The effects of monetary policy through housing and mortgage choices on aggregate demand

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Motivation

- Since the Great Recession mortgage and housing markets have been a concern for many central banks
  - 40 percent of households in the U.S. have a mortgage, mortgage debt corresponds to 70 percent of GDP
  - Owned housing is the largest asset on most households' balance sheets

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  - Owned housing is the largest asset on most households' balance sheets
- A large theoretical and empirical literature suggests that liquidity-constrained households often respond strongly to changes in their cash flows
- Monetary policy can substantially influence households' cash flows by affecting their mortgage and housing choices

Research question

- What role do mortgages and housing play in the transmission of monetary policy?
  - To what extent does monetary policy affect aggregate demand by influencing households' housing and mortgage choices?
  - What role does changes in mortgage interest rates and house prices play?
  - Do aggregate responses depend on the type of mortgages that are used? Fixed-rate vs adjustable-rate mortgages

Method

- A heterogeneous-agent life-cycle model to trace out aggregate consumption demand as a function of a real interest rate path
  - Mortgage and housing markets are modeled in detail, and house prices are endogenous
  - Incomplete markets and illiquid housing equity
  - Wealthy hand-to-mouth households
  - Relatively poor households with large exposures to interest-rate shocks

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  - Incomplete markets and illiquid housing equity
  - Wealthy hand-to-mouth households
  - Relatively poor households with large exposures to interest-rate shocks
- Focus on the mechanisms on the demand side
  - Choices in the mortgage and housing markets
  - Heterogeneous cash-flow effects
  - Mortgage-market specifications

Preview of Results

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- About half of the increase in aggregate demand is driven by a relatively small share of households who update their discrete mortgage and housing choices
  - Households who adjust their tenure choice and, by doing so, improve their liquidity explain 21 percent of the response in demand
  - Together with households who use cash-out refinancing, they are the main contributors to the aggregate demand response

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  - Households who adjust their tenure choice and, by doing so, improve their liquidity explain 21 percent of the response in demand
  - Together with households who use cash-out refinancing, they are the main contributors to the aggregate demand response
- These mechanisms are more pronounced when mortgages have adjustable as opposed to fixed rates: the aggregate consumption response is larger
- The flexibility of both the mortgage *and* the housing market matters for the transmission of monetary policy

Literature Review

- Empirical studies on importance of mortgages for monetary policy

  Calza, Monacelli, and Stracca (2013); Di Maggio, Kermani, Keys, Piskorski, Ramcharan, Seru, and Yao (2017); Cloyne, Ferreira, and Surico (2019); Flodén, Kilström, Sigurdsson, and Vestman (2021); Wong (2021)

- Importance of liquid and illiquid wealth for fiscal and monetary policy

  Kaplan and Violante (2014); Kaplan, Moll, and Violante (2018); Auclert (2019)

- Mortgages and housing, and monetary policy

  Beraja, Fuster, Hurst, Vavra (2019); Berger, Milbradt, Tourre, Vavra (2021); Chen, Michaux, Roussanov (2013); Eichenbaum, Rebelo, Wong (2020); Garriga, Kydland, Sustek (2017); Greenwald (2018); Hedlund, Karahan, Mitman, Ozkan (2019); Wong (2021)

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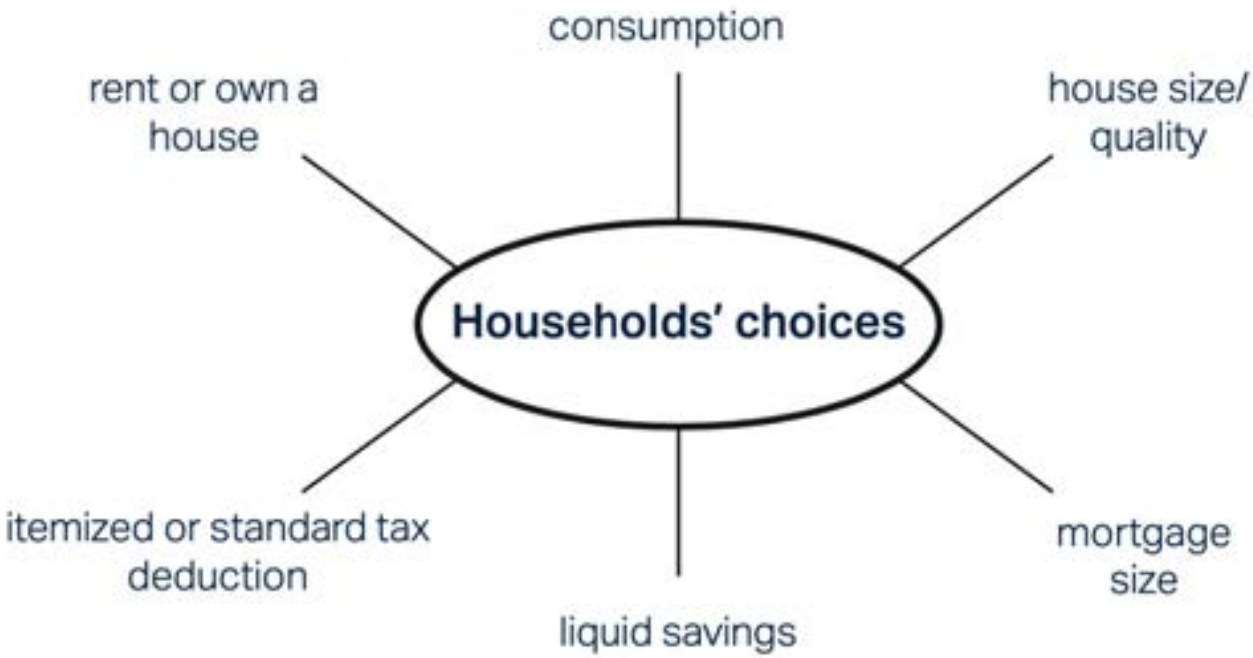
Model overview

A heterogeneous-agent incomplete-markets life-cycle model to investigate how consumers respond in the aggregate to a real interest rate shock



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- $U_j(c, s) = e_j \frac{\left(c^\alpha s^{1-\alpha}\right)^{1-\sigma}}{1-\sigma}, \quad U^B(q) = \upsilon \frac{\left(q' + \bar{q}\right)^{1-\sigma}}{1-\sigma}$

Markets

- The housing market
  - Fixed aggregate housing supply, but divisible owned and rental housing
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  - Transaction costs when buying and selling a house
  - Rental housing is owned by foreign investors, and the rental rate is given by a user-cost formula rental market

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  - Rental housing is owned by foreign investors, and the rental rate is given by a user-cost formula rental market
- The mortgage market
  - Possibility to finance owned housing with 30-yr non-defaultable mortgages
  - Amortization plans specify the required minimum mortgage payment
  - Down-payment and payment-to-income requirements (LTV & PTI)
  - Fixed and proportional refinancing costs, ς^r and ς_p^r
  - Mortgage interest payments (and property taxes) are deductible, and earnings are taxed progressively taxes

Households' dynamic problem

For each $k \in \{R, B, Ref, S\}$, and $\mathbf{z} = \{h, m, ma, n, x\}$:

$$V_j^k(\mathbf{z}) = \max_{c,s,h',m',b'} U_j(c,s) + (1-\phi_j)U^B(q') + \beta\phi_j \mathbb{E}_j \left[V_{j+1}(\mathbf{z}')\right]$$

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s.t.

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$$\mathbb{I}^{B,Ref} m' \leq (1-\theta)p_h h' \qquad \text{LTV constraint}$$

$$\mathbb{I}^{B,Ref}\left(\frac{\chi_{j+1,ma} m' + (\tau^h + \varsigma^I)p_h h'}{n}\right) \leq \psi \qquad \text{PTI constraint}$$

$$\mathbb{I}^S m' \leq (1+r_m)m - \chi_{j,ma} m \qquad \text{Min payment}$$

$$s = h' \qquad \text{if } h' > 0$$

$$m' \geq 0 \qquad \text{if } h' > 0$$

$$m' = 0 \qquad \text{if } h' = 0$$

$$c > 0, s \in S, h' \in H, b' \geq 0.$$

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Calibration

- Parameters that can be directly calibrated from data are set in that way

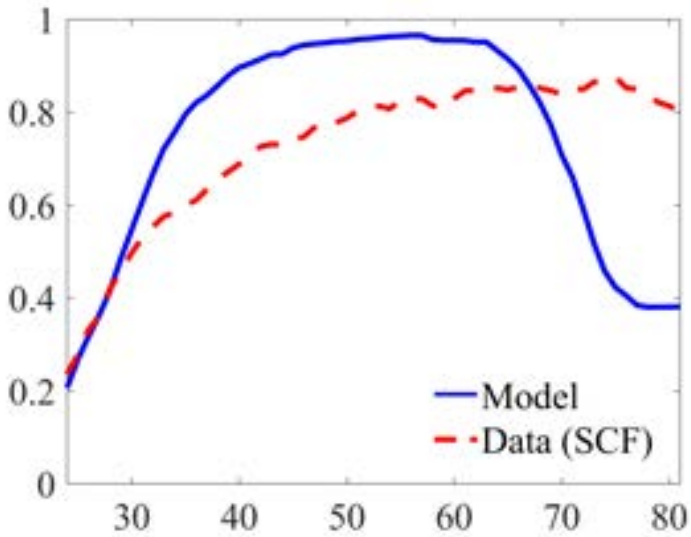
Independently calibrated parameters

- That leaves 10 parameters that are calibrated internally to match cross-sectional and life-cycle moments, e.g.,
  - The homeownership rate
  - Housing wealth relative to earnings
  - Leverage
  - Prevalence of refinancing

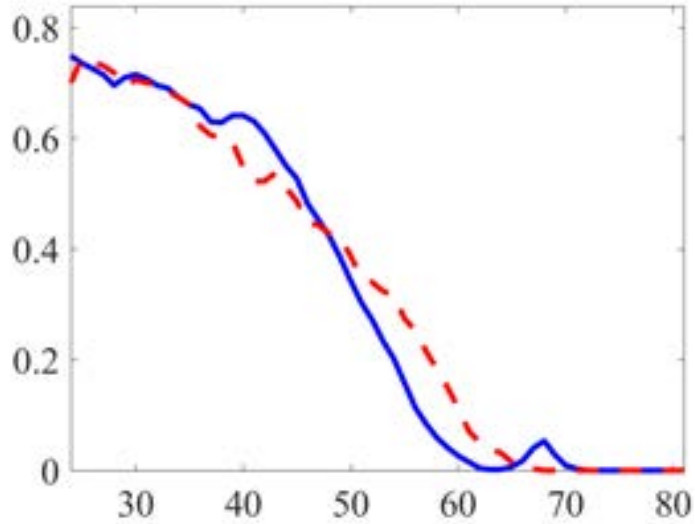
Internally calibrated parameters

Life-cycle profiles

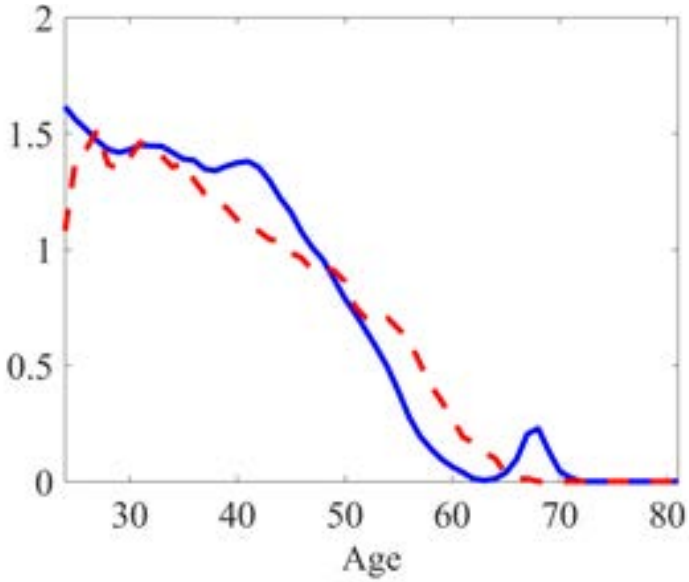
Homeownership rate



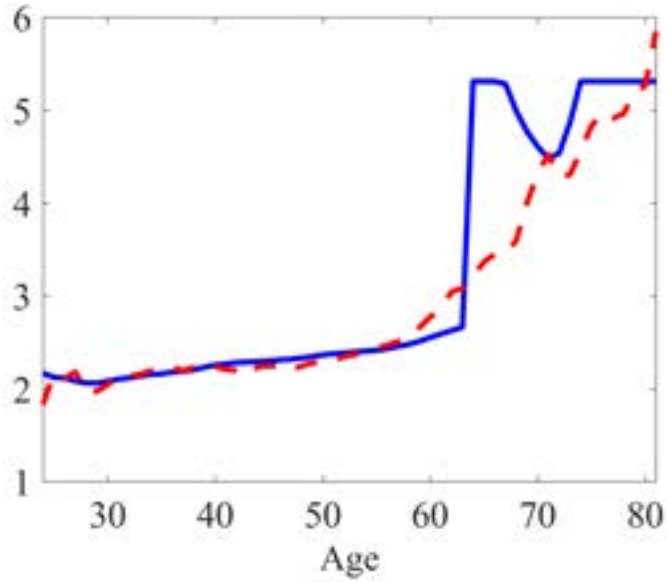
Median LTV



Median mortgage-to-earnings



Median house-to-earnings



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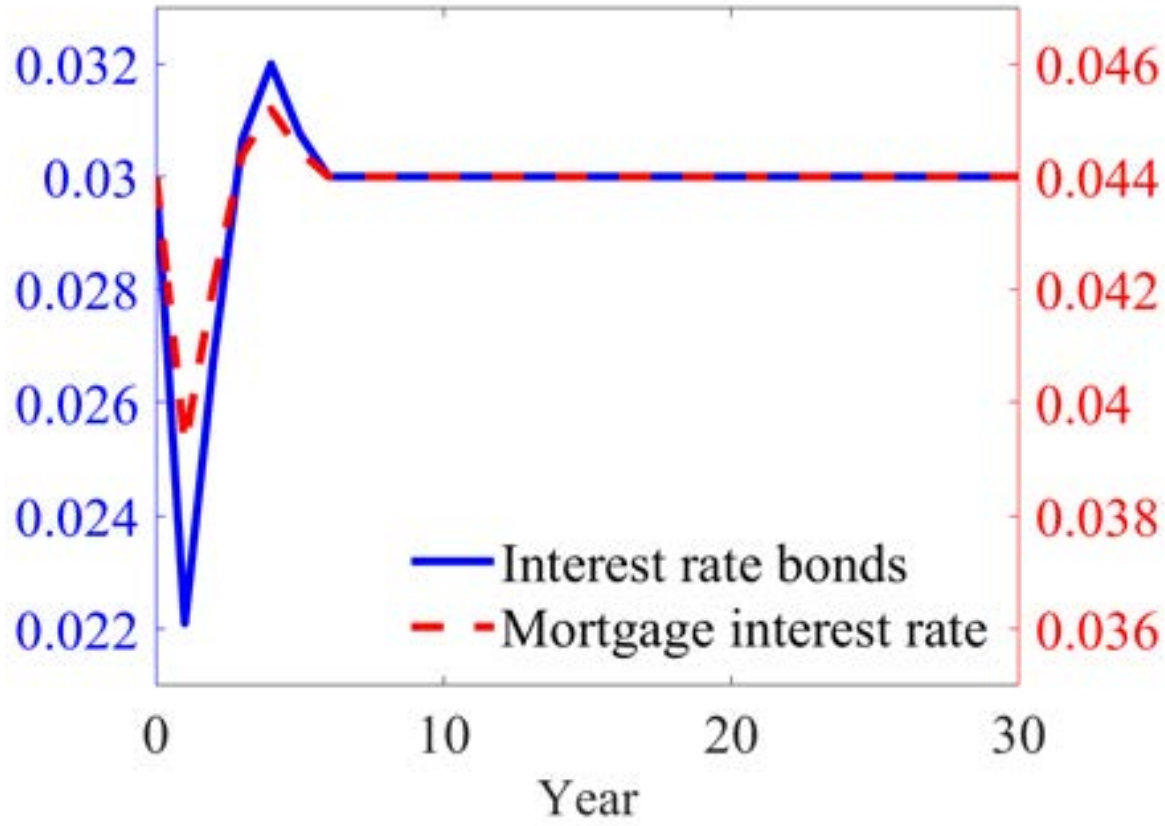
The experiment

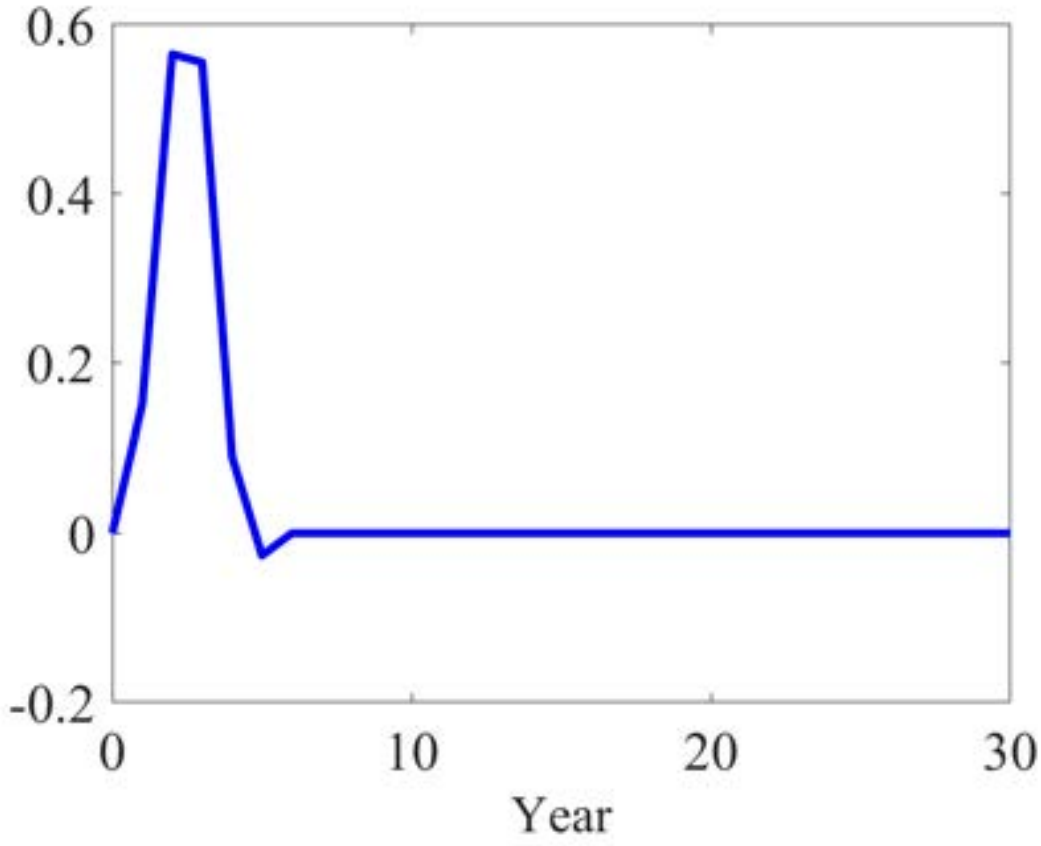
- Start from steady state with an invariant distribution over households
- Study non-linear impulse response functions to a probability zero shock to the real interest rate
- Following Boppart, Krusell, and Mitman (2018) can use IRFs to provide a linearized solution to the model with aggregate risk (i.e. only first-order effects of aggregate shock, as with standard first-order perturbation)

The real interest rate shock



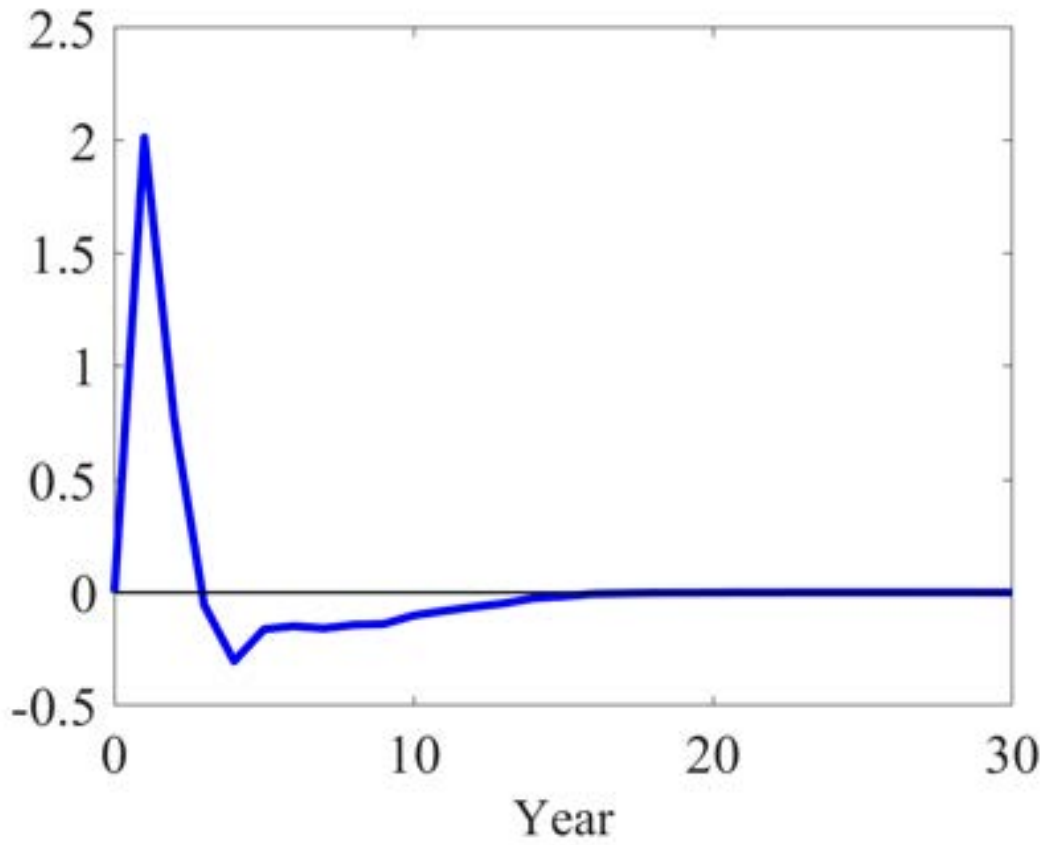
- -100bp monetary policy shock
- Empirically estimated path of the real interest rate, from Auclert, Rognlie, and Straub (2020)
- 60% pass-through to 30-yr rate of fixed-rate mortgages (FRM)

The path of income



- Empirically estimated path of output, also from Auclert et al. (2020)

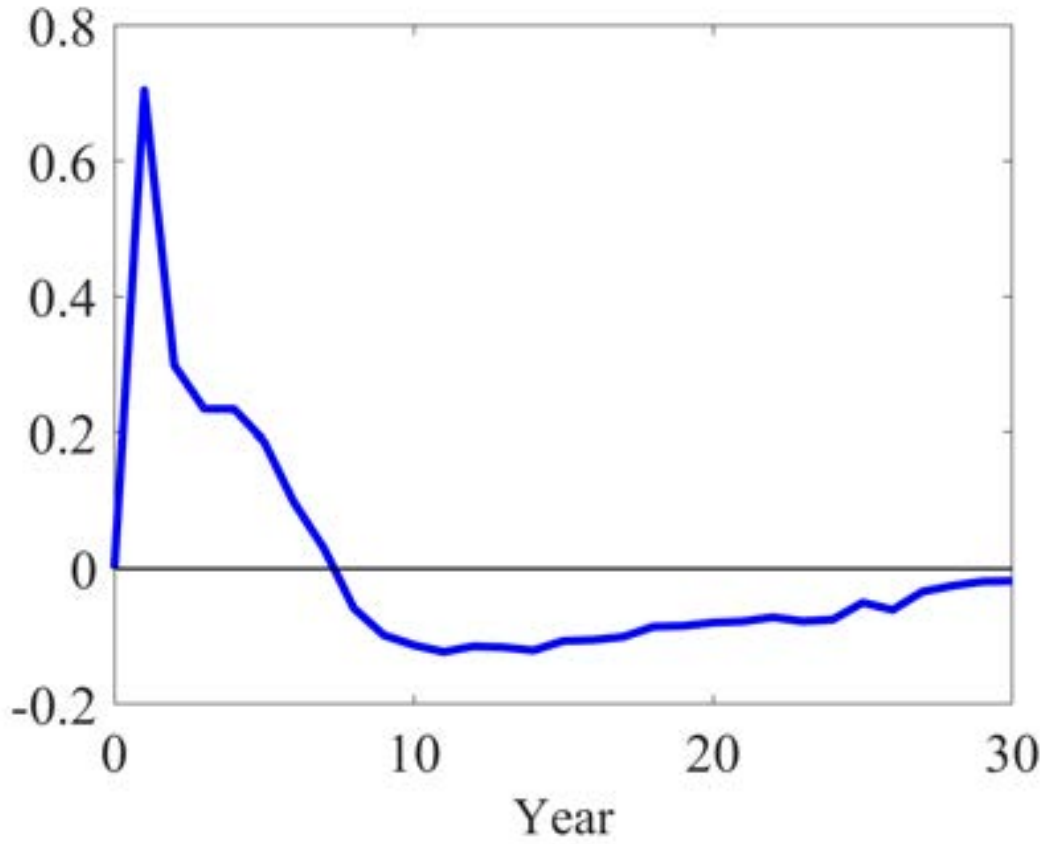
Equilibrium house prices



- House prices increase in response to expansionary monetary policy
- In line with empirical findings

Rental rate

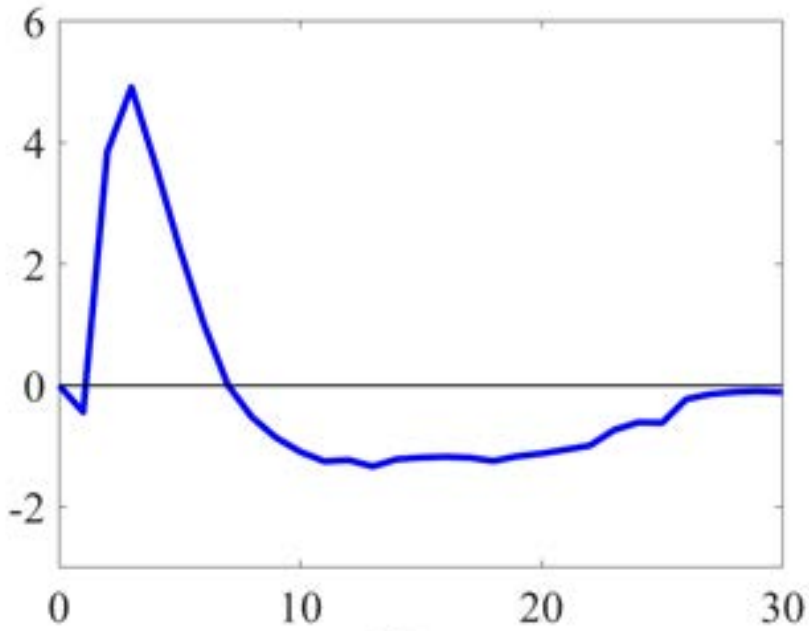
Response of consumption



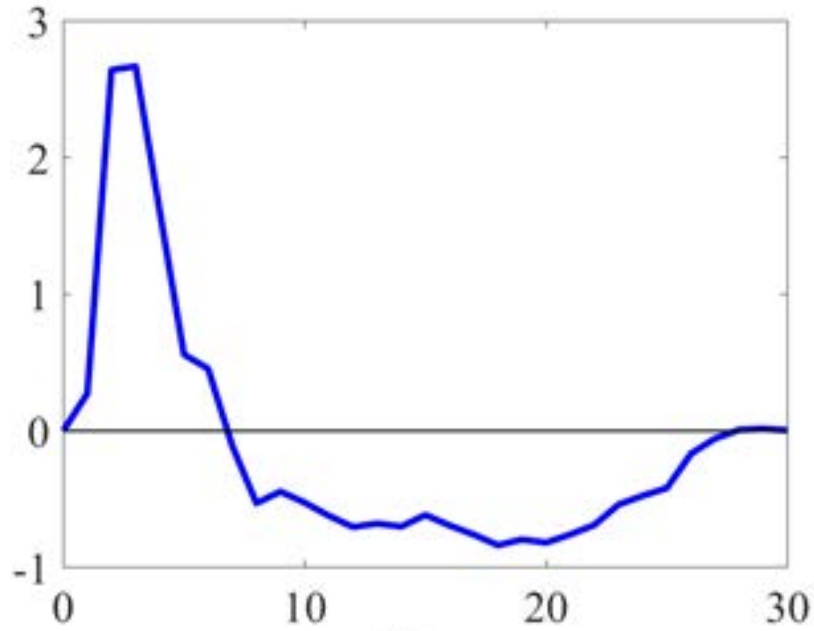
Changes in discrete choices over time

Savings behavior

Liquid savings



Mortgages



- Savings in liquid bonds actually increase...
- ... While the aggregate mortgage balance also increases

The mechanisms: prices and discrete choices

First period of the transition, Δ consumption (%):

	$\Delta\ r$	$+\ \Delta\ r_m$	$+\ \Delta\ p_h$	$+\ \Delta\ y$
Δ C	0.06	0.18	0.29	0.70

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Δ C, optimal portfolio choices	0.70
Δ C, steady-state discrete choices	0.34

Half of the aggregate demand response is driven by households' discrete portfolio updates

Discrete choices & consumption

Mean Δ consumption (%)

	Buyers	Refinancers	Movers	Stayers	Renters
Buyers	0.2	-	-	-	7.8
Refinancers	-	1.8	14.4	-10.9	14.1
Movers	-	7.6	1.5	-12.2	0.2
Stayers	-	14.3	6.9	0.1	27.7
Renters	-4.2	-11.9	-3.6	-18.3	0.6

Discrete choices & consumption

Mean Δ consumption and shares of households (%)

	Buyers	Refinancers	Movers	Stayers	Renters
Buyers	0.2 (2.4)	-	-	-	7.8 (0.5)
Refinancers	-	1.8 (4.7)	14.4(0.2)	-10.9 (0.4)	14.1 (0.0)
Movers	-	7.6 (0.1)	1.5 (2.3)	-12.2 (0.3)	0.2 (0.2)
Stayers	-	14.3 (2.0)	6.9 (0.8)	0.1 (59.5)	27.7 (0.4)
Renters	-4.2 (0.3)	-11.9 (0.1)	-3.6 (0.1)	-18.3 (0.3)	0.6 (25.9)

5.7 percent of households make an extensive-margin portfolio adjustment, due to the shock

The role of changes in liquid savings

Mean Δ consumption (%), red indicates that liquid savings increase on average

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Changes in liquid savings

The role of changes in liquid savings

Cash-out refinance, due to the shock

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The role of changes in liquid savings

Update tenure choice and increase liquid savings, due to the shock

- move to a new house
- choose to rent instead of own

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Contributions to overall Δ consumption

	Buyers	Refinancers	Movers	Stayers	Renters
Buyers	0.01	-	-	-	0.04
Refinancers	-	0.16	0.03	-0.05	0.00
Movers	-	0.01	0.04	-0.03	0.00
Stayers	-	0.45	0.06	0.13	0.08
Renters	-0.01	-0.01	-0.00	-0.04	0.15

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Contributions to overall Δ consumption

Those who update tenure choice and increase liquid savings, due to the shock, account for 21% of the increase in aggregate demand

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Contributions to overall Δ consumption

Those whose updated discrete choice leads to less liquid savings contribute with negative 14% to the increase in aggregate demand

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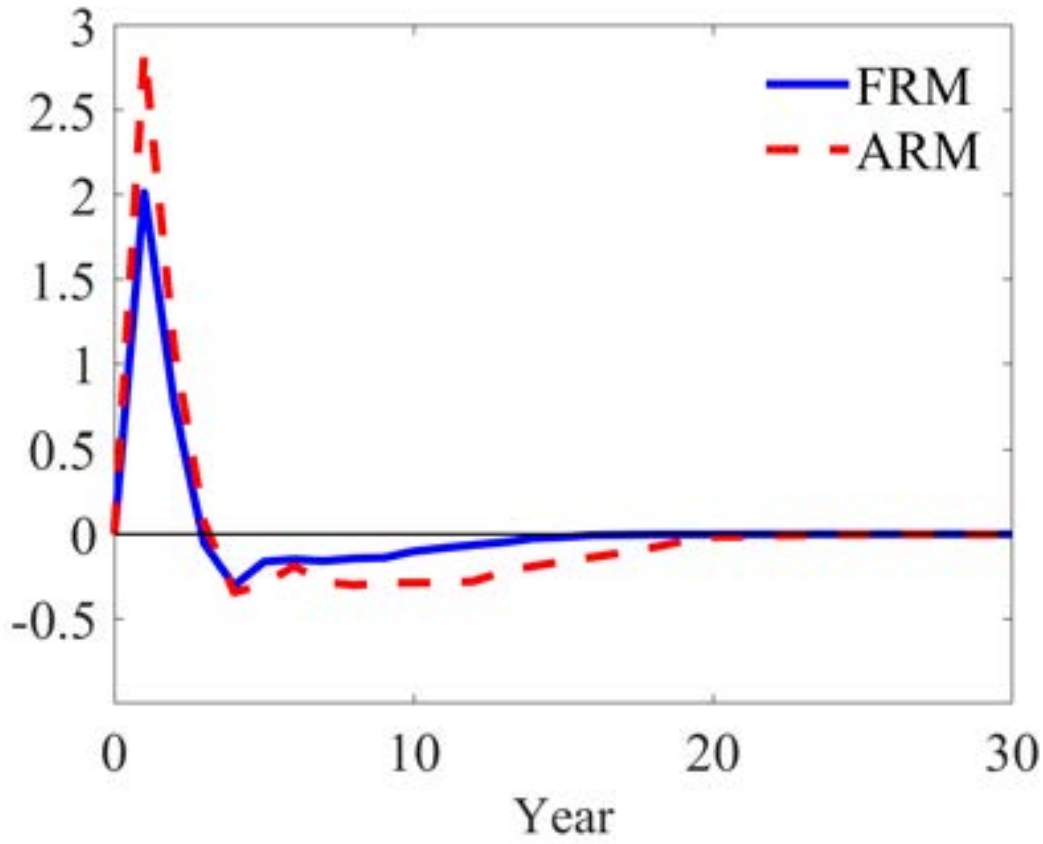
Summary discrete choices

FRM vs ARM

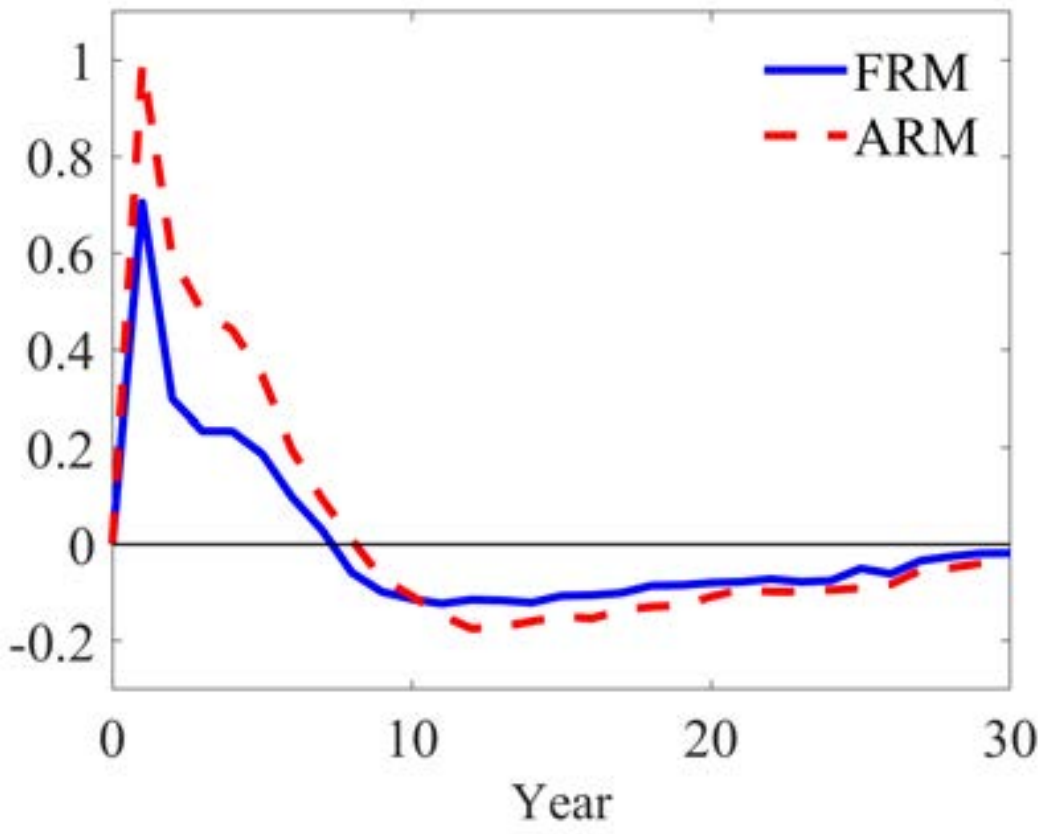
The real interest rate shock

Equilibrium house prices



- Consistent with empirical findings (see, e.g., Calza et al. (2013)), house prices respond stronger in economies with more variable-rate contracts

Response of consumption



- The initial response of consumption is significantly larger under ARMs

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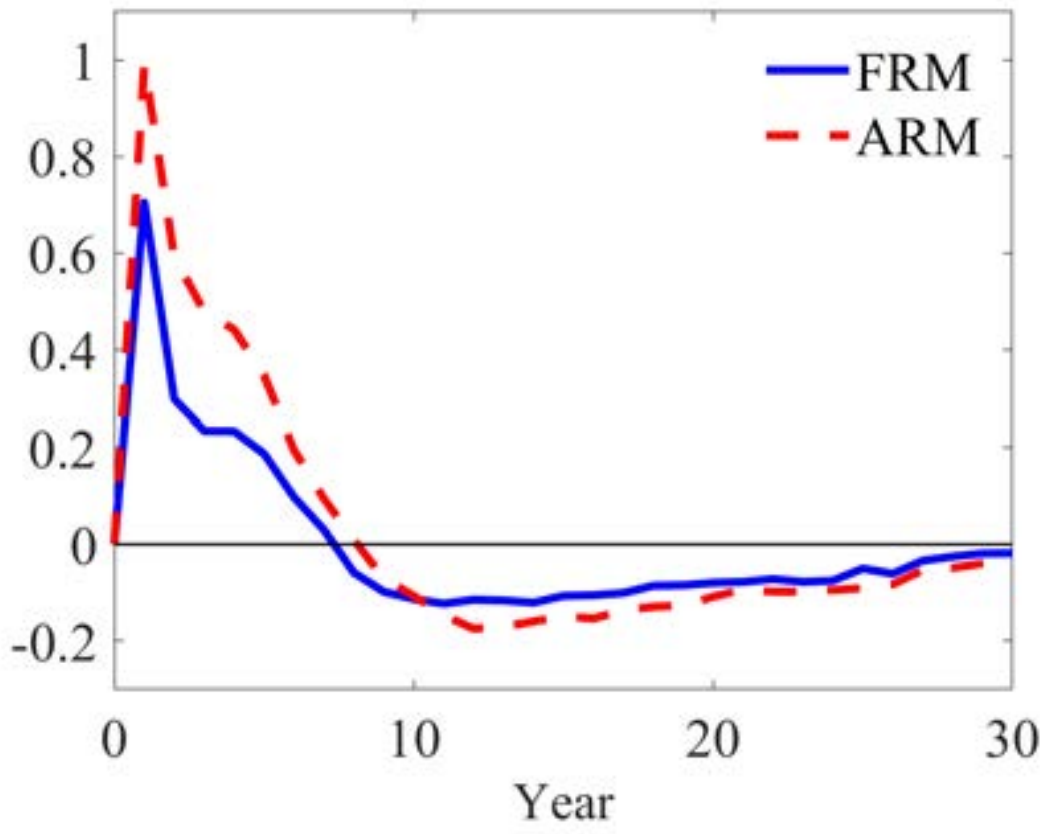

- The initial response of consumption is significantly larger under ARMs
- The response in mortgage rates is the key difference between the contracts

	FRM geo avg	FRM 60% pass-through	FRM 100% pass-through	ARM
Δ C	0.48	0.70	1.02	0.99

Conclusions

- Changes in mortgage interest rates and house prices amplify the response in aggregate demand to an expansionary monetary policy shock
- Households who update their discrete mortgage and housing choices account for approximately half of the increase in consumption
  - Households whose liquidity endogenously improves, through adjusted tenure choices or cash-out refinancing, increase consumption the most

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- Households who update their discrete mortgage and housing choices account for approximately half of the increase in consumption
  - Households whose liquidity endogenously improves, through adjusted tenure choices or cash-out refinancing, increase consumption the most
- These mechanisms are stronger when mortgage rates respond more
  - Larger response in aggregate demand with adjustable-rate mortgages as compared to fixed-rate contracts
- The flexibility of both the mortgage and the housing market matters for the transmission of monetary policy

Thank You!

Rental firms

The rental firms are owned by foreign investors with a long-term investment horizon. The rental rate in steady state

$$p_r^{ss} = \left[1 - \beta_f + \beta_f \left(\delta^r + \tau^h\right)\right] p_h,$$

is such that the rental firms earn their required rate of return, after paying maintenance costs ($\delta^r p_h$) and property taxes ($\tau^h p_h$).

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The rental rate in general

$$p_r = (1 - \beta_f)p_h + \beta_f(\delta^r + \tau^h)p_h' + \beta_f \Delta p_h' \frac{S - S^{ss}}{S},$$

where $\Delta p_h' \equiv p_h - p_h'$, and $S - S^{ss}$ is the deviation in the rental stock from the steady state level, which is transacted in the market.

Back to model

Cash-on-hand and taxes

Define cash-on-hand x as

$$x \equiv \begin{cases} y + (1+r)b - (1+r^m)m + (1-\varsigma^s)p_h h - \delta^h p_h h - \Gamma & \text{if } j > 1 \\ y - \Gamma + a & \text{if } j = 1, \end{cases}$$

where total taxes are

$$\Gamma = \tau^l y + I^w \tau^{ss} y + \tau^c r b + \tau^h p_h h + T(\tilde{y}).$$

Progressive earnings taxes

$$T(\tilde{y}) = \tilde{y} - \lambda \tilde{y}^{1-\tau^p}$$

where mortgage interest and property taxes are deductible.

Back to model

Independently calibrated parameters

Parameter	Description	Value
σ	Coefficient of relative risk aversion	2
r	Interest rate	0.03
κ	Yearly spread, mortgages	0.014
τ^l	Local labor income tax	0.05
τ^c	Capital income tax	0.15
τ^{ss}	Payroll tax	0.153
τ^h	Property tax	0.01
θ	Down-payment requirement	0.20
ψ	Payment-to-income requirement	0.28
δ^h	Depreciation, owner-occupied housing	0.03
ς^I	Home insurance	0.005
ς^b	Transaction cost if buying house	0.025
ς^s	Transaction cost if selling house	0.07
ς_p^r	Proportional refinancing cost	0.01
R	Replacement rate for retirees	0.50
B^{max}	Maximum benefit during retirement	0.61

Back to Calibration

Internally calibrated parameters

Using simulated method of moments

Parameter	Description	Value	Target moment	Data	Model
α	Consumption weight	0.75	Median house value-to-earnings	2.30	2.30
β	Discount factor	0.92	Median LTV	0.35	0.35
δ^r	Depreciation rate, rentals	0.055	Homeownership rate, age < 35	0.44	0.40
$\underline{h}$	Min. owned house value	0.35	Homeownership rate	0.70	0.73
ς^r	Fixed refinancing cost	0.12	Refinance rate	0.08	0.08
$\bar{q}$	Luxury of bequests	6.8	Net worth p75/p25, age 68-76	5.37	5.26
υ	Utility shifter of bequests	190	Mean net worth/mean earnings	1.38	1.40
SD	Standard deduction	0.081	Itemization rate	0.53	0.53
λ	Level, tax function	0.975	Average marginal tax rates	0.13	0.13
τ^p	Progressivity, tax function	0.17	Distr. of marginal tax rates	N.A.	N.A.

Sources: Survey of Consumer Finances (SCF), Gorea and Midrigan (2017), Congressional Budget Office, The Tax Foundation, 2013

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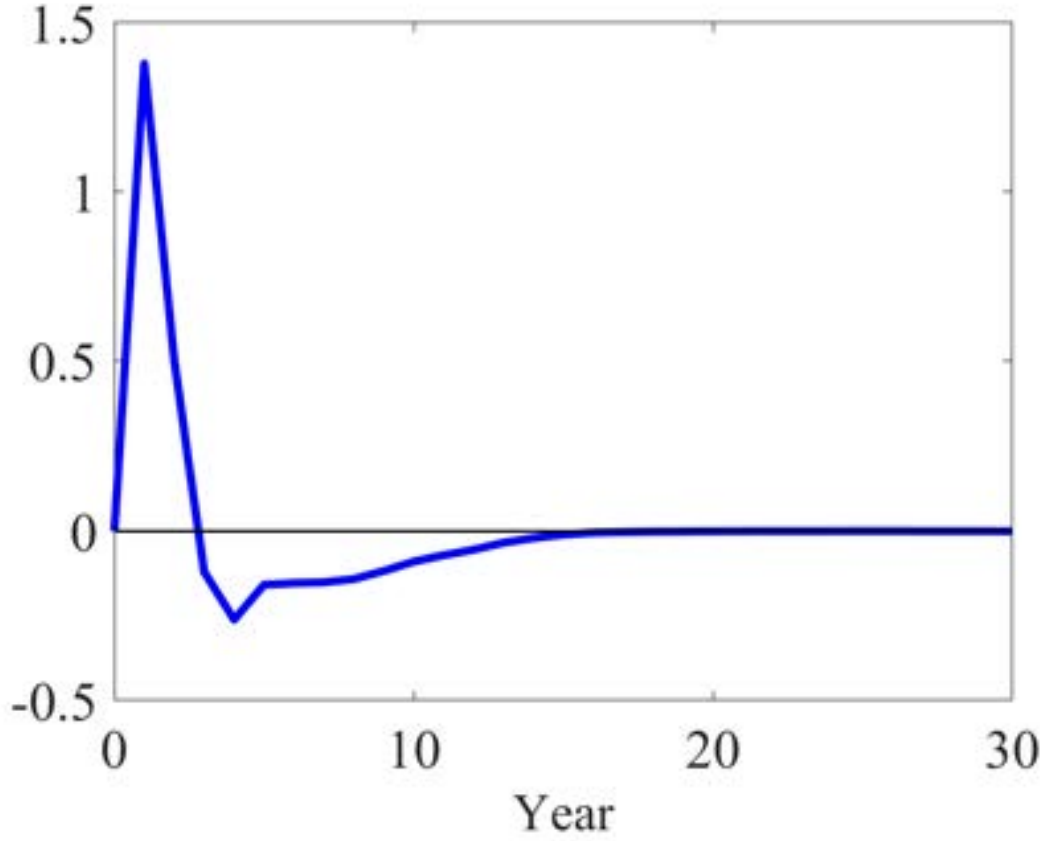
Rental rate



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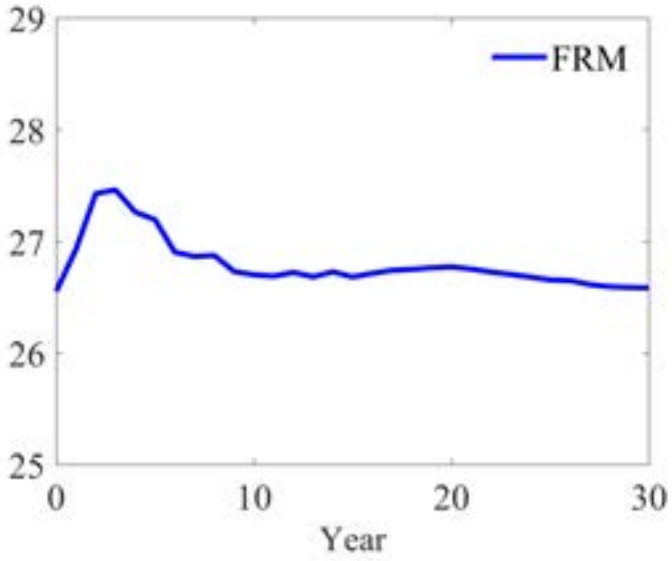
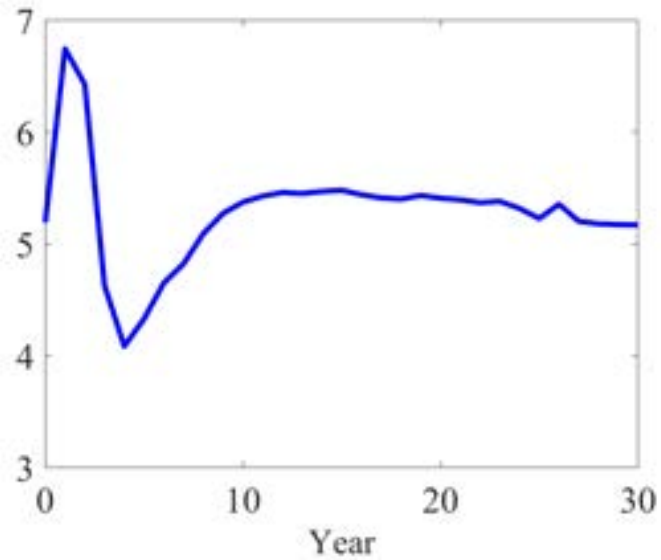
Shares

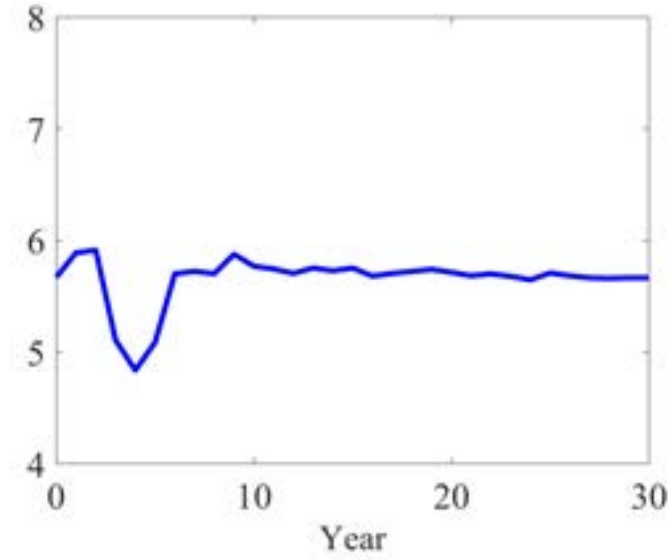
Renters



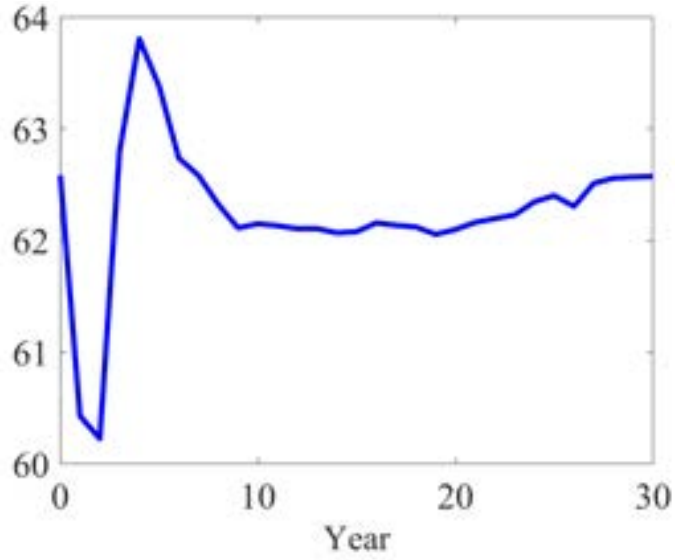
Refinancers



Buyers

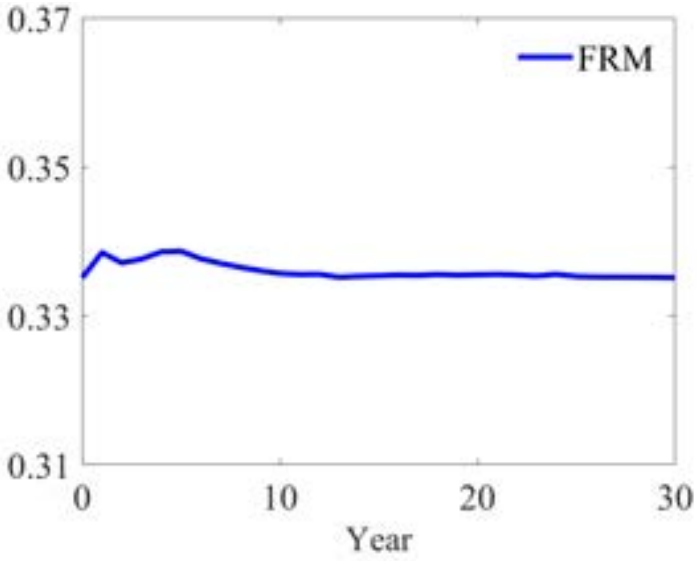


Stayers

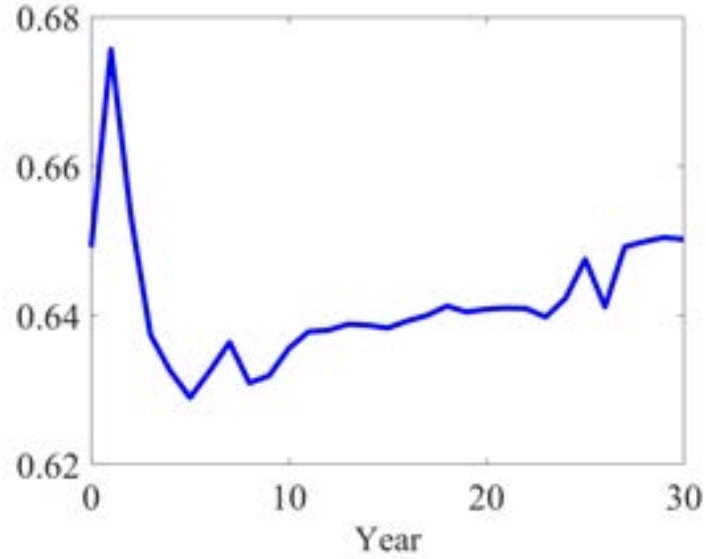


Mean consumption

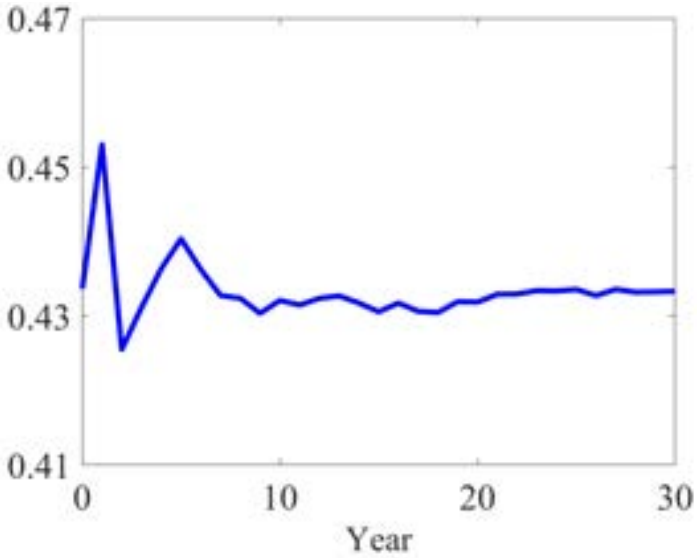
Renters



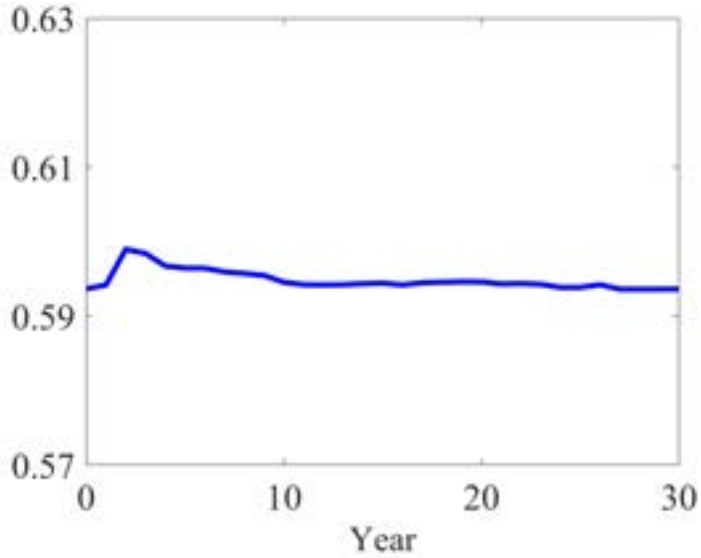
Refinancers



Buyers



Stayers



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Discrete choices & liquid savings

Mean Δ liquid savings (%)

	Buyers	Refinancers	Movers	Stayers	Renters
Buyers	13	-	-	-	347
Refinancers	-	96	14	-95	1585
Movers	-	63	2	-93	223
Stayers	-	2172	7	-6	3838
Renters	-62	-74	-4	-99	-1

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Summary - discrete choices

When mortgage interest rates are low and house prices are high:

- Liquidity-constrained homeowners increase consumption
  - use cash-out refinancing to smooth consumption
  - sell when house prices are high and become renters
  - move to a new house to access their housing equity
- Some renters increase consumption
  - postpone buying a house when house prices are high
- Whereas others endogenously become more liquidity constrained
  - some owners choose to no longer sell or refinance
  - some renters advance their house purchases

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