

# 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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  - 40 percent of households in the U.S. have a mortgage, mortgage debt corresponds to 70 percent of GDP
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  - 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
- A large theoretical and empirical literature suggests that liquidity-constrained households often respond strongly to changes in their cash flows
- Monetary policy can directly influence households' cash flows, by affecting their mortgage and housing choices
  - Optimal reallocation of households' holdings of houses and mortgages when mortgage interest rates and house prices change
  - Housing and mortgage choices are among the largest financial decisions households make and substantially impact their liquidity

# 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 mortgage-market specifications?  
Fixed-rate (FRM) vs adjustable-rate mortgages (ARM)  
Pass-through to mortgage rates

Literature Review

# 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
  - Incomplete markets and illiquid housing equity
  - Wealthy and poor hand-to-mouth households

# METHOD

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  - Mortgage and housing markets are modeled in detail
  - Incomplete markets and illiquid housing equity
  - Wealthy and poor hand-to-mouth households
- 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

- Changes in mortgage interest rates and house prices *amplify* the response in aggregate consumption to an expansionary real interest rate shock
- The amplification is driven by a relatively small share of households who update their discrete mortgage and housing choices, accounting for 50 percent of the increase in aggregate demand
  - Mortgage refinancing explains approximately two thirds
  - Adjusted housing choices account for one third

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  - Mortgage refinancing explains approximately two thirds
  - Adjusted housing choices account for one third
- The different pass-through of the policy rate to short and long mortgage rates drives the difference between economies with ARMs and FRMs
- The flexibility of both the mortgage *and* the housing market matters greatly for the transmission of monetary policy

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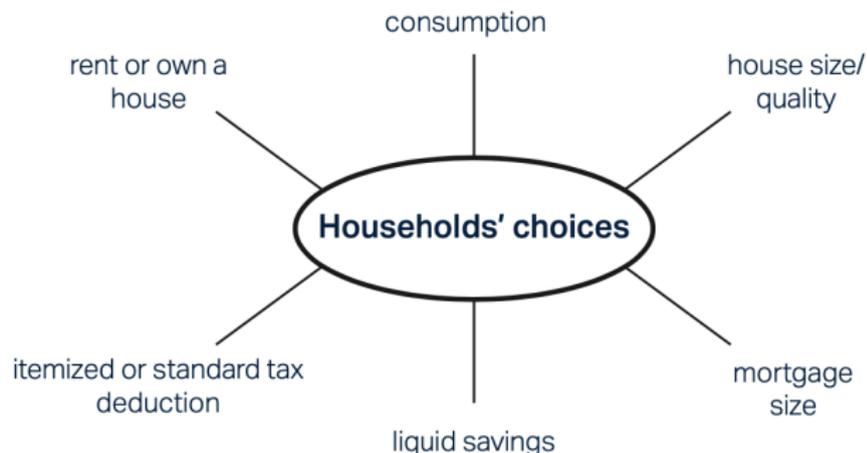
1 MODEL

2 CALIBRATION

3 RESULTS

# MODEL OVERVIEW

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



# HOUSEHOLDS

- Households live at most  $J = 60$  periods (ages 23-82)
  - Age-dependent death probability:  $1 - \Phi_j$ , with  $1 - \Phi_J = 1$

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  - Itemized deductions including mortgage interest payments
  - Progressive earnings tax

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

Households' dynamic problem

# MARKETS

- The housing market
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  - House prices are endogenous
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- The mortgage market
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  - Down-payment and payment-to-income requirements (LTV & PTI)
  - Amortization plans specify the required minimum mortgage payment
  - Fixed and proportional refinancing costs,  $\zeta^r$  and  $\zeta_p^r$

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  - Amortization plans specify the required minimum mortgage payment
  - Fixed and proportional refinancing costs,  $\zeta^r$  and  $\zeta_p^r$
  - For precautionary reasons many households save in liquid bonds while having a mortgage
  - I compare a setting where the long-term mortgages have either fixed or adjustable interest rate
  - The mortgage interest rate is given by the risk-free rate plus an exogenous credit spread

# THE OTHER AGENTS

- Rental market
  - Rental housing is owned by foreign investors, and the rental rate is given by a user-cost formula Rental firms
- Government
  - Taxes the households and provides social security
  - Collects bequests and distributes some of these to the newborn population

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# CALIBRATION

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

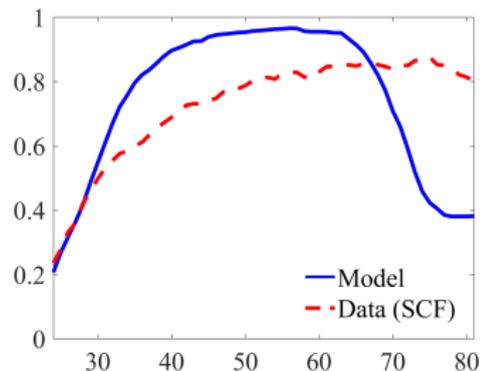
Independently calibrated parameters

- 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

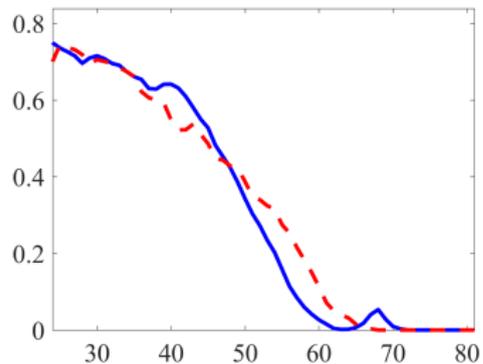
Internally calibrated parameters

# LIFE-CYCLE PROFILES

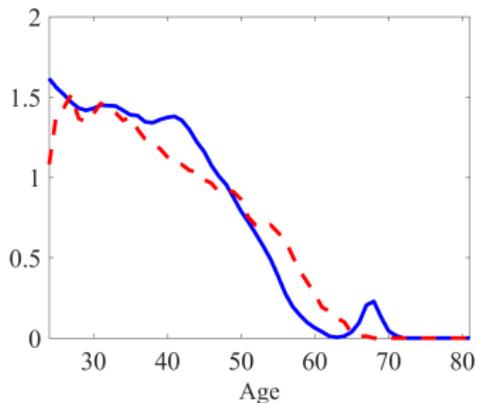
## Homeownership rate



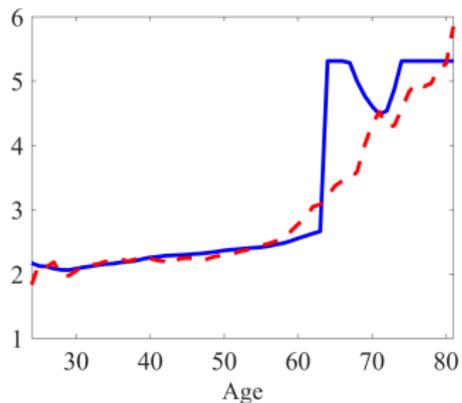
## Median LTV



## Median mortgage-to-earnings

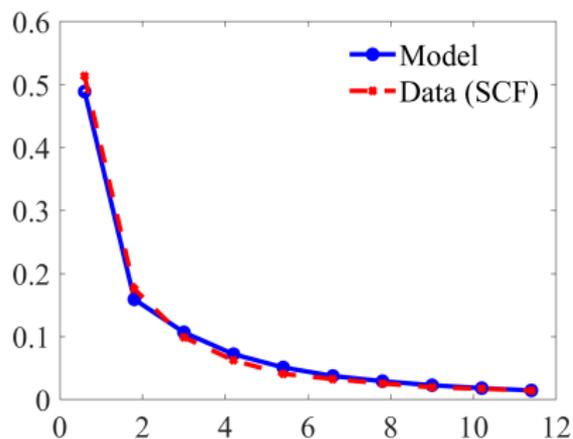


## Median house-to-earnings

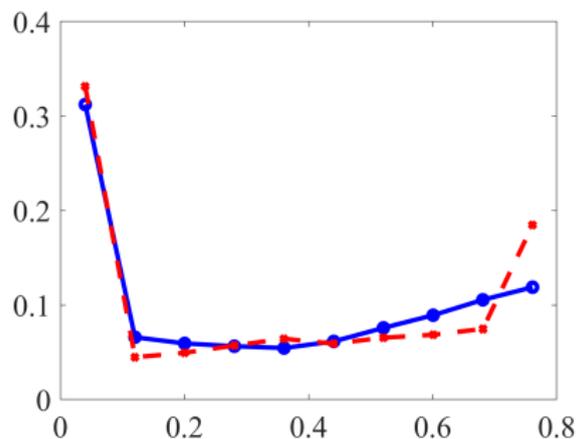


# PREVALENCE OF CONSTRAINED HOUSEHOLDS

Liquid asset-to-earnings



LTV



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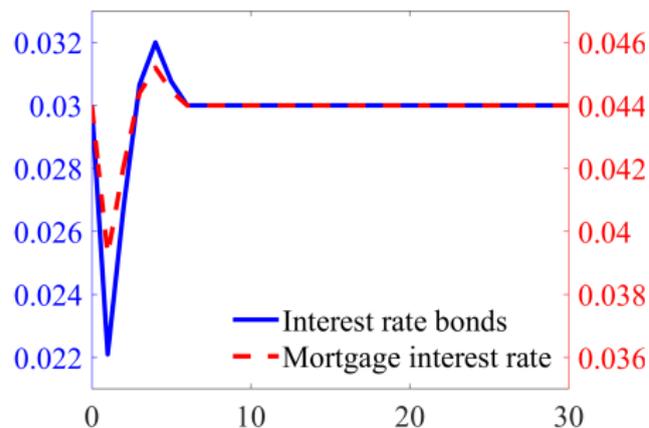
3 RESULTS

# THE EXPERIMENT

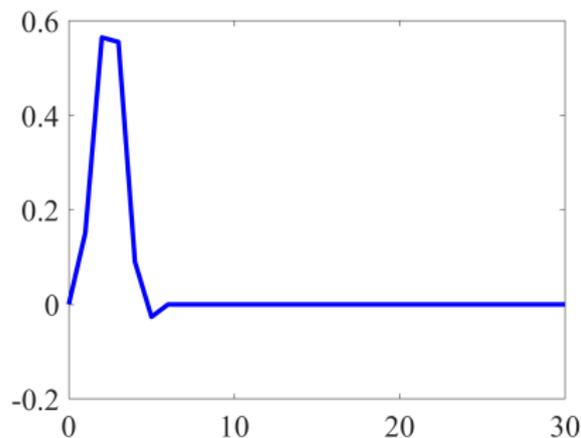
- Start from steady state with an invariant distribution over households
- Study non-linear impulse response functions (IRFs) to a probability zero shock to the real interest rate
- Following Boppart, Krusell, and Mitman (2018) can use IRFs to provide a linearized solution to the model with aggregate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

# THE REAL INTEREST RATE SHOCK

Real interest rates



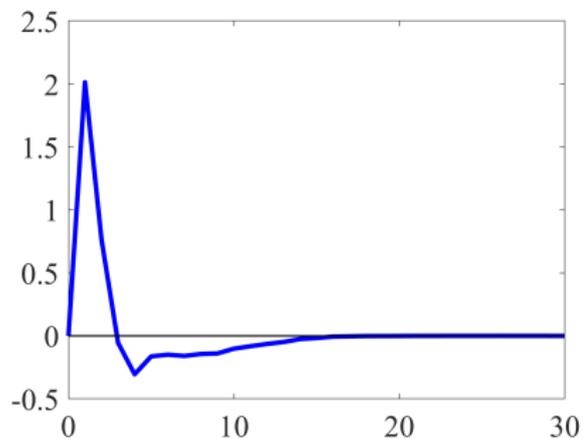
Aggregate income (%)



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

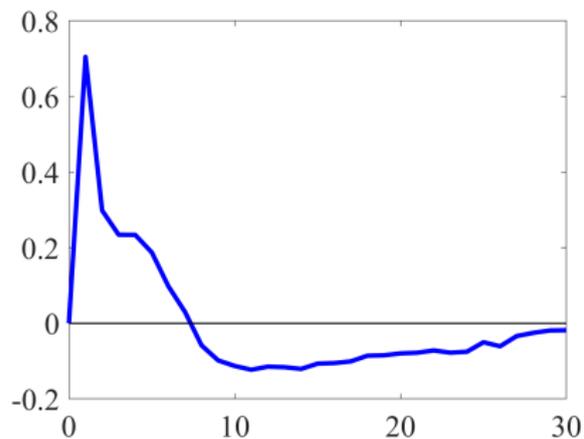
# ENDOGENOUS RESPONSES

Equilibrium House Prices (%)



Rental rate

Consumption (%)



# THE MECHANISMS: PRICES AND DISCRETE CHOICES

Consumption responses (%),  $\Delta C$  first period of the transition

	$\Delta r$	$+\Delta r^m$	$+\Delta p_h$	$+\Delta Y$
$\Delta$ aggregate consumption	0.06	0.18	0.29	0.70

Changes in mortgage interest rates and house prices *amplify* the response in aggregate consumption

# THE MECHANISMS: PRICES AND DISCRETE CHOICES

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$\Delta$ aggregate consumption	0.06	0.18	0.29	0.70

Changes in mortgage interest rates and house prices *amplify* the response in aggregate consumption

$\Delta C$ , optimal portfolio choices	0.70
$\Delta C$ , steady-state choice to refinance	0.45
$\Delta C$ , steady-state discrete choices	0.34

Half of the aggregate demand response is driven by households' discrete portfolio updates, out of which refinancing explains approximately two thirds

# DISCRETE CHOICES & CONSUMPTION

Mean  $\Delta$  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  $\Delta$  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  $\Delta$  consumption (%), red indicates that liquid savings increase on average

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# THE ROLE OF CHANGES IN LIQUID SAVINGS

Cash-out refinance, due to the shock

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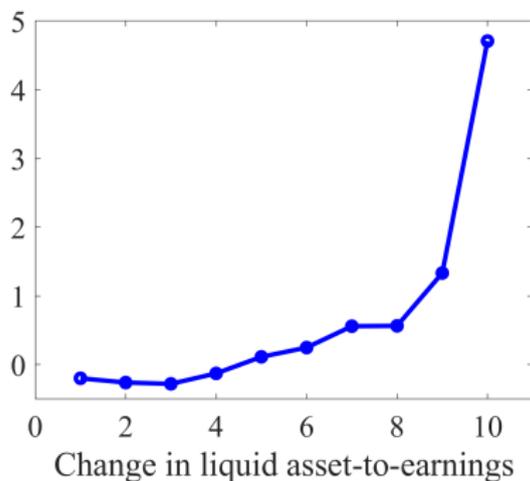
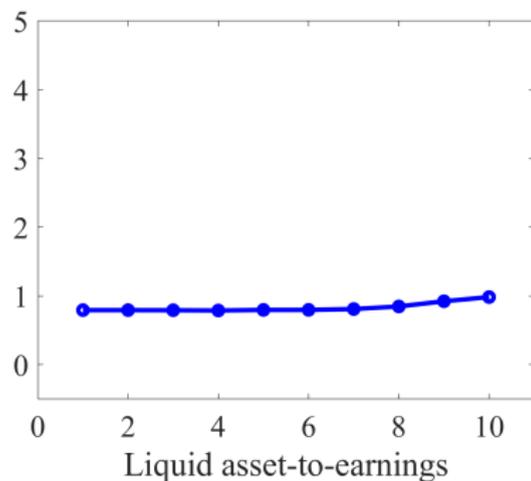
Update tenure choice and increase liquid savings, due to the shock

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

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# LIQUID SAVINGS VS CHANGES IN LIQUID SAVINGS

First period of the transition,  $\Delta$  consumption (%):



# CONTRIBUTIONS TO OVERALL $\Delta$ 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 $\Delta$ CONSUMPTION

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 $\Delta$ 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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# TAKING STOCK - DISCRETE CHOICES

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

- 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 and access their housing equity
- Some renters increase consumption
  - postpone buying a house when house prices increase
- Whereas others endogenously become more liquidity constrained
  - some owners choose to no longer sell or refinance
  - some renters advance their house purchases

# EXTENSIONS AND ROBUSTNESS

- Different shock sizes Nonlinearity
- Expansionary vs contractionary shocks Asymmetry
- FRMs vs ARMs Mortgage contracts
- Pass-through rate to mortgage-interest rates Pass-through

# CONCLUSIONS

- Only a small fraction of households adjust their housing and mortgage holdings in response to a monetary policy shock, but these households account for 50 percent of the change in aggregate demand
  - Mortgage refinancing explains approximately two thirds of the contribution, whereas adjusted housing choices account for one third
  - Households whose liquidity endogenously improves, respond strongly

# CONCLUSIONS

- Only a small fraction of households adjust their housing and mortgage holdings in response to a monetary policy shock, but these households account for 50 percent of the change in aggregate demand
  - Mortgage refinancing explains approximately two thirds of the contribution, whereas adjusted housing choices account for one third
  - Households whose liquidity endogenously improves, respond strongly
- These mechanisms rely on a strong pass-through to mortgage interest rates, which in turn affects house prices
- The flexibility of both the mortgage *and* the housing market matters greatly for the transmission of monetary policy

Thank You!

# 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 (2019); Wong (2019)
- 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 (2018); Chen, Michaux, Roussanov (2013); Eichenbaum, Rebelo, Wong (2019); Garriga, Kydland, Sustek (2017); Greenwald (2018); Hedlund, Karahan, Mitman, Ozkan (2019); Wong (2019)

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# CASH-ON-HAND AND TAXES

Define cash-on-hand  $x$  as

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

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.

# HOUSEHOLDS' DYNAMIC PROBLEM

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

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

# HOUSEHOLDS' DYNAMIC PROBLEM

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s.t.

$$\underbrace{c + b' + \mathbb{I}^R p_r s + \mathbb{I}^B (1 + \zeta^b) p_h h' + \mathbb{I}^{Ref, S} (1 - \zeta^s) p_h h + \mathbb{I}^{Ref} (\zeta^r + \zeta_p^r m')}_{\text{"Expenditures"}} \leq \underbrace{x + m'}_{\text{"Money to spend"}}$$

# HOUSEHOLDS' DYNAMIC PROBLEM

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s.t.

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$$q' = b' + p_h h' - m' \quad \text{Bequests}$$

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

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

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

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

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

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

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

# RENTAL FIRMS

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

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

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.

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# INDEPENDENTLY CALIBRATED PARAMETERS

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

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# INTERNALLY CALIBRATED PARAMETERS

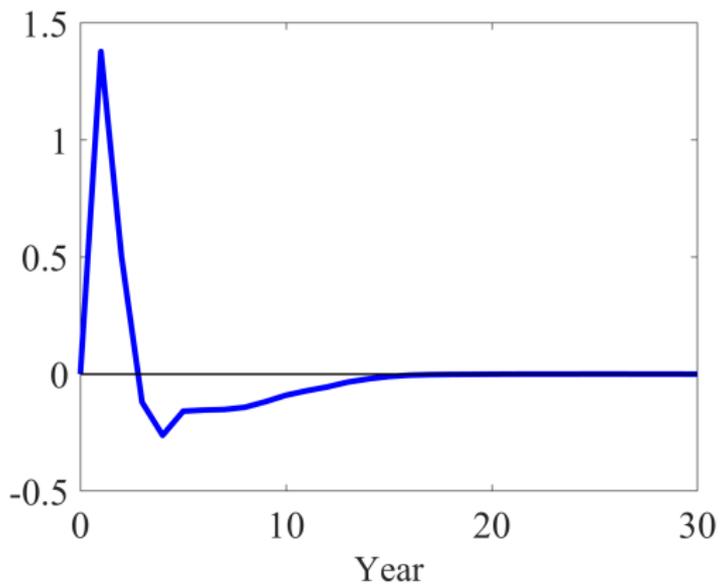
Using simulated method of moments

Parameter	Description	Value	Target moment	Data	Model
$\alpha$	Consumption weight	0.75	Median house value-to-earnings	2.30	2.30
$\beta$	Discount factor	0.92	Median LTV	0.35	0.35
$\delta^r$	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
$\zeta^r$	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
$v$	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
$\lambda$	Level, tax function	0.975	Average marginal tax rates	0.13	0.13
$\tau^p$	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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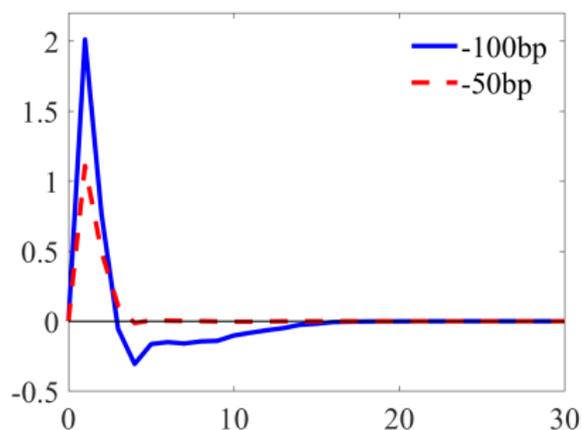
# RENTAL RATE (%)



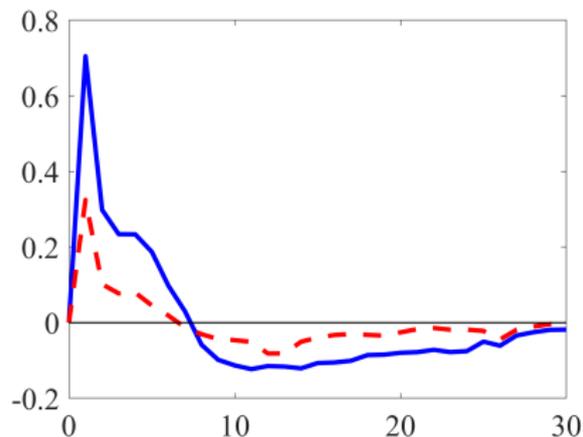
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# SHOCKS OF DIFFERENT SIZES

Equilibrium House Prices (%)



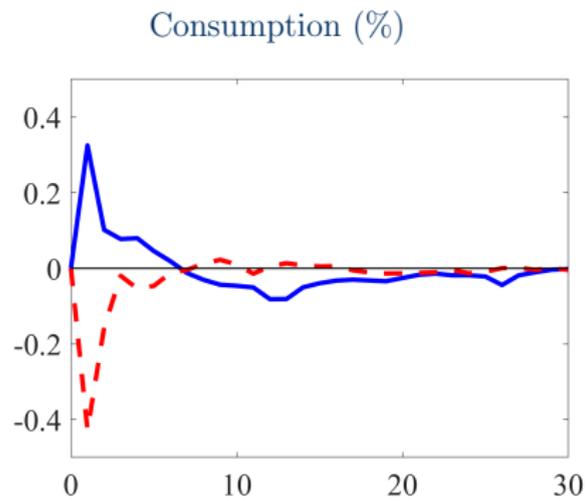
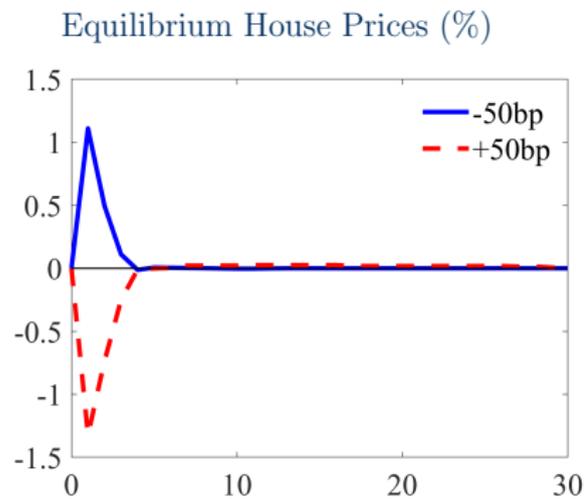
Consumption (%)



- House prices and consumption respond approximately linearly to changes in interest rates
- Discrete portfolio updates account for about half of the aggregate demand response
- Refinancing explains roughly 2/3, updated housing choices 1/3

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# SHOCKS OF DIFFERENT SIGNS

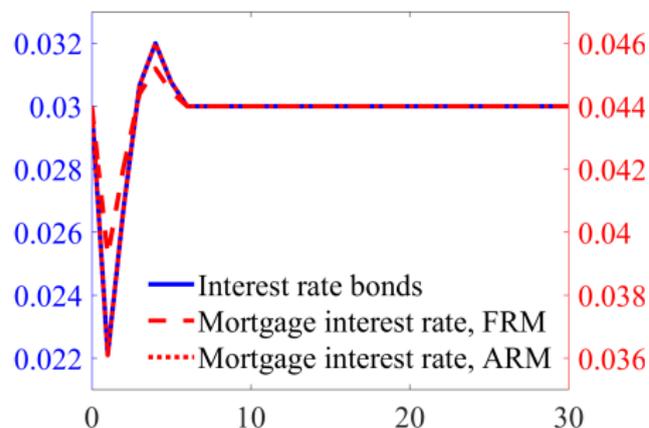


- The contractionary shock worsens the consumption smoothing of households that have a higher marginal value of current consumption, and increases the share of liquidity-constrained households
- Discrete portfolio updates account for about 40 percent of the aggregate demand response
- Refinancing explains roughly 2/3, updated housing choices 1/3

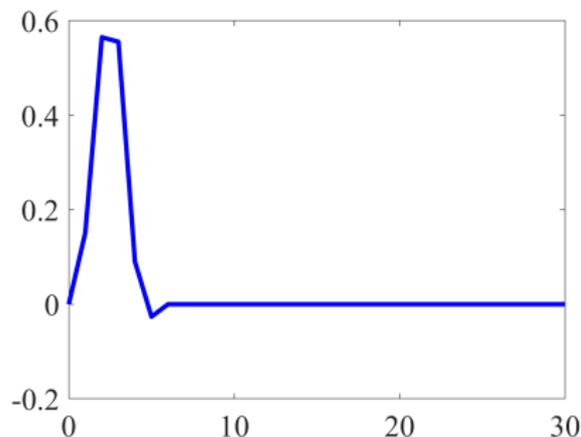
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# SHORT AND LONG MORTGAGE RATES

Real interest rates



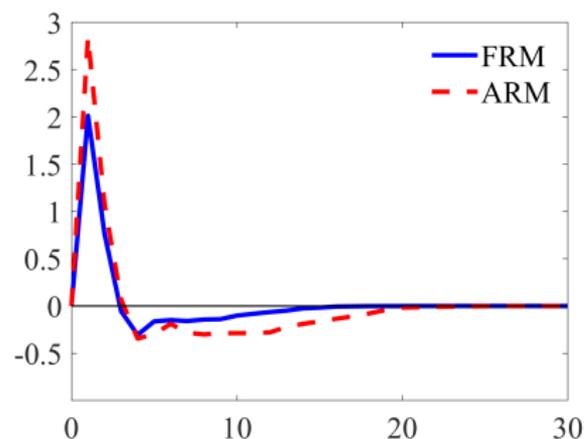
Aggregate income (%)



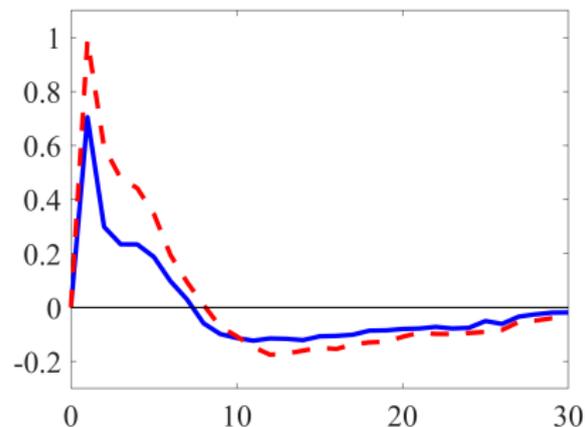
- -100bp monetary policy shock
- Empirically estimated path of the real interest rate and output, from Aulert, Rognlie, and Straub (2020)

# ARMs vs FRMs

Equilibrium House Prices (%)



Consumption (%)



- Consistent with empirical findings, see, e.g., Calza et al. (2013)

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# DIFFERENT PASS-THROUGH TO MORTGAGE-INTEREST RATES

Consumption responses and house prices (%), first period of the transition

	FRM geo avg	FRM 60% pass-through	FRM 100% pass-through	ARM
$\Delta C$	0.48	0.70	1.02	0.99
$\Delta p_h$	0.59	2.01	3.33	2.85

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