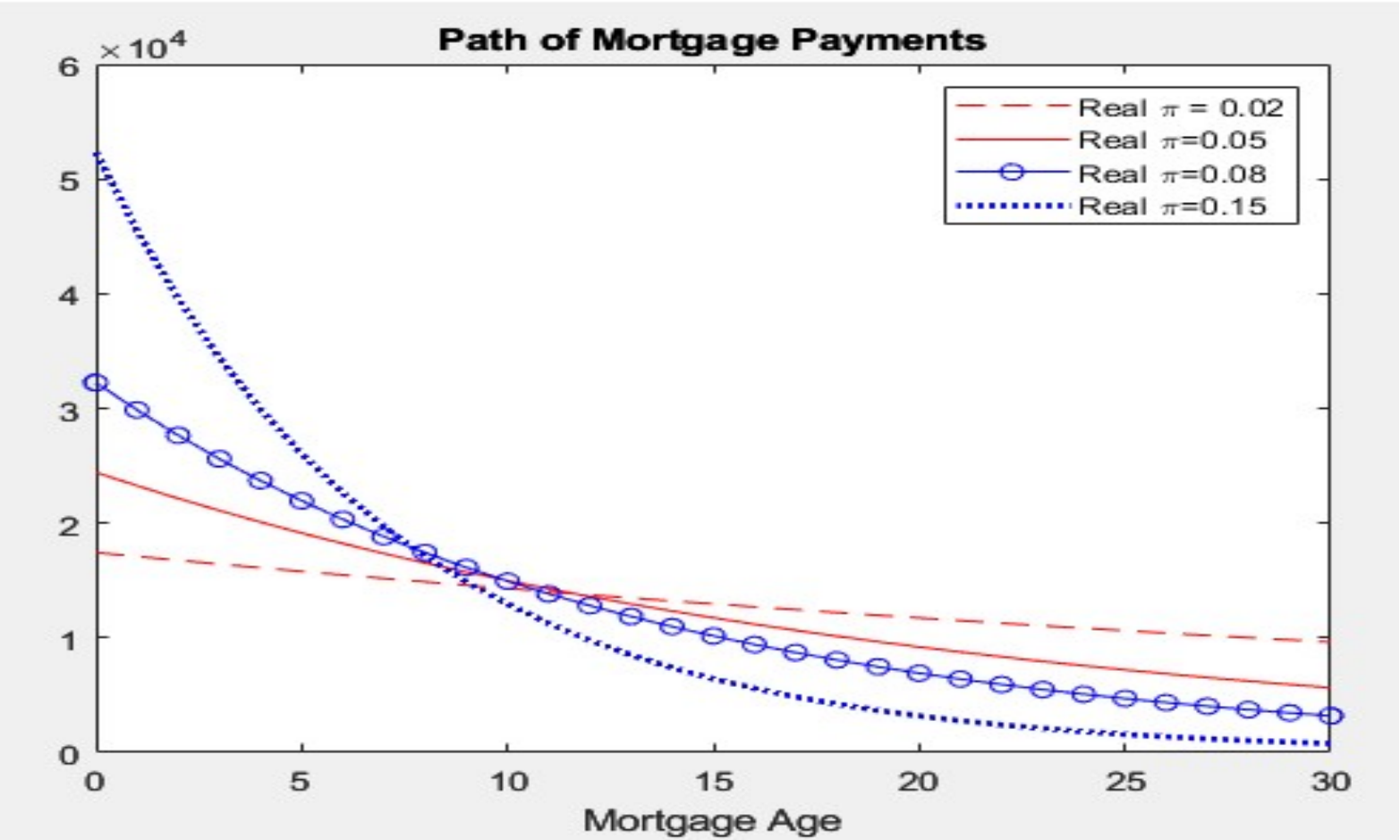
  - Rising inflation increases costs of holding (non-interest) bearing money
  - distorts relative price of consumption over time $\rightarrow$ Welfare loss
- We evaluate welfare cost of higher inflation target through a different **friction**: stemming from typical mortgage contract design
  - Mortgage contract (FRM or ARM) are written in nominal terms $\Rightarrow$ path of real payments and mortgage payment-to-income ratio inflation-dependent
  - Higher inflation front-loads real mortgage payment

Front-loaded Real Payments

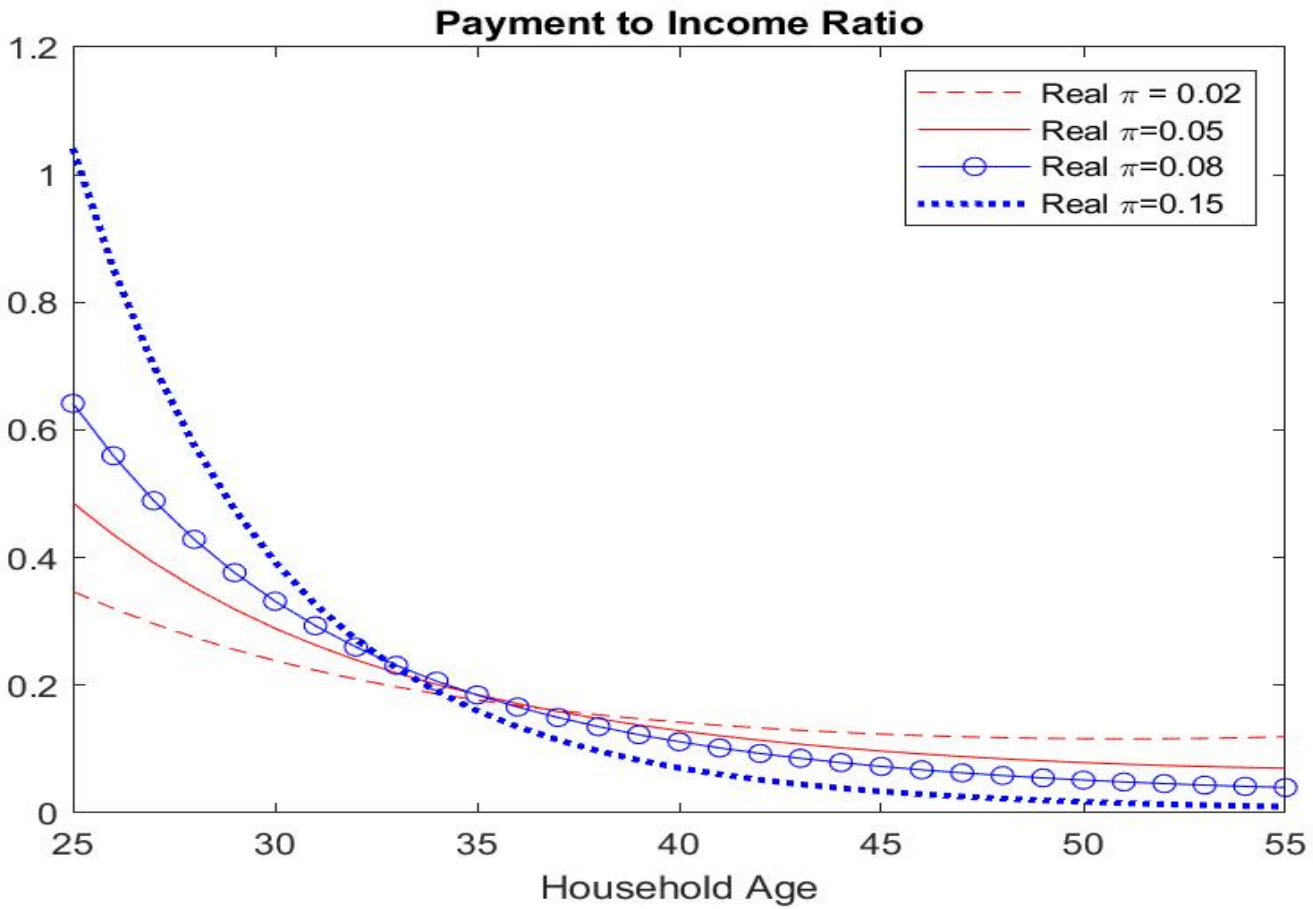
- 300,000 worth of loan: 30 years of amortization with fixed interest
- $1 + r_m = (1 + r)(1 + \pi)$; $RealPayment = \frac{NominalPayment}{(1+\pi)^n}$



Path of payment to income ratio

Front-loaded Payment-to-Income Ratio

- Combine mortgage payment with wage income of average household $\Rightarrow$ PTI is front-loaded



Why Inflation Matters

- **Front-loaded path of real payments when inflation is high**
  - Life-cycle income profile is hump-shaped. Most of prime-age buyers expect wage growth & cannot borrow against future income $\rightarrow$ **Credit constrained**

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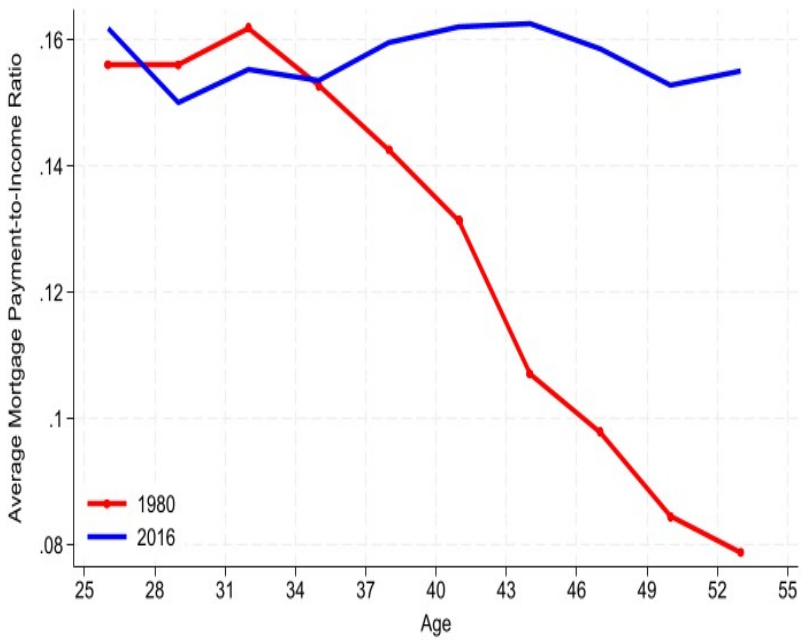
  - Heavier initial payments tighten borrowing constraint+ prevent consumption smoothing $\rightarrow$ tilt lifecycle consumption and housing consumption profile $\rightarrow$ Welfare loss

Empirical Evidence

- Front-loaded PTI and back-loaded non-housing consumption



PTI by age (Census & ACS)

Inflation and Nominal and Real Wage Growth

Empirical Evidence

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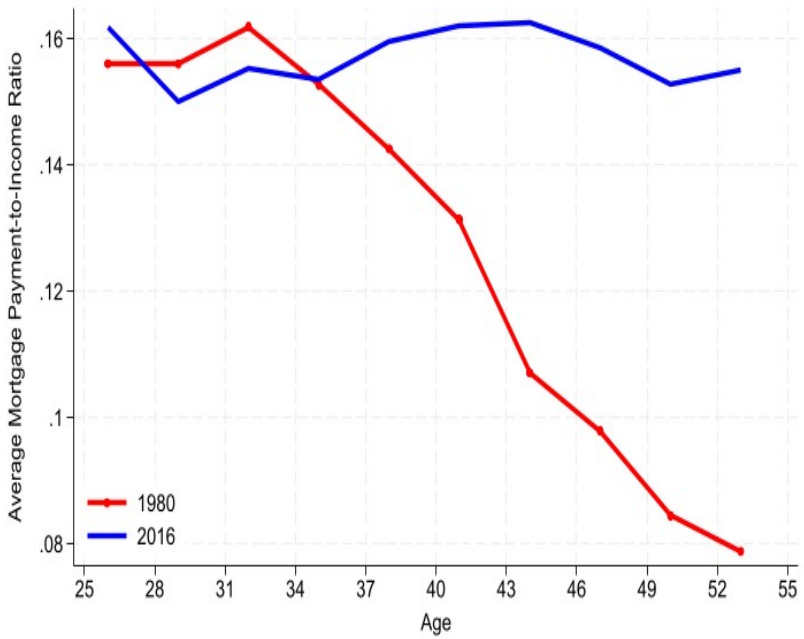
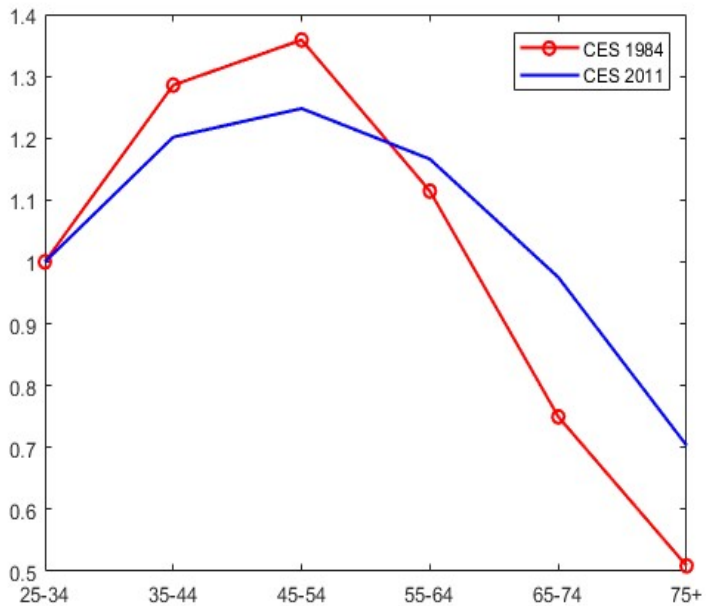


PTI by age (Census & ACS)



Non-housing Consumption (CEX)

What We Do

- Quantify welfare cost of inflation due to credit constraint tightening through housing market
- Develop a life-cycle housing tenure choice model where
  - Households finance housing purchase by standard fixed-amortization *fixed nominal payment* mortgage contracts with borrowing constraints
  - Requirements on LTV and PTI
  - Inflation shifts burden of real mortgage payments over amortization

What We Do

- Develop a life-cycle housing tenure choice model to evaluate welfare cost of inflation through housing market in General Equilibrium setting
- Calibrate the baseline model to match homeownership rates, loan-to-value ratios, DTI ratios and PTI over the life-cycle in 2019 where inflation set to be 2% and conduct counterfactual experiments
  - Vary inflation and compute expected value of a new born
  - Transition from high to low inflation
  - Propose and evaluate two policy changes in terms of alleviating welfare cost of inflation:
    1. Extending amortization from 30 to 36 years
    2. Removing requirement on PTI when mortgage is issued

What We Find

- 1 ppt increase in inflation results in a welfare loss comparable to a 0.053% decrease in life-time consumption
  - Half of estimated welfare cost of inflation in monetary models, less 0.1% by Lucas (2000)

  Welfare cost of inflation could be 53% higher when bring housing market into discussion
- Impact of inflation vary across cities depending on supply elasticity
  - Price adjustment partially alleviates impact of inflation
  - Mild inflation can be beneficial
- Heterogeneous impact of inflation across income groups

  Upper middle income people bear more as they are more likely to become owners
- Removing requirement on PTI alleviates welfare cost of higher inflation

Literature Review

- Estimating welfare cost of inflation
  - *Money demand* (Bailey 1965, Friedman 1969, Lucas 2000)

  Our analysis different friction due to fixed amortization mortgages
- Inflation and Mortgage Borrowing: Lessard and Modigliani (1975) Poterba (1984); Garriga et al. (2017); Chamber et al. (2009); Guren et al. (2020)

  We show implication of inflation for credit constraint and welfare cost of inflation
- Quantitative studies on housing markets
  - low inflation: Leung and Tang (2023), Ma and Zubairy (2021), Sommer, Sullivan, and Verbrugge (2013), Yang (2009), Chambers, Garriga, and Schlagenhauf (2009), Zhang (2023)

  Our paper discusses implication of constant high inflation and transition across inflation targets

Implications of Two-Period Illustrative Model

- Two-period household maximization problem
  - derive utility from housing and non-housing consumption
  - Purchase house with mortgage loan: paid out in two periods
  - Higher inflation shift real mortgage payment from 2nd to 1st period

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- Model implications:
  1. When household are not credit constrained (can borrow against future income)
     - Change in level of inflation has no impact on consumption, housing or welfare
     - Households borrow to cover increase in real mortgage payment due to higher inflation

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     - Change in level of inflation has no impact on consumption, housing or welfare
     - Households borrow to cover increase in real mortgage payment due to higher inflation
  2. Household are credit constrained
     - Higher inflation reduces housing consumption and lifetime welfare
     - Magnitude of welfare loss depends on (i) wage growth (ii) weight of housing consumption in utility

Model: Overview

- To quantify welfare cost of inflation, we develop **General Equilibrium** housing tenure choice model
- Households can finance house purchase using standard fixed-nominal payment fixed amortization mortgages
- Price of housing relative to non-housing good changes endogenously with inflation
- Frictions: Buying and selling house costly, mortgage closing cost and max LTV and max PTI
  - LTV $\leq .9$
  - PTI: $\leq 42\%$

Model: Overview

- Heterogeneous households choose between renting and owning based on age, income, asset
- Preference: Defined over non-durable good and housing service represented by

$$\sum_{j=1}^{J} \beta_j^{j-1} \left(\prod_{l=1}^{j-1} s_l\right) \frac{\left((1-\eta)C^{1-\xi} + \eta h^{1-\xi}\right)^{\frac{1-\sigma}{1-\xi}}}{1-\sigma}$$

- Households subject to income uncertainty and can only borrow using housing asset as collateral
- Typical 30-year fixed-rate fixed-nominal payment mortgage contracts with refinancing cost
- Bequest motive $\frac{B_0(B_1+W)^{1-\sigma}}{1-\sigma}$

More Model Detail

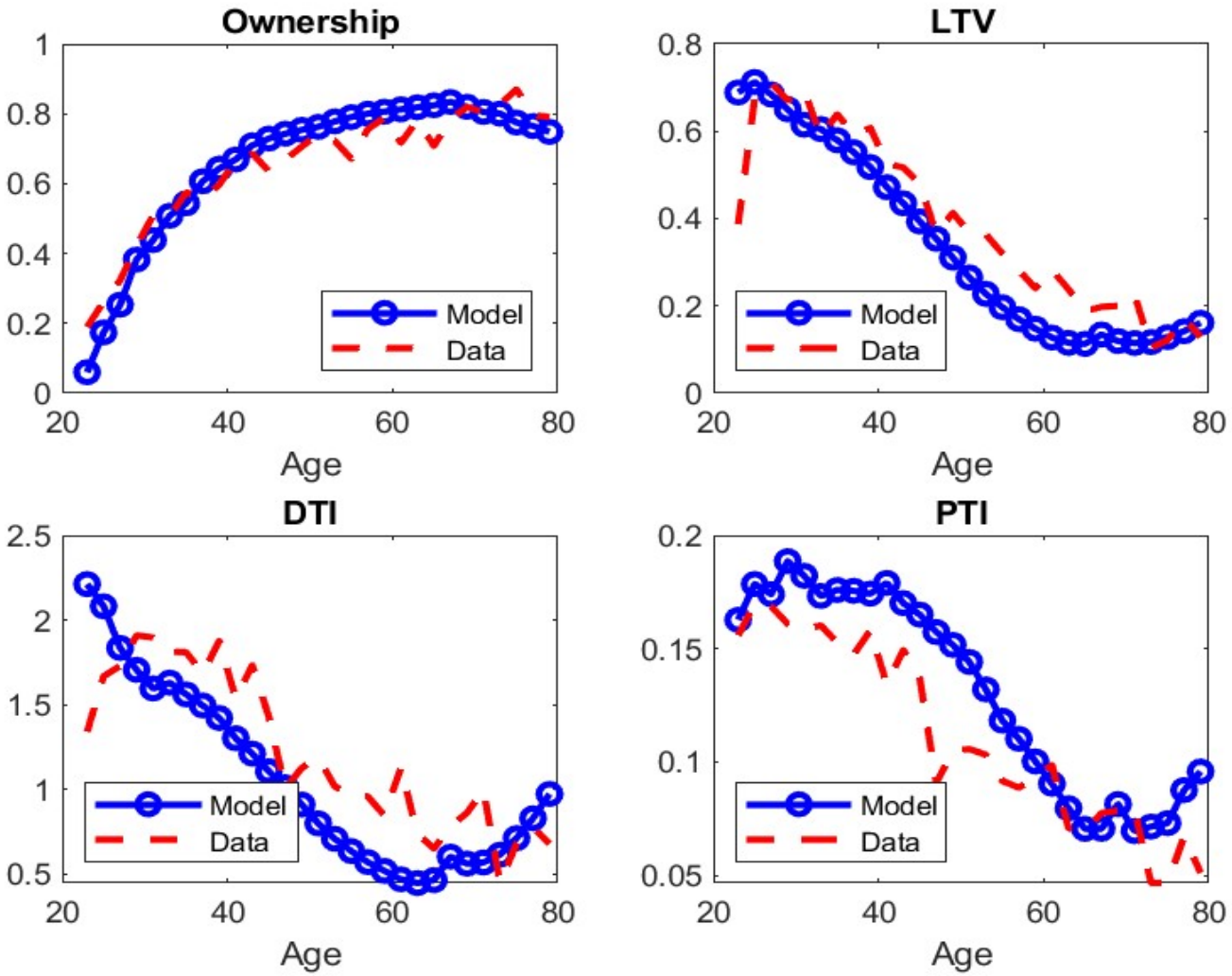
Calibrated Parameters

- Each period = 2 years
- Calibrate to age profile of (i)Homeownership rates (ii) LTV (iii)DTI (iv)PTI

Parameter		Value	Target
	Predetermined Parameters		
σ	Intertemporal Elasticity of Substitution	2	
$\frac{1}{\xi}$	Elasticity of substitution	1.25	
	Calibrated Parameters		
β	Discount Factor	0.9	LTV & DTI
η	Housing Share	0.27	PTI
θ	Ownership Premium	1.8	Homeownership Rate
$\underline{h}$	Minimum House Size	1.1	Homeownership Rate
$\bar{B}_0$	Bequest Motive	13	Homeownership Rate & Mortgage Loan
B_1	Bequest Motive	0.1	of Senior Households

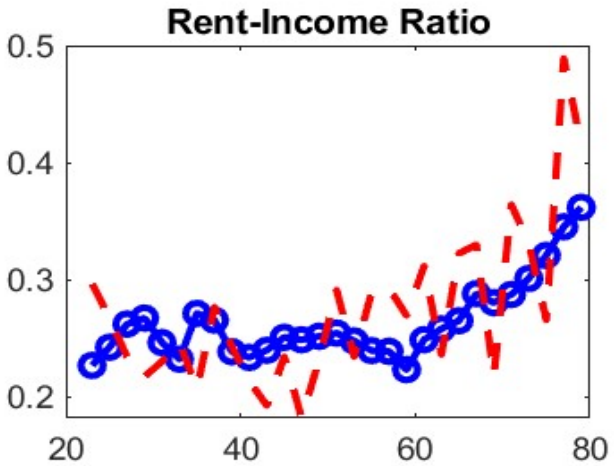
Calibration Results-Targeted Moments

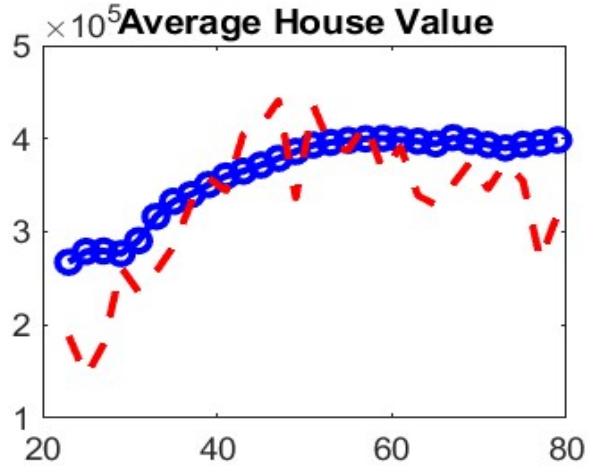
- Model does good job: 7 parameters and 160+ moments

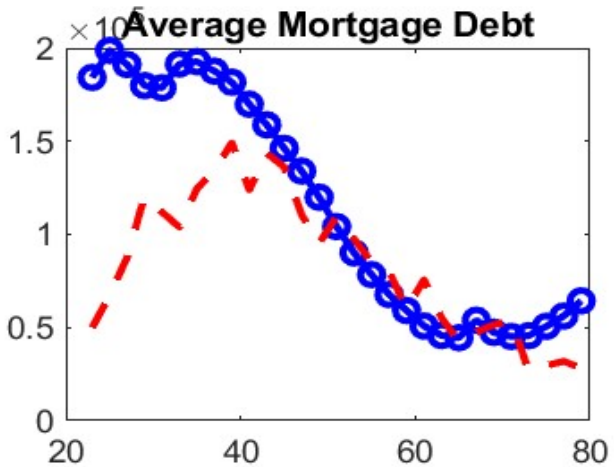


Calibration Results - NonTargeted Moments

- Model matches moments not targeted in calibration





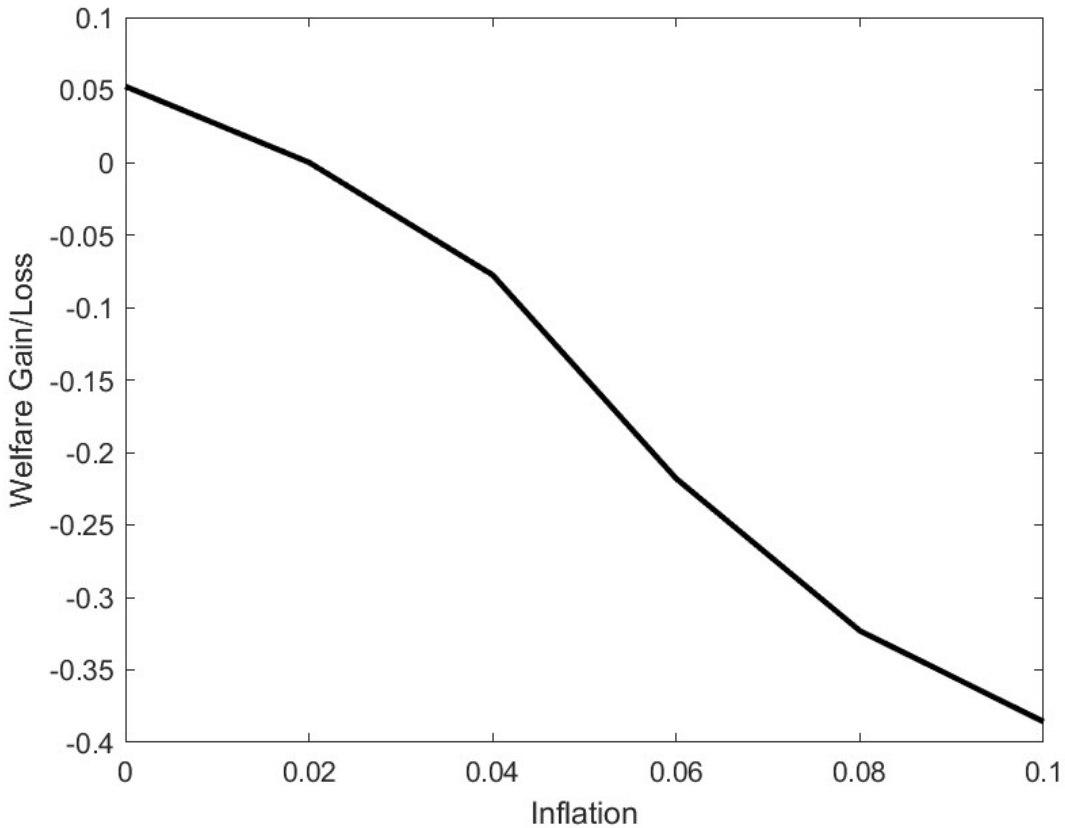


Welfare Cost of Inflation: General Equilibrium

- Higher inflation target affects welfare through two channels
  - Direct channel: tightens borrowing constraints for prime-age buyers ☹ ☹ ☹
  - Indirect channel: housing price adjusts which may partially alleviate welfare cost of high inflation (**General Equilibrium**) ☺ ☺
- To evaluate welfare cost/gain of inflation: vary inflation from 0 to 8% in calibrated model.
- Compute equilibrium price under different inflation rates and calculate expected value by changing inflation rates and house price

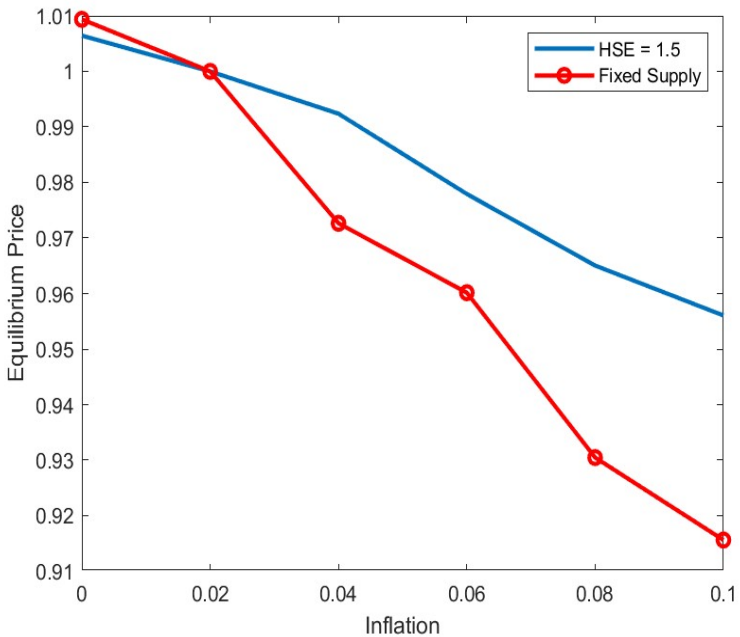
Welfare Cost of Inflation: Partial Equilibrium

- Fix Price and rent, 1 ppt increase in inflation leads to welfare cost comparable to 0.053% drop in life-time consumption
  - $\approx$ half of money demand based estimates of $\approx$ 0.1% (Lucas, 2000)



Welfare Cost of Inflation: General Equilibrium

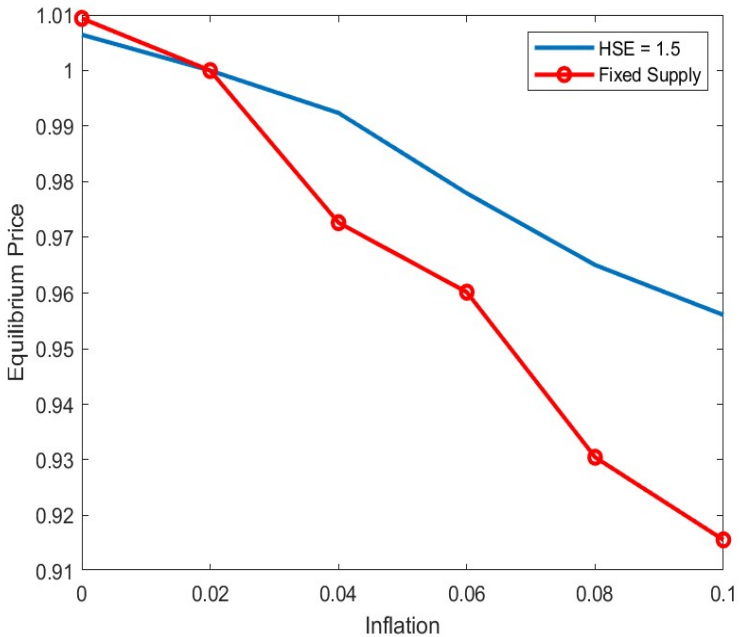
- Welfare Cost of inflation varies with housing supply elasticity
  $\rightarrow$ vary across cities



Steady State Price

Welfare Cost of Inflation: General Equilibrium

- Welfare Cost of inflation varies with housing supply elasticity
  $\rightarrow$ vary across cities
  - Mild inflation target can be welfare enhancing in cities with low supply elasticity



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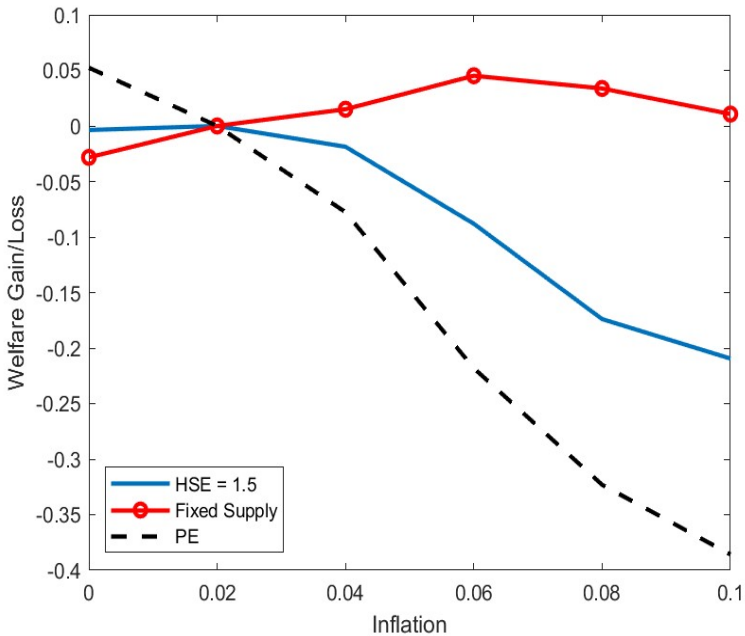
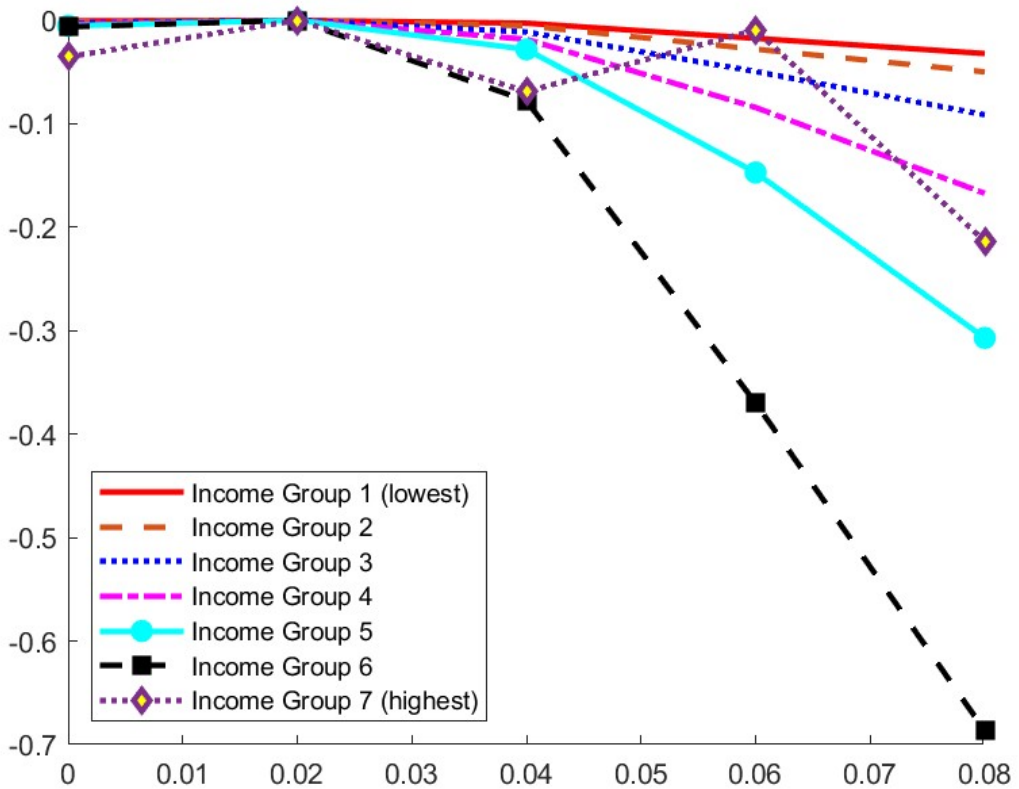


Welfare Loss/Gain

Heterogeneous Impact of Inflation across Income Groups

- Inflation has larger impact on upper middle-income households (HSE = 1.5) Fixed Supply Fixed Price



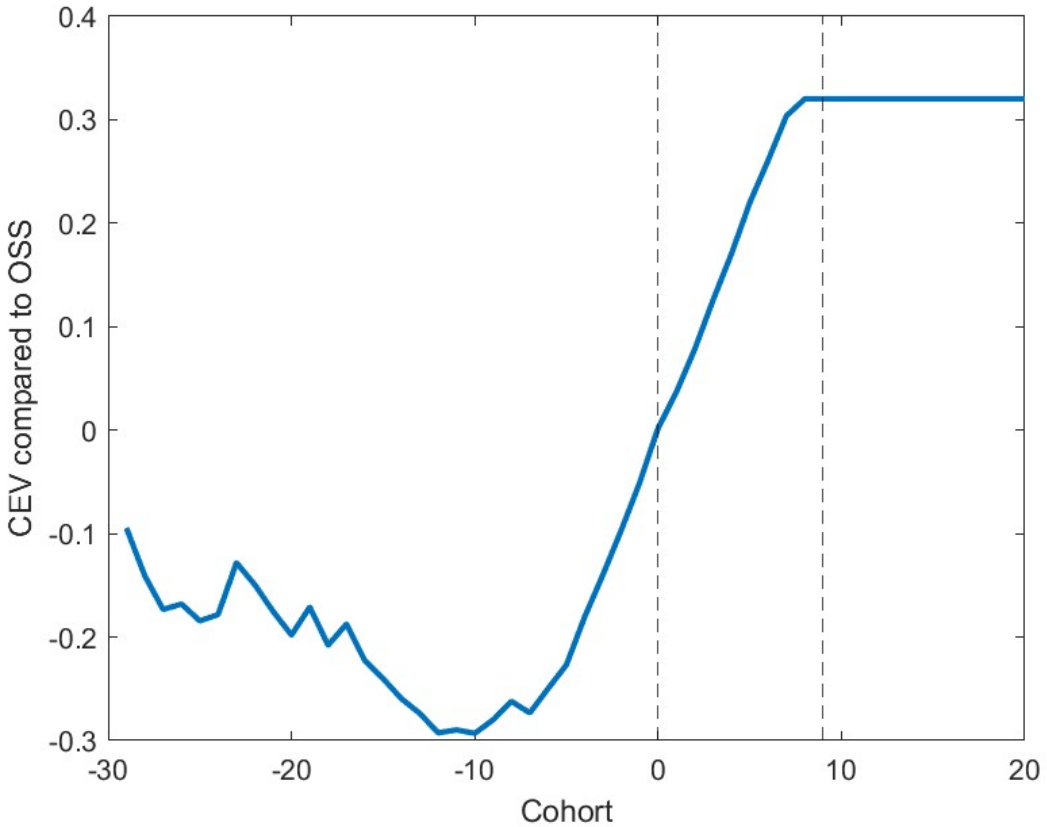
Transition Analysis

- Suppose we start with 8% inflation steady state and gradually bring inflation down to 2% in 8 periods (16 years)
  - Along inflation fall: mortgage interest is tied to inflation of period when mortgage contract was signed
  - Households refinance with a cost

Transitional Cost of Lower Inflation (PE)

- Start in 8% inflation steady state

  Announce inflation will decline to 2% in 9 periods (18 years)



Can Changing Mortgage Finance make Inflation less Costly?

- Consider two policies aiming at alleviating welfare cost of higher inflation
  1. Extending amortization from 30 to 36 year
  2. Removing cap on PTI $\Leftarrow$ more effective policy

Mortgage Payments and Amortization

Conclusion

- We show fixed nominal payment mortgages and borrowing constraints result in inflation distorting life cycle consumption
  - Path of mortgage payments are inflation dependent and rising inflation tightens owners borrowing constraints
- We quantify the welfare cost of inflation due to fixed nominal payments mortgages
  - Welfare cost of inflation through housing market is comparable to money demand based estimates – but a different mechanism
  - Uneven impact of inflation across cities and income groups
    - Cities with low supply elasticity see larger price drop and lower welfare cost of higher inflation
- Lowering inflation to transition to new steady state: Cost mostly born by prime-age buyers with largest mortgage debt when transition starts

Thank You!

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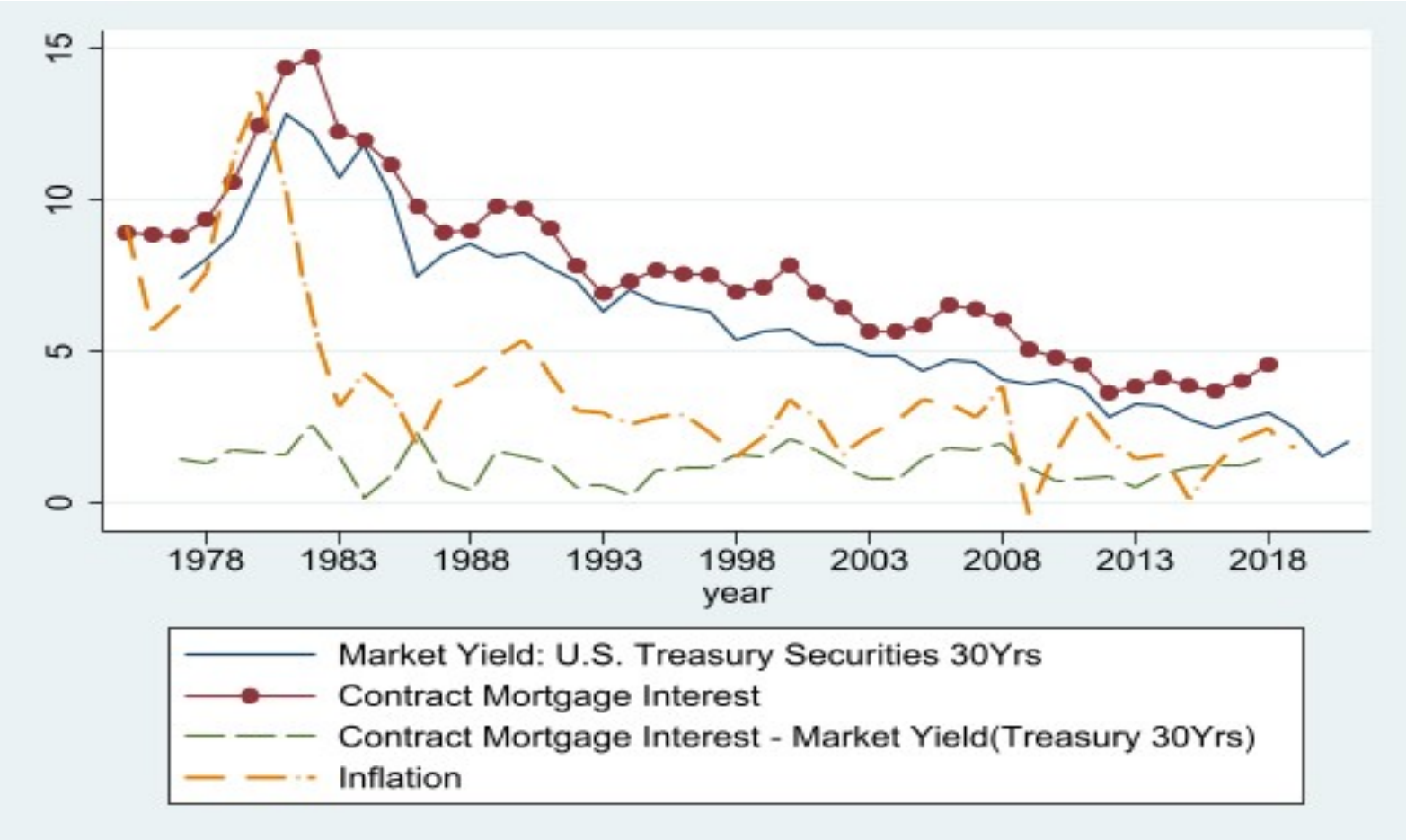
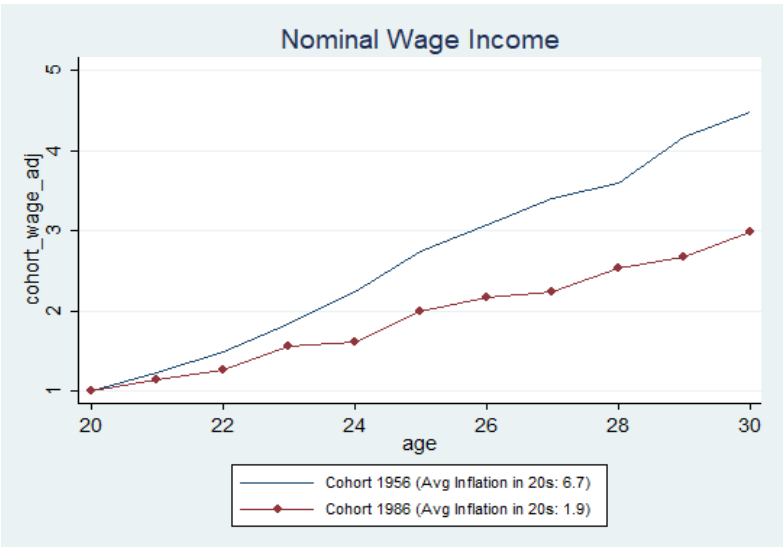
Mortgage Interest, Nominal Interest and Inflation

- Mortgage interest and nominal interest are both highly positively correlated with inflation



Inflation and Nominal Wage Growth

- Faster **nominal** income growth during high inflation era



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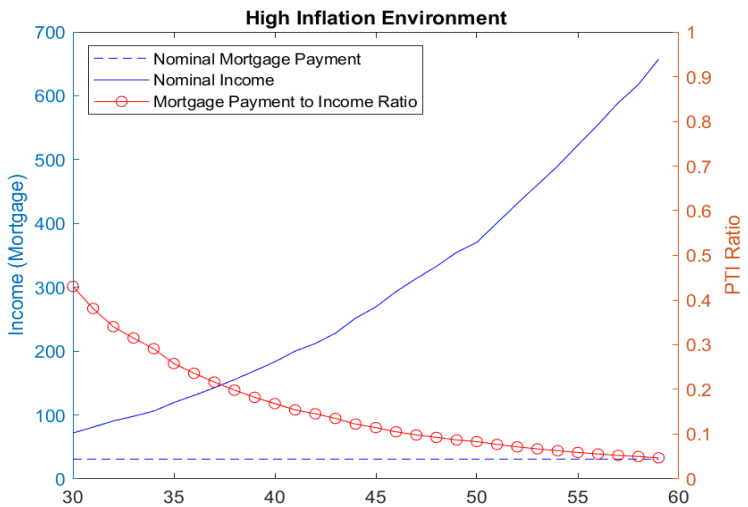
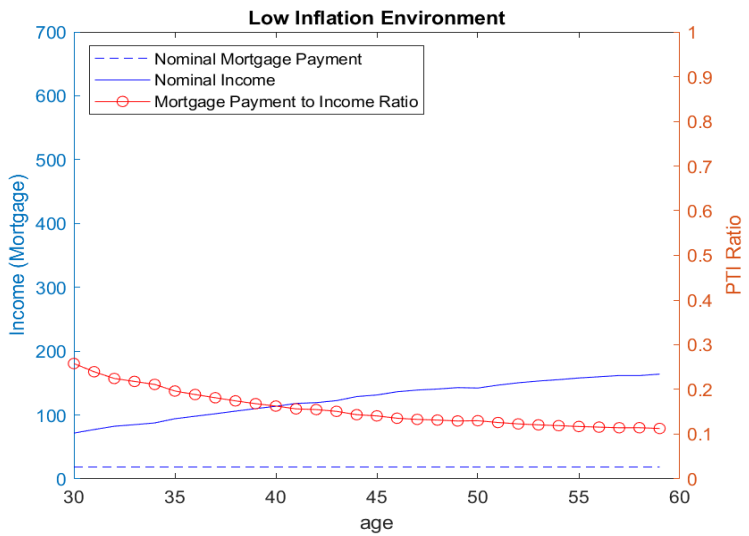
Front-loaded Real Payments

- A household with fixed real income path, takes a 30 year fixed rate mortgage loan with total value 300,000.
  - High Inflation: high annual nominal payment (30,871), high initial PTI(40%)
  - Low Inflation: low nominal annual payment (18,504), low initial PTI (28%)





Path of Real Payment

Model-Asset

Three types of asset

- Housing
  - Provide housing services
  - Cost: Depreciate with rate δ + property tax
  - Subject to transaction costs
  - Can be used as collateral to get mortgage
  - Subject minimum house size $\underline{h}$
- Saving: fix rate of return r
- Mortgage
  - 30-year fix rate mortgage: constant nominal payments over time
  - Downpayment requirement: 10%
  - Cap on payment-to-income ratio: 42%
  - Costly to obtain mortgage debt: mortgage closing cost

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Pre-determined Parameters

Parameter	Value	Source
Maximum of life length J	33	
Working life Jr	23	
Annual discount factor β	0.97	Standard in the literature
Equivalence scale e_j		Standard in the literature
Survival Probabilities s_j		National Center for Health Statistic
Annual risk free interest rate	2%	Standard in the literature
Annual inflation rate π	2%	Inflation target and realized inflation rates (2010-2019)
Mortgage spread ζ_m	0.25%	Federal Housing Finance Agency & Federal Reserve Bank
Annual property tax	1%	American Community Survey
Annual depreciation cost	2%	American Community Survey
Transaction cost for buyers	6%	Sommer et al. (2013)
Mortgage closing cost	0.64%	Federal Housing Fiance Agency
Annual auto correlation of earnings ρ	0.97	Kaplan et al. (2020)
Standard deviation of earning σ_ϵ	0.2	Kaplan et al. (2020)
Downpayment requirement χ	10%	LTV distribution
Cap on PTI φ	0.42	Dodd-Frank legislation
Tax schedule τ_0	4.787	Kaplan et al. (2020)
Tax schedule τ_1	0.151	Kaplan et al. (2020)
Replacement rate rpc	40%	Standard in the literature
Income Profile $\bar{w}_j$		American Community Survey

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Data

Construct moments from American Community Survey (2019), Survey of Consumer Finance (2019), and Life Table (CDC).

- Household Income (ACS 2019): wage income and social security income on household level
- Mortgage payment, Mortgage Debt (SCF 2019)
- LTV (SCF 2019)
- Homeownership rate (ACS 2019)

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Value Functions

- Choose to be a renter:

$$V^1(a,h,m,n,\epsilon,j,\theta;P_t)=\max_{c,d,a'}\frac{(c^{1-\eta}d^{\eta})^{(1-\sigma)}}{1-\sigma}+\beta_j s_j E_{\epsilon'|\epsilon,\theta'}(V(a',0,0,0,\epsilon',j+1,\theta';P_{t+1}))+\beta_j(1-s_j)B(a')$$

$$s.t.\ c+a'+Rd=y(m,n,\epsilon,j)+(1+r)a-(\delta+\tau_h)P_t h-\frac{m}{(1+\pi)^n}+(1-k_s)Ph-\frac{D(m,n)}{(1+\pi)^n}$$

- Owners choose to continue with the current mortgage contract:

$$V^2(a,h,m,n,\epsilon,j,\theta;p_t)=\max_{c,a'}\frac{(c^{1-\eta}(\theta h)^{\eta})^{(1-\sigma)}}{1-\sigma}+\beta_j s_j E_{\epsilon'|\epsilon,\theta'}(V(a',h,m,n+1,\epsilon',j+1;p_t)_{n<30}$$

$$+V(a',h,0,0,\epsilon',j+1;p_t)_{n=30})+\beta_j(1-s_j)B(W_T)$$

$$s.t.\ c+a'=y(m,n,\epsilon,j)+(1+r)a-(\delta+\tau_h)P_t h-\frac{m}{(1+\pi)^n}.$$

- Choose to be an owner with new mortgage contract

$$V^3(a,h,m,n,\epsilon,j,\theta;P_t)=\max_{c,h',m',a'}\frac{(c^{1-\eta}(\theta h')^{\eta})^{(1-\sigma)}}{1-\sigma}+\beta_j s_j E_{\epsilon'|\epsilon}(V(a',h',m',1,\epsilon,j+1;P_t))+\beta_j(1-s_j)B(W_T)$$

$$s.t.\ c+a'+P_t h'=y(m,n,\epsilon,j)+(1+r)a-(\delta+\tau_h)P_t h-\frac{m}{(1+\pi)^n}-(k_s P_t h+k_b P_t h')_{h\neq h'}$$

$$+P_t h-\frac{D(m,n)}{(1+r)^n}+(1-\tau_m)\frac{m(1-(1+r_m)^{-30})}{r_m}$$

Debt Evolution

- Nominal mortgage payment schedule of a L dollar value loan is for each year is denoted as

$$m = \frac{r_m L}{1 - (1 + r_m)^{-30}}.$$

Real mortgage payment for a loan L that was issued $n \in \{1, 2, ..., 30\}$ years ago is

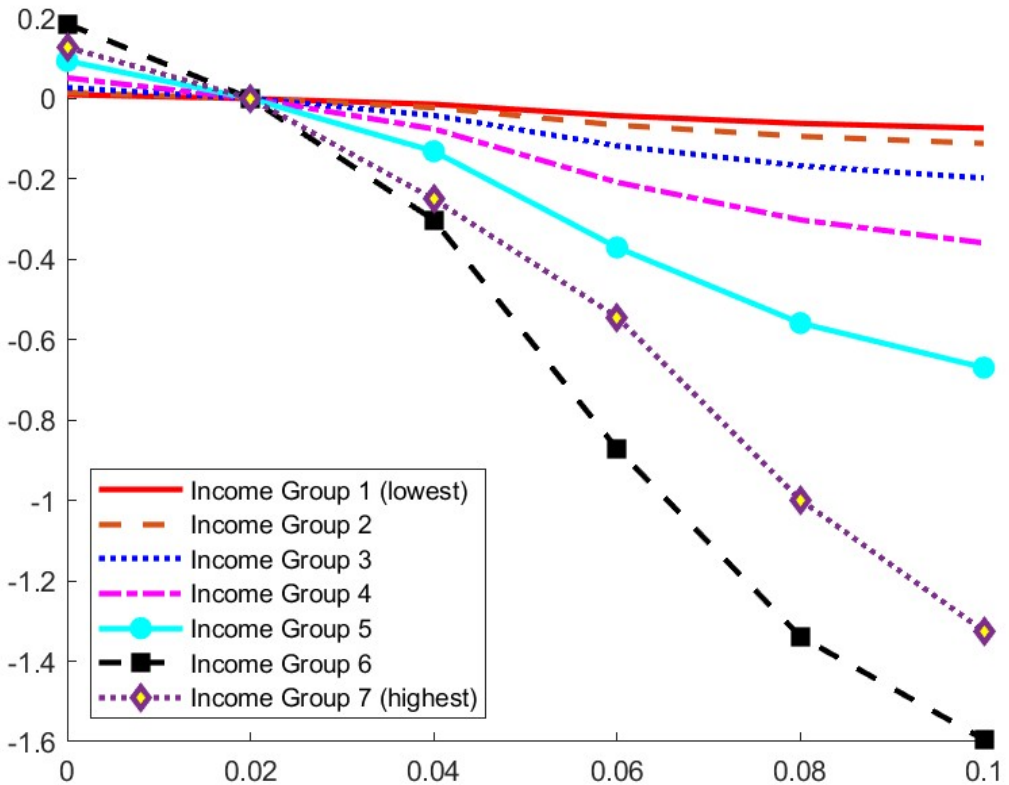
$$\frac{r_m L}{(1 - (1 + r_m)^{-N})(1 + \pi)^n}$$

The evolution of the nominal debt of a mortgage contract issued n years ago, which specifies a nominal payment m is described by

$$D(m, 0) = \frac{m(1 - (1 + r_m)^{-30})}{r_m}$$

$$D(m, n) = (1 + r_m)D(m, n - 1) - m, \quad n \in \{1, 2, ..., 30\}$$

Heterogeneous Impact of Inflation: PE



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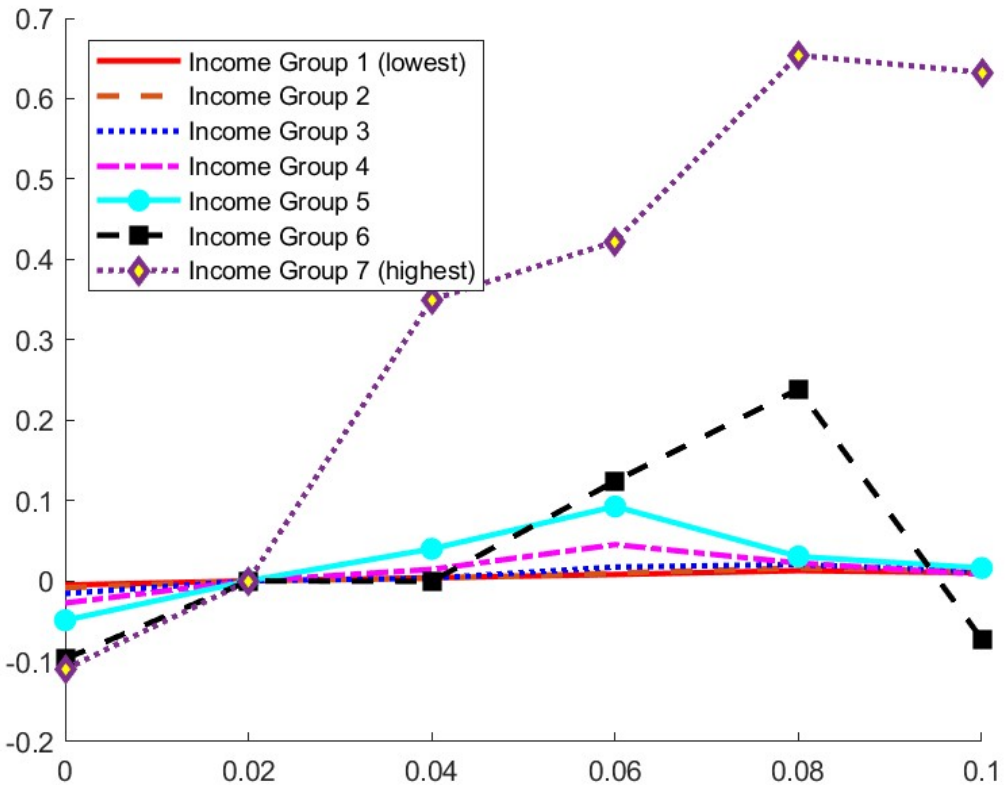
Heterogeneous Impact of Inflation: PE



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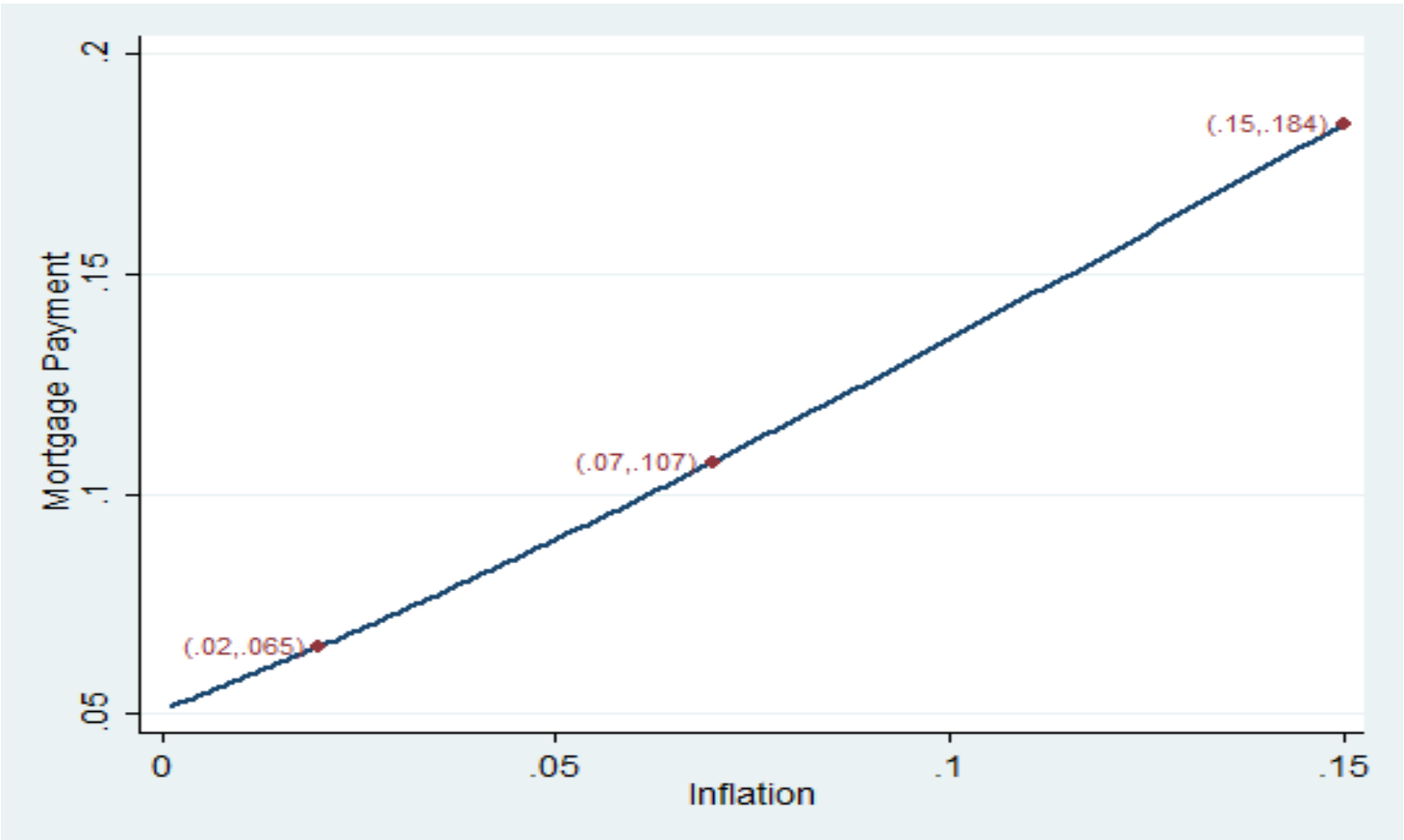
Appendix: Statistics on Mortgage Holders

	LTV $<$=0.85	LTV $>$0.85
Interest	3.99 (LTV $\sim$=0)	4.48
House Value	313576	190986
Mortgage Debt	93497	183944
DSR(Payment to Income)	0.11	0.22
Income	138989	88624
LTV	0.30	0.99

Initial Nominal Mortgage Payments and inflation

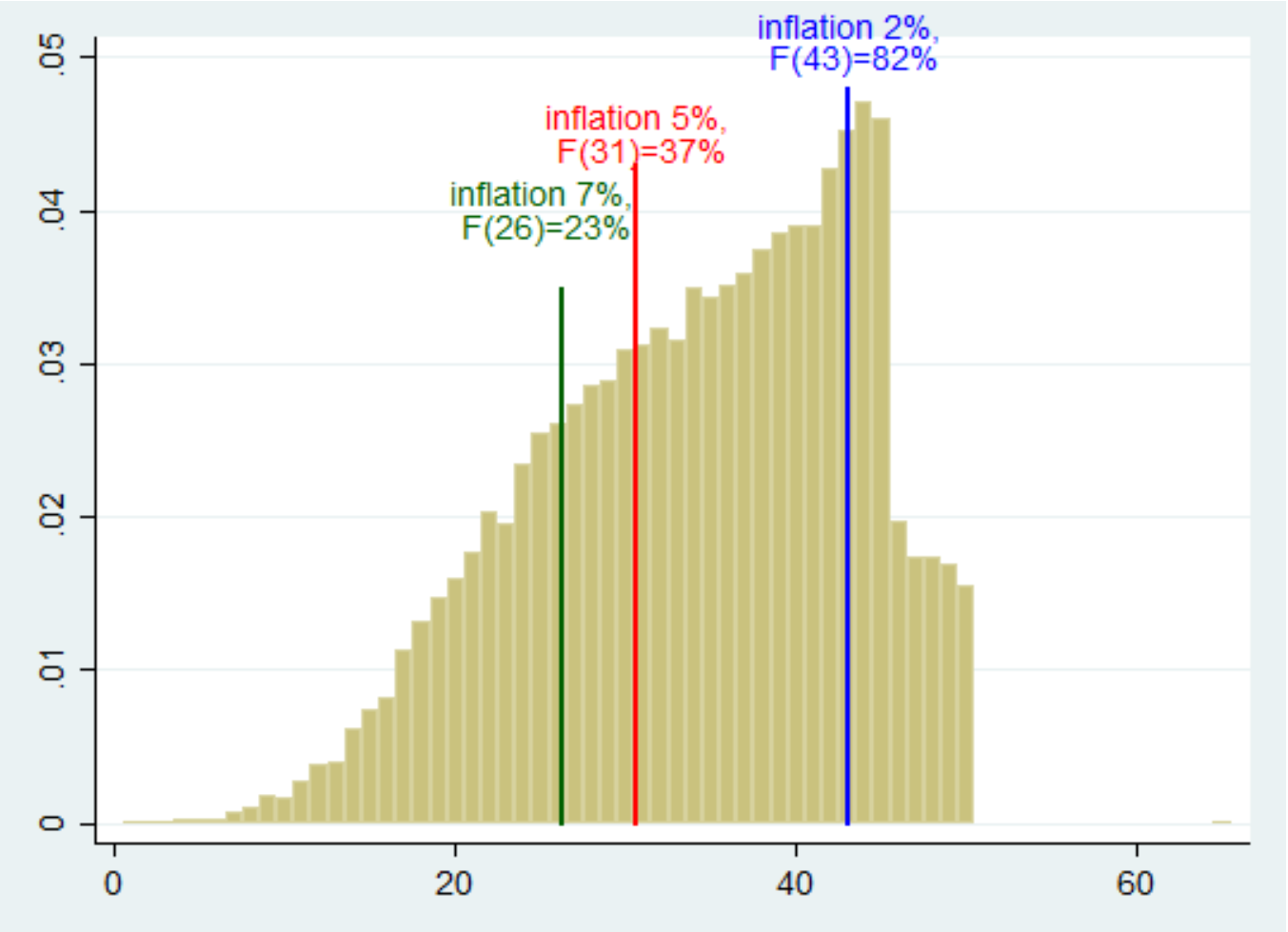
- Initial nominal mortgage payments increases in inflation:

$$m = \frac{r_m}{1 - \frac{1}{(1+r_m)^N}}, 1 + r_m = (1 + r)(1 + \pi) + \delta$$



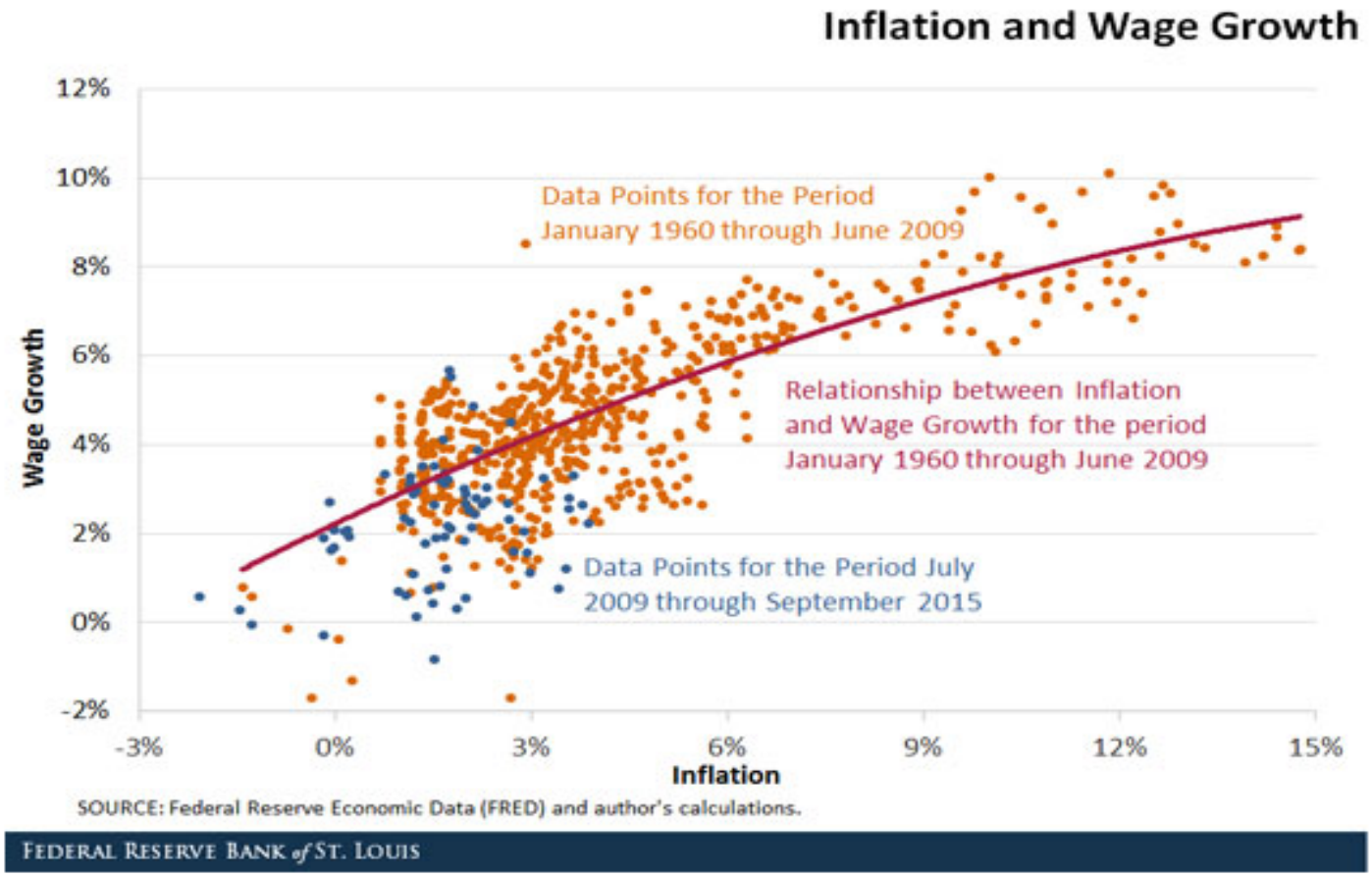
Cap on PTI and inflation

Figure 1: Distribution of Payment-to-Income Ratios: 2016



Nominal Wage Growth and Inflation

- Nominal wage grows faster in high inflation environment



Sanchez (2015)

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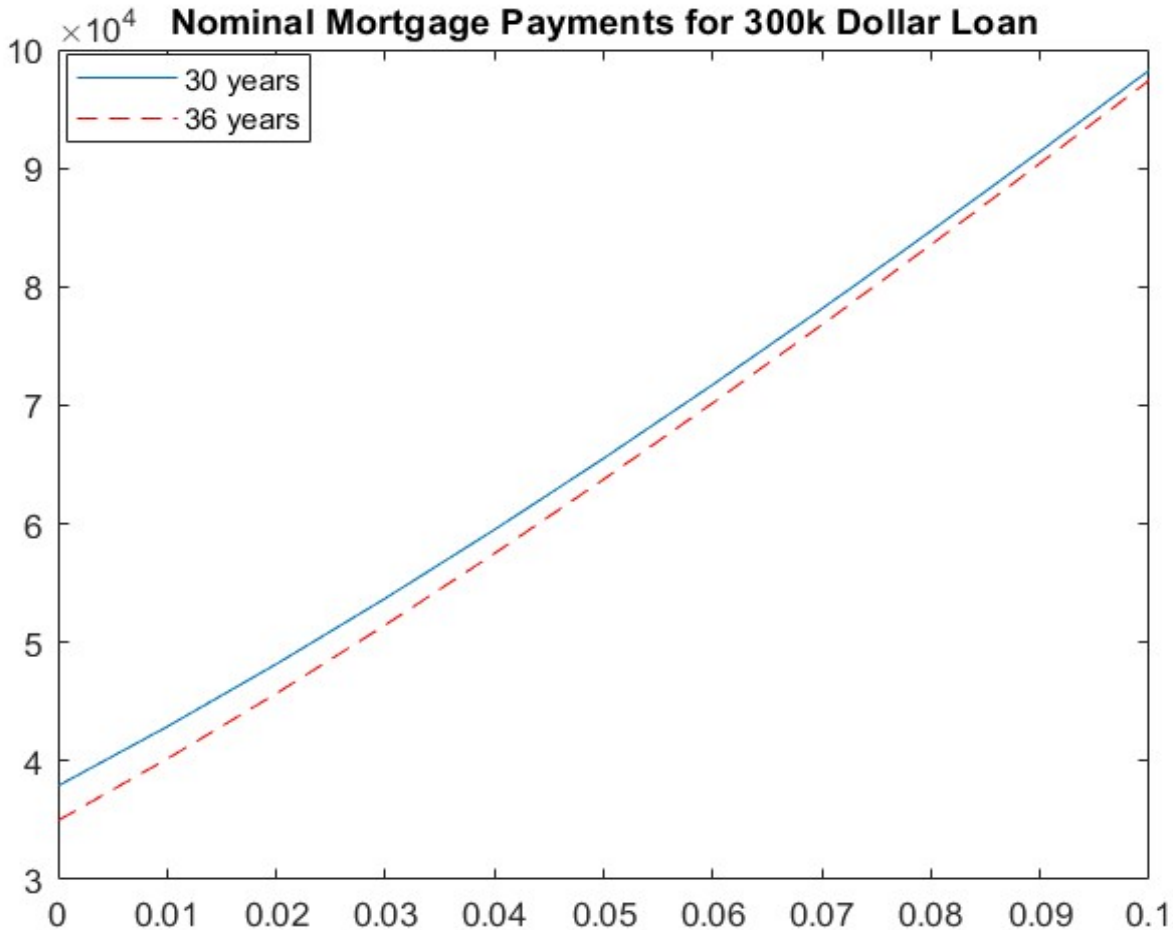
Mortgage payments and amortization

- Nominal Mortgage payments and amortization



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