Aggregate and Distributional Impacts of Housing Policy: China's Experiment

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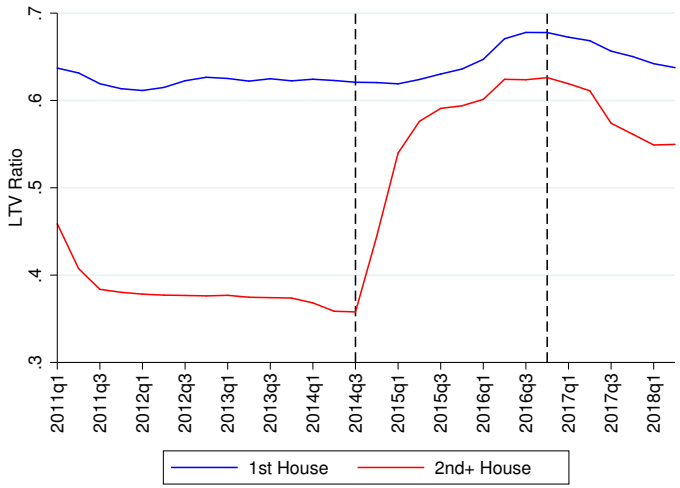
General issues

- How does a relaxation of loan-to-value (LTV) limits for mortgage loans transmit into housing booms?
- What are the distributional impacts of such policy changes across households of different characteristics?
- In this paper, we take China's recent change in housing policy as an experiment because
  - only country to experience extraordinary changes in LTV.

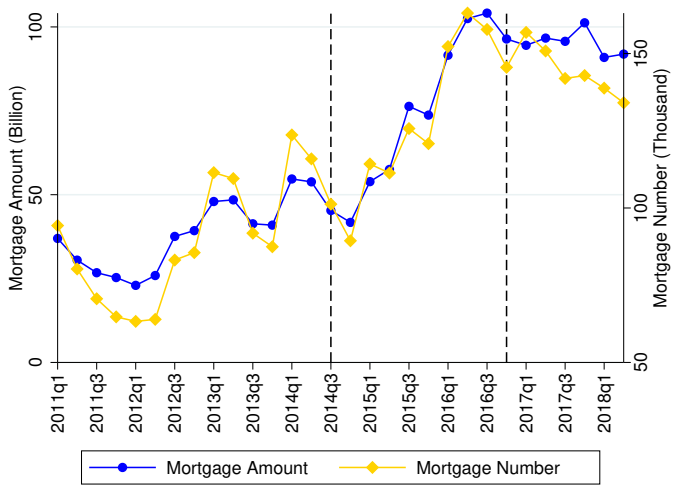
China experiment

- China relaxed its LTV policies between 2014Q4 and 2016Q3
  - 1st house: the minimum down payment ratio decreased from 30% to 20%.
  - **2nd+ house: the minimum down payment ratio decreased from 60-70% to 30%**.
- Mortgage credit and housing market booms
  - The average annual newly issued mortgage amount is 30 percent higher than its counterpart during 2011Q1-2014Q3.
  - The average annualized growth rate of housing prices for the 70 cities in China increased by 5.68% during 2014Q4-2016Q3.
- Consumption growth has been slowing down since 2016Q4.

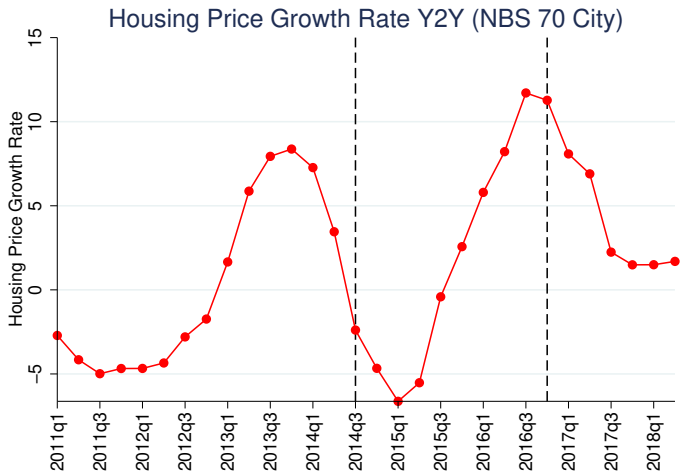
Average Loan-to-Value Ratio



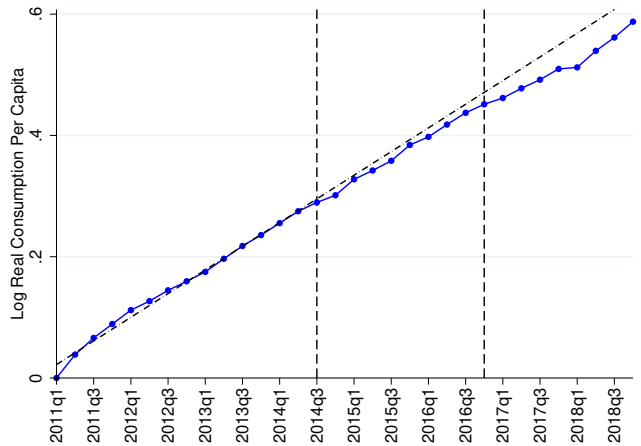
Total Mortgage Across Time



House Price



Real Consumption Per Capita (Log)



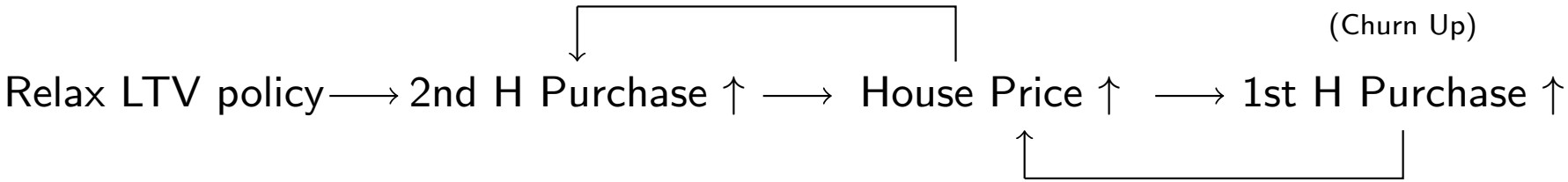
In this paper

We explore the aggregate and distributional impacts of this LTV policy relaxation on mortgage, housing demand, and household consumption.

What we do in this paper?

- Empirics: narrative approach with two micro-level data
  - Loan-level mortgage origination data: explore the reallocation of mortgage loan across households of different ages and education levels following the policy change.
  - Household finance survey data: (1) explore changes in consumption growth across age-education groups; (2) establish the empirical linkage between mortgage debt burden and consumption growth at household level.
- Theory: dynamic OLG economy with household heterogeneity
  - calibrate it to match various aggregate and cross-sectional moments before the policy relaxation.
  - quantify the effects of LTV policy changes on housing prices, mortgage and non-housing consumption at both aggregate and disaggregate levels.

Main Mechanism



Roadmap of the remaining presentation

1. Data

2. Micro-level Evidence

3. Theory

Proprietary Mortgage Origination Data

- All mortgage loans by one of the biggest commercial banks in China
- Outstanding mortgage loans held by this bank account for around 14% of total outstanding mortgage loans in China, roughly constant across time
- About 3.3 million mortgage loans for new, residential properties during 2011Q1 - 2018Q2, covering 70 major cities
- Detailed information
  - Loans' characteristics: down payment, mortgage loan, maturity, mortgage interest rate, primary or non-primary house
  - House price and size
  - Home buyers' characteristics: age, gender, occupation, education, (reported) income, number of houses, city, zip code

China Household Finance Survey

- The most comprehensive household survey in China (Chinese version of CEX + SCF)
- Survey every other year, from 2011 to 2017 (e.g. in 2013, sample includes 19,203 urban households).
- Overview of the questionnaire
  - Asset and liabilities (non-financial assets, such as real estates, and financial assets)
  - Expenditure (e.g. various categories of nondurables, travel expenses, health care and medical expenses, etc.)
  - Demographic characteristics and labor market
  - Others (Social and commercial insurance)

Roadmap

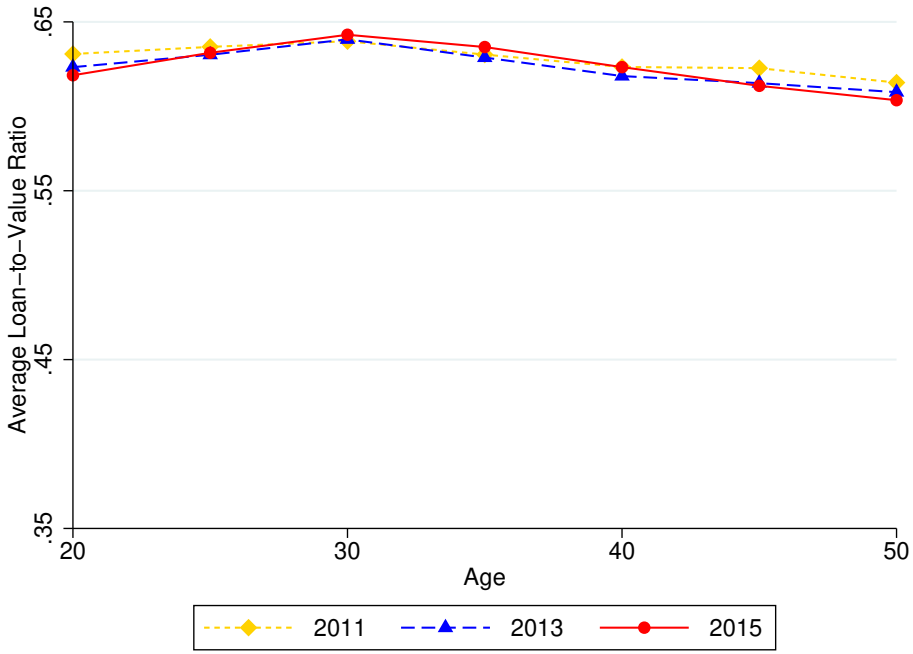
1. Data

2. Micro-level Evidence

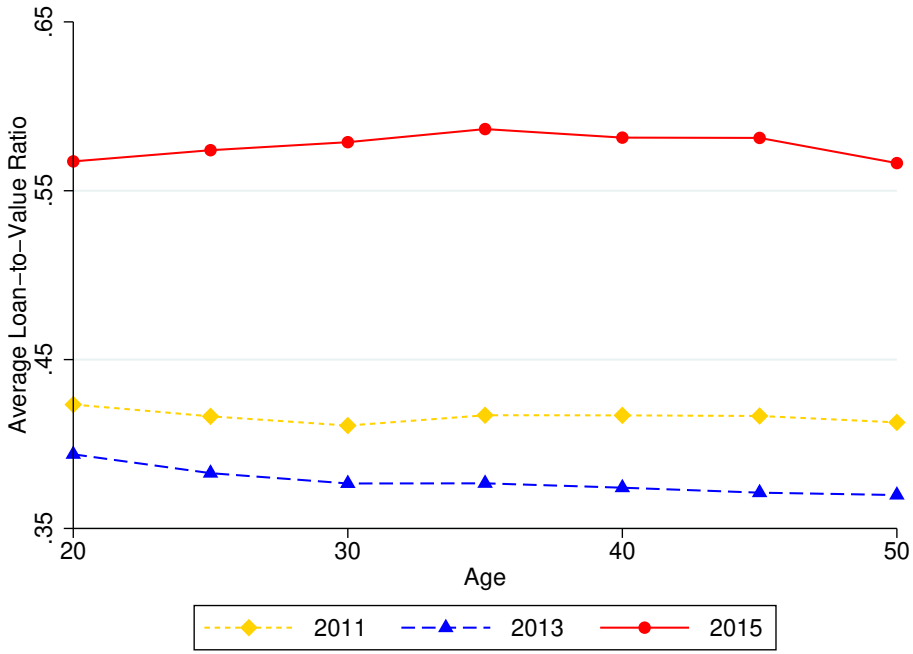
3. Theory

Loan-to-Value Ratio for Primary and Secondary Houses

Loan-to-Value Ratio: 1st House

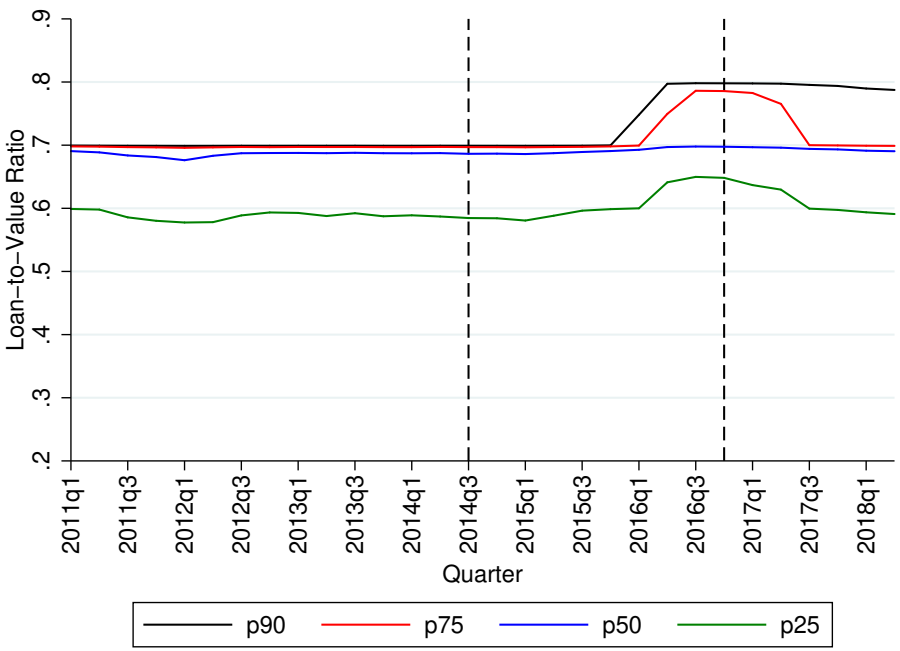


Loan-to-Value Ratio: 2nd+ House

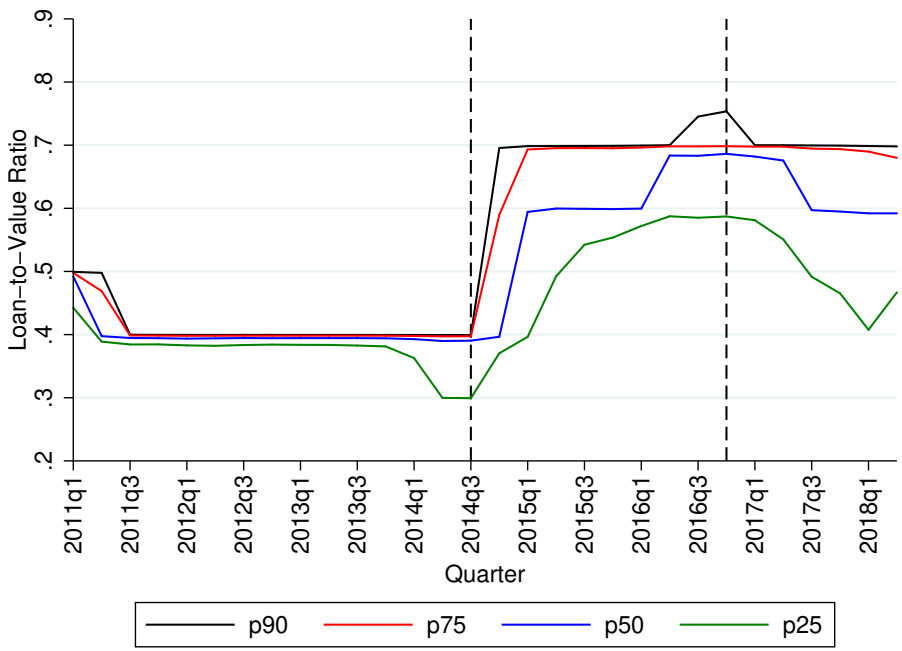


Loan-to-Value Ratio Distribution along Time

LTV Ratio Distribution: 1st House

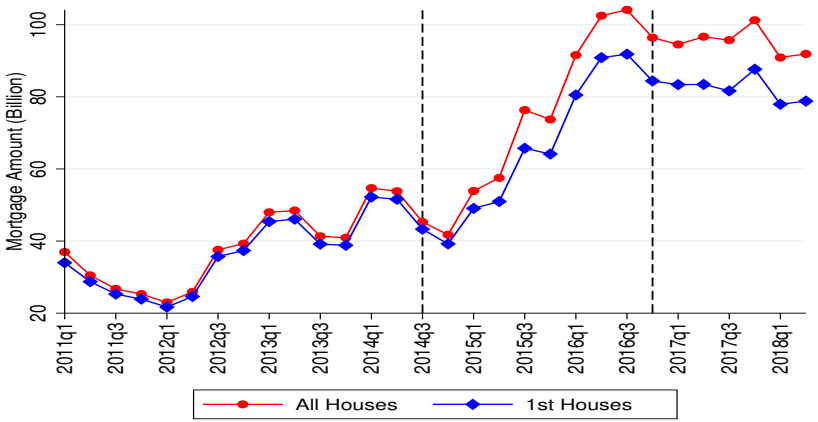


LTV Ratio Distribution: 2nd+ House

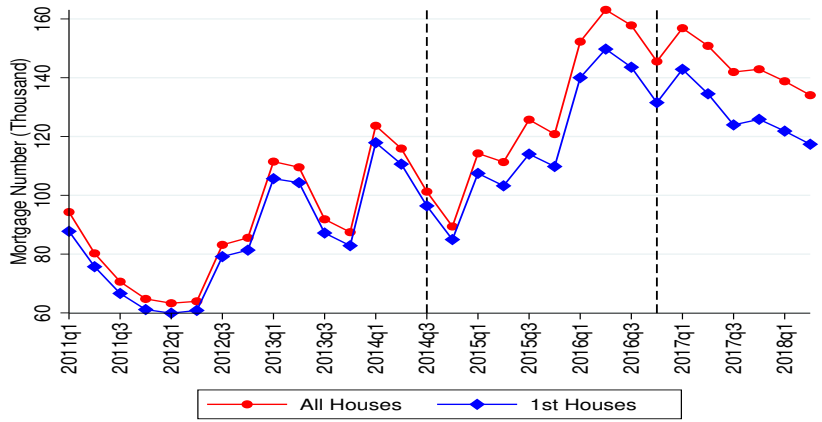


Dynamics of Mortgage Debt and Debt Burden

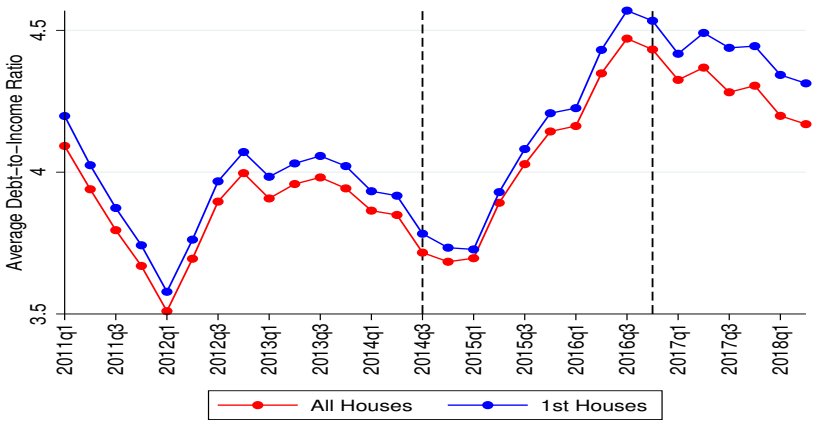
Mortgage Origination Amount



Mortgage Origination Number



Mortgage DTI Ratio at Origination

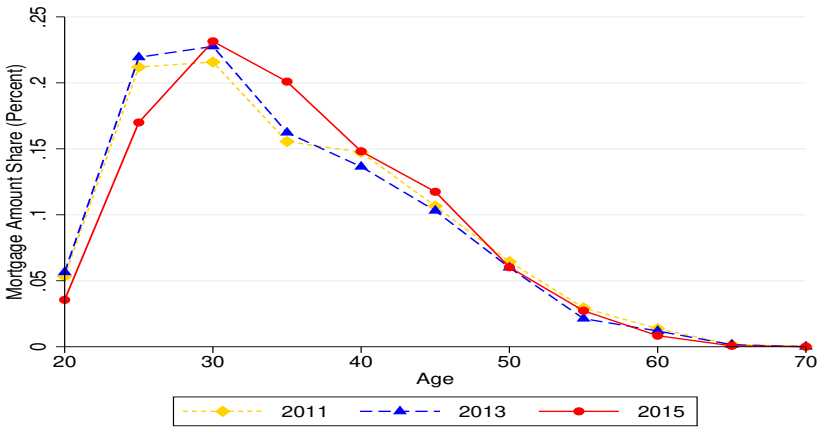


House Value to Income Ratio

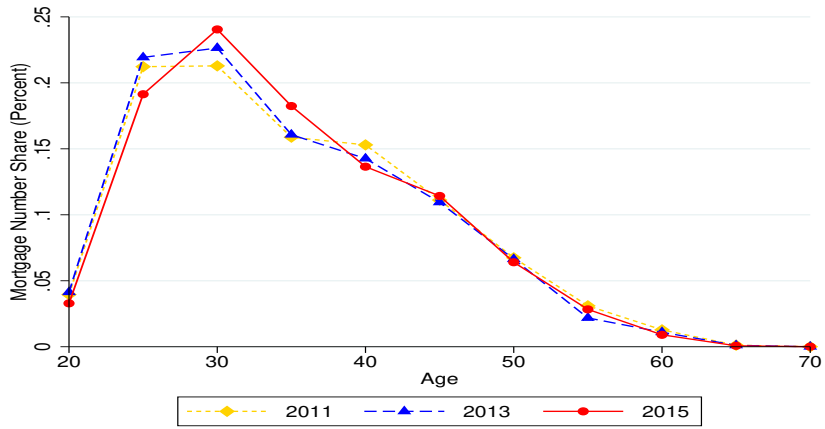


Age Profile of Mortgage Debt

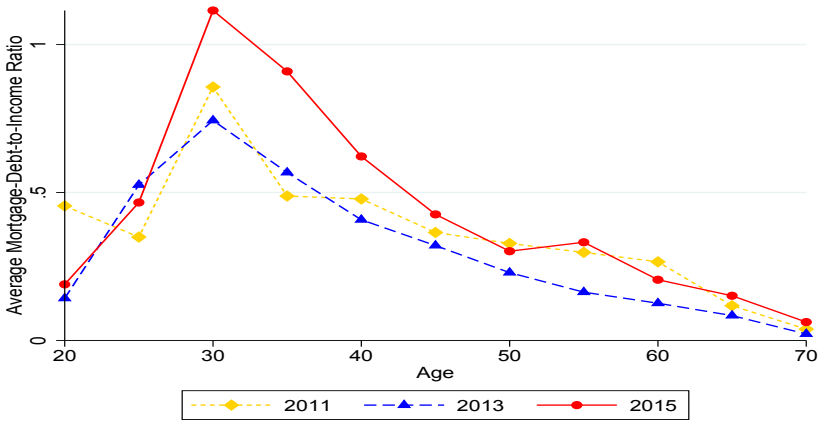
Mortgage Amount



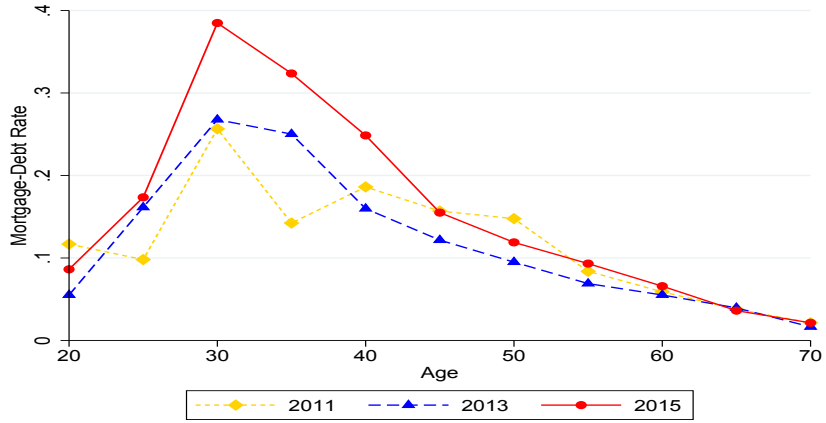
Mortgage Origination Number



Average Outstanding DTI



Mortgage Debt Rate



Mortgage Share Change by Age and Education

Mortgage Amount Share Change between 2013 and 2015

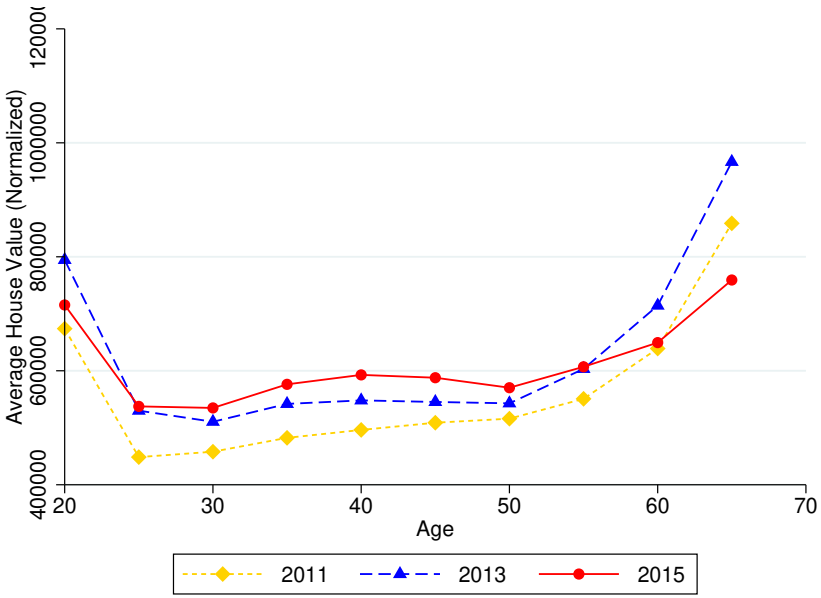
	High School and Below	College and Above
Age $<$ 30	-4.13	-2.58
30 $\leq$ Age $<$ 50	-6.66	13.45
Age $\geq$ 50	-0.90	0.82

Mortgage Number Share Change between 2013 and 2015

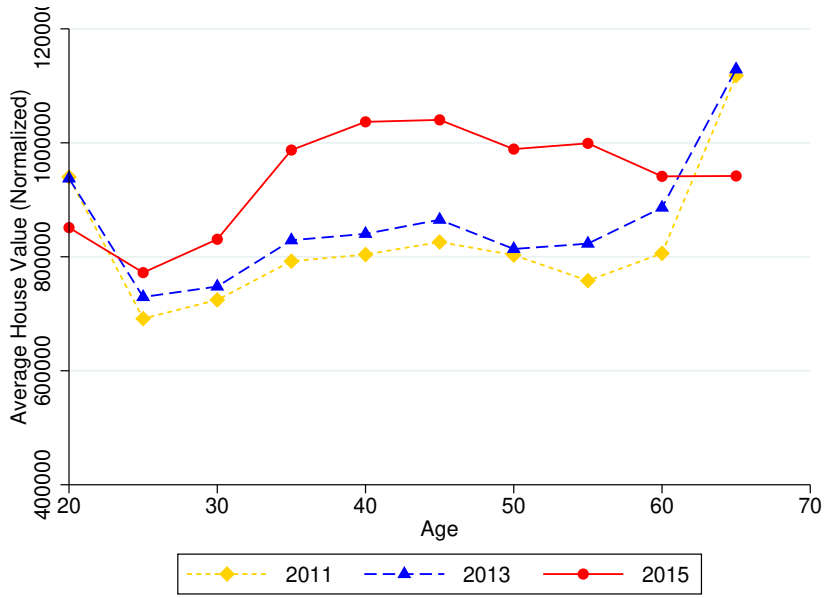
	High School and Below	College and Above
Age $<$ 30	-2.66	-0.09
30 $\leq$ Age $<$ 50	-5.60	8.12
Age $\geq$ 50	-0.37	0.60

Average Housing Value: 1st House

Low-educated Households



High-educated Households



Consumption Growth Rate by Age and Education

Table: Changes in Consumption Growth between 2015-2017 and 2013-2015 by Age and Education

	Consumption		Income	
	Low Edu	High Edu	Low Edu	High Edu
Age < 30	1.39	0.04	2.99	0.24
$30 \leq$ Age < 50	-1.40	-3.59***	1.19	5.15***
Age ≥ 50	-0.09	1.35	6.27***	7.76***

Significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Consumption Growth Rate by Age and Education: Homeowners

Table: Changes in Consumption Growth between 2015-2017 and 2013-2015 by Age and Education

	Consumption		Income	
	Low Edu	High Edu	Low Edu	High Edu
Age < 30	-1.08	-0.96	6.90	-2.35
$30 \leq$ Age < 50	-2.18**	-3.68***	1.04	5.11***
Age ≥ 50	-0.19	1.20	6.47***	7.45***

Significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Consumption Growth Rate by Age and Education: Renters

Table: Changes in Consumption Growth between 2015-2017 and 2013-2015 by Age and Education

	Consumption		Income	
	Low Edu	High Edu	Low Edu	High Edu
Age < 30	13.30*	5.38	3.20	9.59
$30 \leq$ Age < 50	5.91**	-2.29	3.88	5.53
Age ≥ 50	1.44	3.45	3.02	7.75

Significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Regression of Consumption Growth on Mortgage Debt

Table: The Effects of Mortgage Debt on Consumption Growth

Consumption Growth Rate	(1)	(2)
Mortgage debt dummy	-5.31***	
Mortgage debt to income ratio		-0.55**
Income growth rate	0.13***	0.18***
Controls	Y	Y
City-Time Fixed Effects	Y	Y
N	28457	2739
R^2	0.07	0.17

Controls include age, age squared, education dummies, and family size growth rate. Significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Roadmap

1. Data

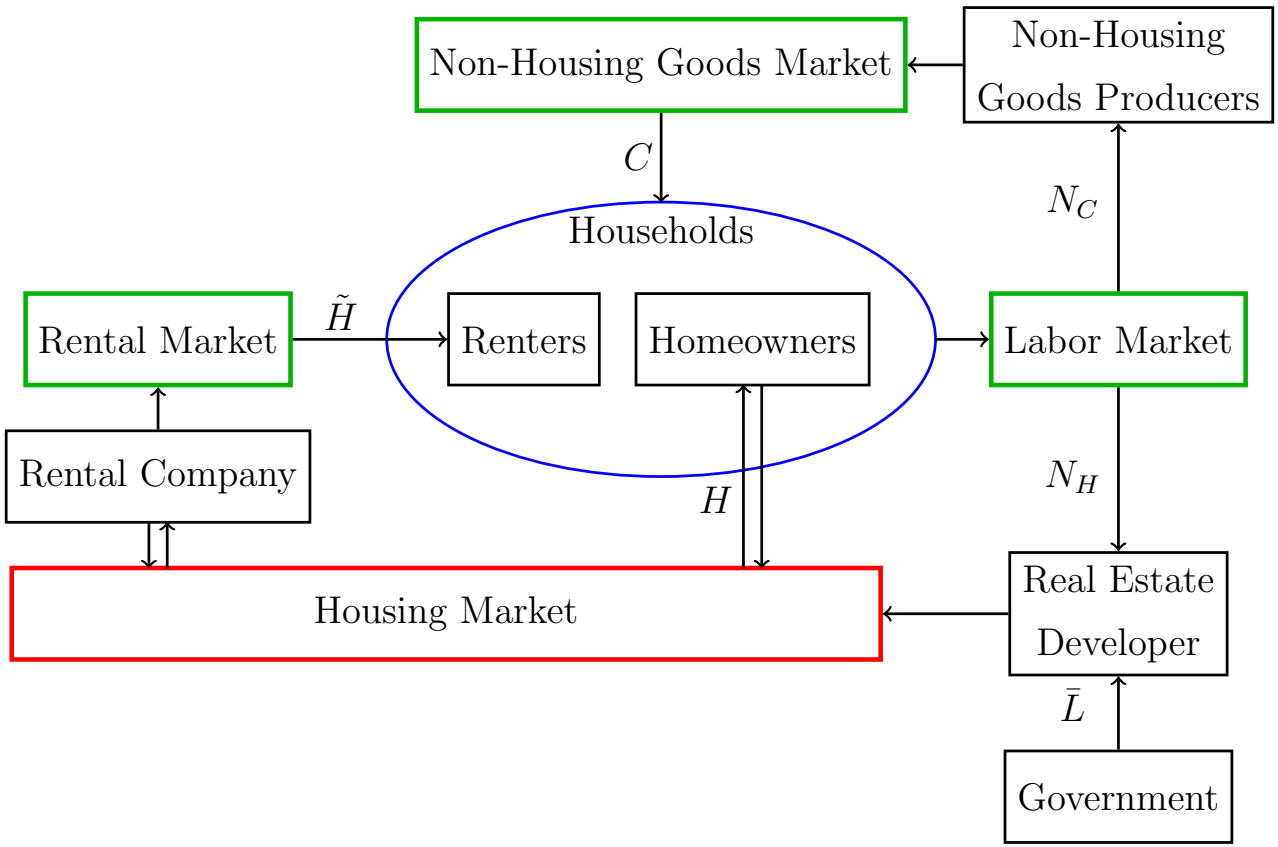
2. Micro-level Evidence

3. Theory

Model framework

- Multi-period OLG model with household heterogeneity
  - Household income: two permanent-income groups; age-specific components and idiosyncratic shocks
- Key ingredients
  - Primary and non-primary (or so-called secondary) houses are subject to different minimum down payment ratios.
  - households' utility on housing services contains two stochastic regimes, which captures belief about future housing demand.
  - Rental markets are frictional, which prevent households with secondary houses to rent them out to those without houses.

Sketch of the equilibrium



Household: Utility

- Expected lifetime utility of the household

$$E_0 \left[\sum_{k=1}^{J} \beta^{j-1} u_j \left(c_j, s_j \right) + \beta^J v(\mathfrak{b}) \right]$$

- CES utility over non-housing consumption $(1-\phi)$ and housing (ϕ)

$$u(c, s; \phi) = \frac{\left[(1-\phi) c^{1-\gamma} + \phi s^{1-\gamma} \right]^{\frac{1-\sigma}{1-\gamma}}}{1-\sigma}$$

- Warm-glow bequest motive

$$v(\mathfrak{b}) = \varphi \frac{\mathfrak{b}^{1-\sigma}}{1-\sigma}$$

Housing Preference

- Housing preference: a two-state Markov process $\phi \in \{\phi^L, \phi^H\}$, with transitional probability matrix Π,

$$\begin{bmatrix} 1-\Pi_{lh} & \Pi_{lh} \\ 0 & 1 \end{bmatrix}$$

- Housing size h
  - 1st house: $\min\{h, \hat{h}\}$
  - 2nd house: $\max\{0, h-\hat{h}\}$; no utility

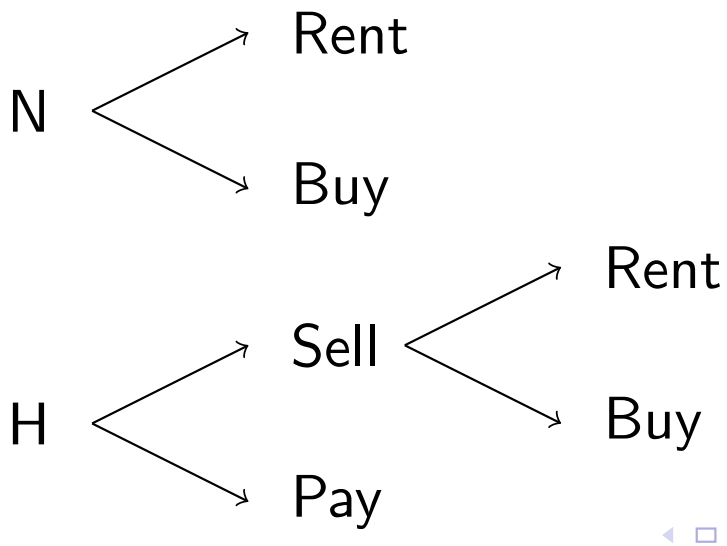
Household: income

- Two permanent-income groups η_k: high and low
- Idiosyncratic uninsurable income shocks ϵ within each permanent-income group
- Worker income: $y = w \cdot \varepsilon_j \cdot \eta_k \cdot \epsilon$
- retirement income: a pension benefit equal to a fraction ξ of the income at the last period of working age, denoted as $y = \xi y^{ret}$.
- Saving in risk-free bonds (exogenous interest rate)
- No borrowing except for mortgage

Housing Tenure Choice

- Housing can be bought at p_h (sold with transaction cost) or rented at ρ_h
- Housing status

Beginning-of-period State		Intermediate/Choice			
w house	w/o house	sell	pay	rent	buy
H	N	s	p	r	b



Mortgage

- Long-term mortgages
  - No refinance, or HELOC
  - Non-defaultable
  - Adjustable mortgage rate (exogenous)
  - Minimum mortgage payment in each period following constant amortization over the remaining of lifetime
- maximum mortgage loan

$$\lambda_m(h')p_h h' = \begin{cases} \lambda_1 p_h h' & \text{if } h' \leq \hat{h} \text{ and } j \leq J^M \\ \lambda_1 p_h \hat{h} + \lambda_2 p_h (h' - \hat{h}) & \text{if } h' > \hat{h} \text{ and } j \leq J^M \\ 0 & \text{if } j > J^M \end{cases}$$

Household's Problem

- Idiosyncratic state vector $\chi = (b, m, h, y, j)$
- The measure of household across individual states: $\mu(\chi)$
- Aggregate state $\Omega = (\phi, \mu)$

Beginning-of-period function

- W/o house

$$V_j^N(b, y; \Omega) = \max\{V_j^r(b, y; \Omega), V_j^b(b, y; \Omega)\}$$

- W house

$$V_j^H(b, m, h, y; \Omega) = \max\{V_j^p(b, m, h, y; \Omega), V_j^s(b, m, h, y; \Omega)\}$$

Household's Problem

Intermediate value function

- Buy

$$V_j^b(b, y; \Omega) = \max_{\{c, b', m', h'\}} u(c, s; \phi) + \beta E_{y', \phi'}[V_{j+1}^H(b', m', h', y'; \Omega')|y, \phi]$$

$$\begin{aligned} s.t. \quad & c + p_h h' + q_b b' + \kappa_m \cdot 1_{\{m'>0\}} + \kappa_j \leq b + y + m' \\ & b' \geq 0, \ m' \geq 0 \\ & s = h', h' \in \mathcal{H}^1 \\ & m' \leq \lambda_m(h') p_h h' \\ & \mu' = \Gamma_\mu(\mu; \phi', \phi) \end{aligned}$$

Household's Problem

Intermediate value function

- Rent

$$V_j^r(b, y; \Omega) = \max_{\{c, b', \tilde{h}'\}} u(c, s; \phi) + \beta E_{y', \phi'}[V_{j+1}^N(b', y'; \Omega')|y, \phi]$$

$$\begin{aligned} s.t. \quad & c + \rho_h \tilde{h}' + q_b b' \leq b + y \\ & b' \geq 0 \\ & s = \omega \tilde{h}', \tilde{h}' \in \tilde{\mathcal{H}} \\ & \mu' = \Gamma_\mu(\mu; \phi', \phi) \end{aligned}$$

Household's Problem

Intermediate value function

- Pay

$$V_j^p(b,m,h,y;\Omega) = \max_{\{c,b',\pi\}} u(c,s;\phi) + \beta E_{y',\phi'}[V_{j+1}^H(b',m',h',y';\Omega')|y,\phi]$$

$$\begin{aligned} s.t. \quad & c + \delta_h p_h h + \pi + q_b b' \leq b + y \\ & b' \geq 0 \\ & s = \min\{h', \hat{h}\}, h' = h \\ & \pi \geq \pi_m \equiv \frac{r_m(1+r_m)^{J+1-j}}{(1+r_m)^{J+1-j}-1} m \\ & m' = (1+r_m)m - \pi \\ & \mu' = \Gamma_\mu(\mu;\phi',\phi) \end{aligned}$$

Household's Problem

Intermediate value function

- Sell

$$V_j^s(b, m, h, y; \Omega) = \max\{V_j^{sr}(b_n, y; \Omega), V_j^{sb}(b_n, y; \Omega)\}$$

$$s.t. \quad b_n = b + (1 - \delta_h - \kappa_h)p_h h - (1 + r_m)m - \kappa_j$$

Supply Side

- Rental housing sector
  - The representative rental company's problem

$$J(\tilde{H};\Omega) = \max_{\tilde{H}'} \; [\rho_h(\Omega) - \psi]\tilde{H}' - p_h(\Omega)[\tilde{H}' - (1-\delta_h)\tilde{H}] + \frac{1}{1+r_b} E_{\Omega'|\Omega} J(\tilde{H}';\Omega')$$

  - Zero-profit condition $\rightarrow$ equilibrium rental rate

$$\rho_h(\Omega) = \psi + p_h(\Omega) - \frac{1-\delta_h}{1+r_b} E_{\Omega'|\Omega}[p_h(\Omega')]$$

Supply Side (cont.)

- Non-housing goods production sector
  - Linear technology in labor: $Y = \Theta N_c$
- Housing production sector
  - The government issues new permits equivalent to $\bar{L}$ units of land each period. These permits are sold in a competitive markets to real estate developers.
  - After acquiring the land permit, each competitive real estate developer combines labor and land to produce new houses

$$\max_{N_h} \; p_h I_h - w N_h$$

$$s.t. \; I_h = (\Theta N_h)^{\alpha} (\bar{L})^{1-\alpha}$$

  - Housing supply function

$$I_h = (\alpha p_h)^{\frac{\alpha}{1-\alpha}} \bar{L} \Rightarrow p_h = \frac{1}{\alpha} (I_h)^{\frac{1-\alpha}{\alpha}}$$

- Free mobility of labor between the two sectors

Housing Market

- Housing market clear

$$\tilde{H}' + H' = (1 - \delta_h)(\tilde{H} + H) + I_h$$

where

- $\tilde{H}' = \int \tilde{h}' d\mu$
- $H' = \int h' d\mu$

Calibration

- We calibrate initial steady state of the model to match the key aggregate and cross-sectional moments before the relaxation of LTV policy in 2014Q4.
- Each period corresponds to a two-year horizon.

Parameter Values and Targeted Moments

Parameters	Description	Target
Demographics		
J^{ret}	Retirement age (years)	avg. retirement age
J	Length of life (years)	avg. life expectancy
ν	High labor-ability household share	0.5
Preferences		
γ	Inv. elasticity of substitution	Piazzesi, Schneider and Tuzel (2017)
σ	Risk aversion	standard in literature
β	Discount factor	Wealth to income ratio
ϕ_L	Housing preference	Housing expenditure share
ϕ_H	Housing preference	2nd house home ownership rate
Π_{lh}	Prob: ϕ_L to ϕ_H	Average ratio of mortgage debt to income
ω	Utility discount for renting	Average homeownership rate
φ	Strength of bequest motive	Net worth ratio b/w 75 and 55
Endowments		
ε_j	Life-cycle profile	He, Ning and Zhu (2018)
ρ_ϵ	Income correlation	Imrohoroglu and Zhao (2018)
σ_ϵ	S.D. of income shocks	Imrohoroglu and Zhao (2018)
η_H	High labor ability	College Premium, Wang (2012)
ξ	Replacement rate	0.5

Parameter Values and Targeted Moments

Parameters	Description	Target
Housing		
$\mathcal{H}$	Owner housing grid	Housing wealth to wealth ratio
$\tilde{\mathcal{H}}$	Renter housing grid	owner to renter income ratio
$\hat{h}$	2nd house cutoff	2nd house mortgage amount share
κ_h	Housing sale transaction cost	3%
δ_h	Housing depreciation rate	OECD
ψ	Rent company operation cost	Home ownership rate under 30
$\alpha/(1-\alpha)$	Housing supply elasticity	Wang, Chan and Xu (2012)
$\bar{L}$	Land endowment	Housing price to income ratio
Financial Instruments		
r_b	interest rate for financial assets	Deposit rate
r_m	Mortgage rate	Average mortgage rate
κ_m	Mortgage origination cost	2nd house mortgage number share
κ_j	Moving cost	Middle-aged & old mortgage number share

Targeted Moments: Model vs Data

Moments	Data	Model
Homeownership rate	0.86	0.86
Homeownership rate under 30	0.67	0.69
2nd house mortgage amount share	0.05	0.03
2nd house mortgage number share	0.05	0.04
2nd house homeownership rate	0.15	0.06
Aggregate wealth to income ratio	9.20	8.54
Outstanding mortgage to income ratio	3.38	3.12
Owner over renter income ratio under 30	2.65	3.10
Purchased house value to income ratio	7.30	8.11
Net worth ratio of 75 to 55	0.82	0.81
Mortgage number share for middle-aged	0.58	0.57
Mortgage number share for old	0.06	0.07
housing wealth to net wealth ratio: p10	0.56	0.68
housing wealth to net wealth ratio: p50	0.88	0.95
housing wealth to net wealth ratio: p90	0.98	1.00

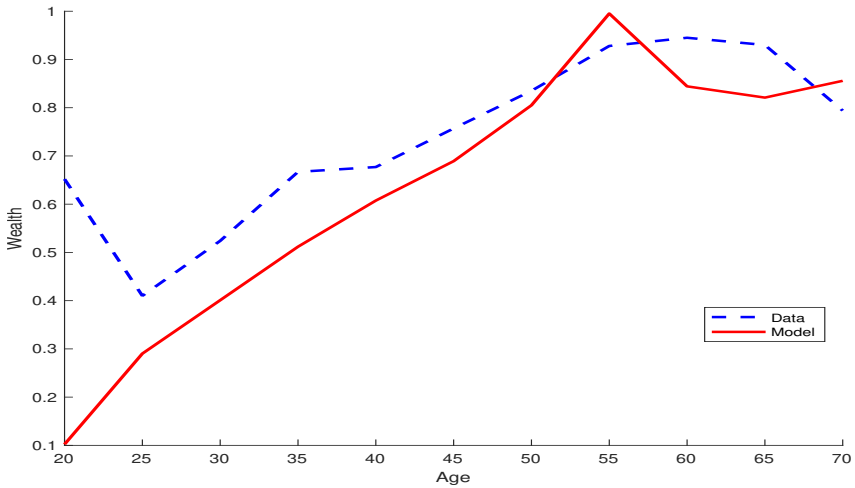
Cross-sectional (Untargeted) Moments: Model vs Data

Moments	Data	Model
Net wealth Gini coefficient	0.59	0.46
Net housing wealth Gini coefficient	0.56	0.50
Net wealth share: bottom quintile	0.01	0.04
Net wealth share: middle quintile	0.11	0.15
Net wealth share: top quintile	0.62	0.51
Housing wealth to income for owners: p10	2.27	4.46
Housing wealth to income for owners: p50	9.75	9.04
Housing wealth to income for owners: p90	42.05	15.13

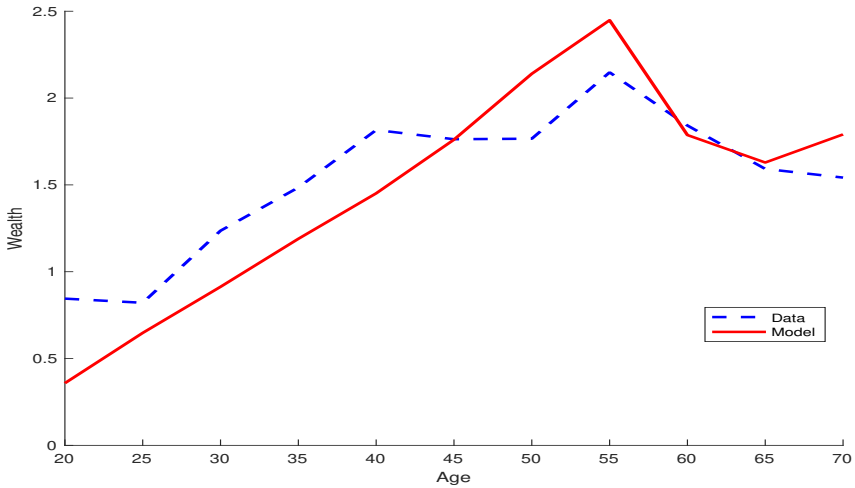
Note: The table reports cross-sectional moments. The empirical moments are calculated from China Household Finance Survey.

Lifecycle Profiles of Wealth: Model vs Data

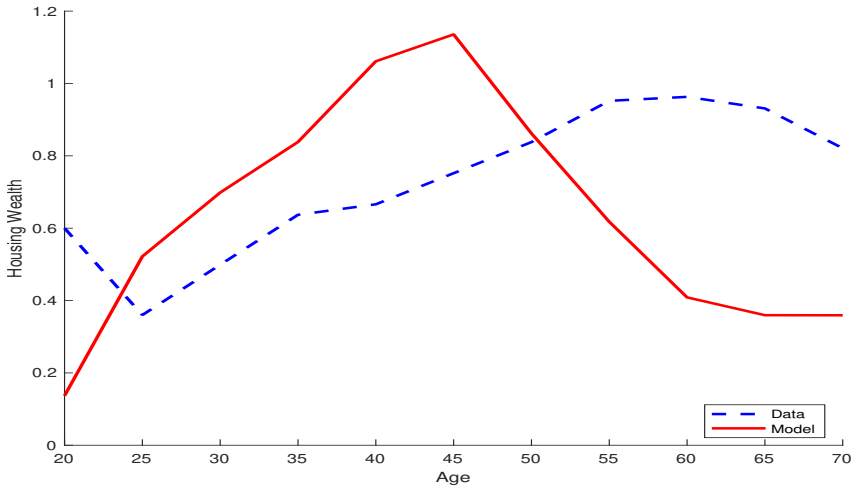
Wealth: Low Income



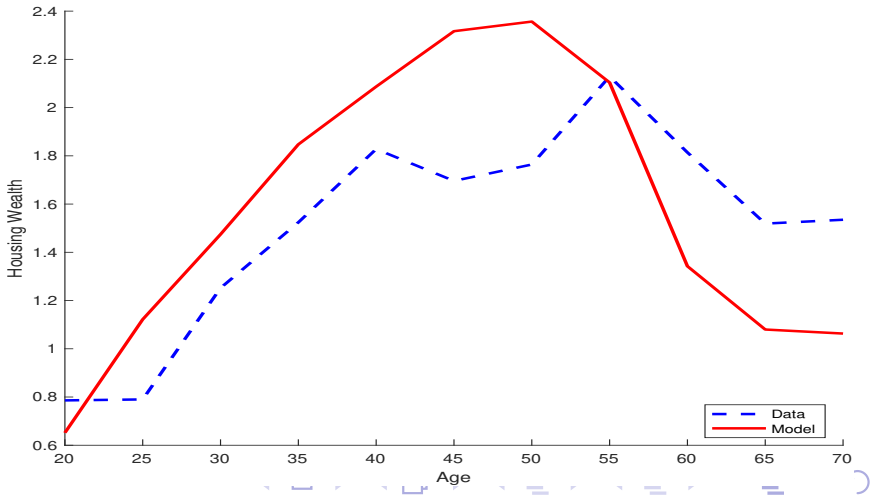
Wealth: High Income



Housing Wealth: Low Income

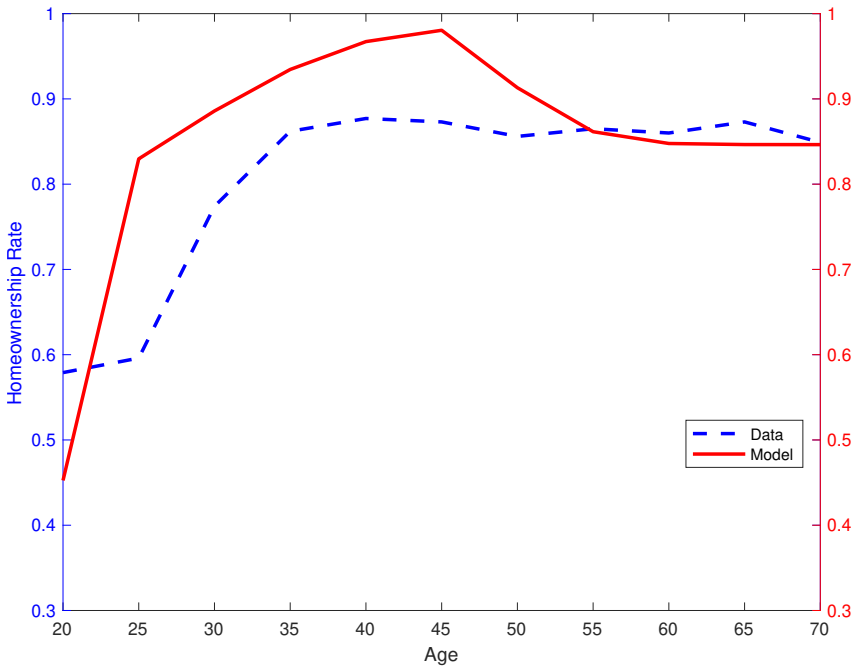


Housing Wealth: High Income

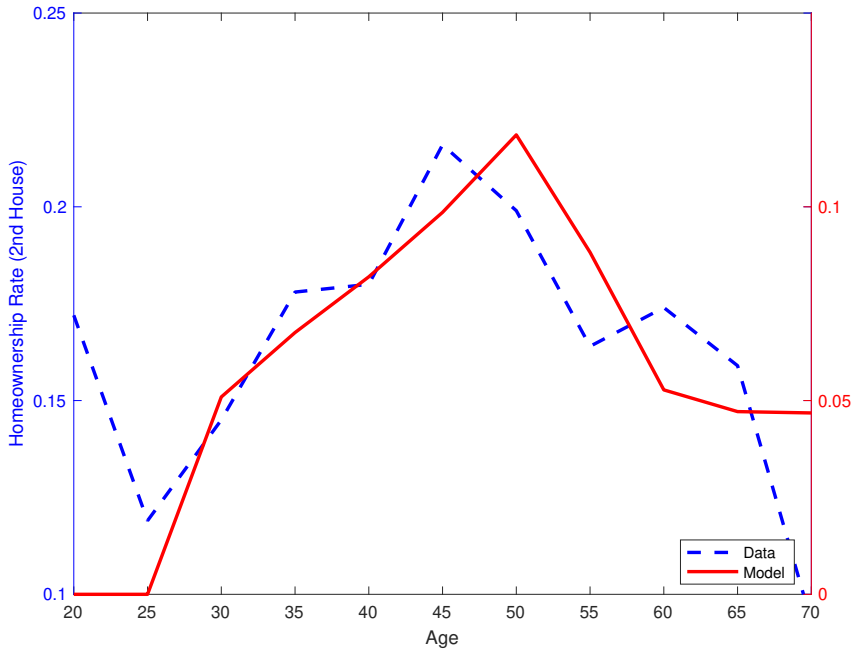


Lifecycle Profiles of Homeownership Rate: Model vs Data

Homeownership Rate



Homeownership Rate: 2nd+ House



Mortgage Policy Change: Baseline Experiment

- In period 1, higher max LTV for 2nd house (MIT shock)
  - 2nd H LTV limit $\uparrow$ from 0.3 to 0.7.
  - Households expect that the new LTV policy will last forever.
- In period 2, the 2nd H LTV limit experiences a surprise reversal back to 0.3.
- 2nd H LTV limit $= 0.3$ is maintained throughout the rest of transition period and the new steady state.

Aggregate Impacts of Relaxation of LTV Policy

Table: Aggregate Impacts on Housing Prices, Mortgage and Consumption

	Model	Data
House price	3.97%	5.68%
Mortgage amount	28.49%	30.38%
Mortgage number	12.64%	17.13%
Mortgage amount (1st H)	19.53%	27.28%
Mortgage number (1st H)	8.43%	15.59%
Consumption	-2.60%	-0.89%

Distributional Impacts on Mortgage and Consumption

Table: Changes in Mortgage Share and Consumption by Age and Education

	Share Change				Growth Rate	
	Mortgage Amount		Mortgage Number		Consumption	
	L Edu	H Edu	L Edu	H Edu	L Edu	H Edu
Young	-4.29%	1.51%	-8.70%	2.60%	1.43%	-6.36%
Middle-aged	-6.28%	11.62%	-1.45%	8.75%	0.36%	-0.86%
Old	-0.33%	-2.22%	-0.27%	-0.93%	-8.17%	-0.77%

The Role of Increasing Housing Prices (1/2)

- The counterfactual experiment: (2nd house) LTV policy changes but house price don't increase.

Table: Counterfactual Experiment: Aggregate Impacts on Housing Prices, Mortgage and Consumption

	Counterfactual	Benchmark	Data
House price	0.00%	3.97%	5.68%
Mortgage amount	10.45%	28.49%	30.38%
Mortgage number	3.48%	12.64%	17.13%
Mortgage amount (1st H)	-0.72%	19.53%	27.28%
Mortgage number (1st H)	-0.43%	8.43%	15.59%
Consumption	-0.11%	-2.60%	-0.89%

The Role of Increasing Housing Prices (2/2)

Table: Changes in Mortgage Share for 1st Houses by Age and Education

	Share Change			
	Mortgage Amount		Mortgage Number	
	L Edu	H Edu	L Edu	H Edu
Young	-0.04%	0.23%	0.05%	0.16%
Middle-aged	0.46%	-0.68%	0.30%	-0.55%
Old	0.01%	0.02%	0.01%	0.04%

The Contribution of Churning-Up to the Housing Boom

Table: The Contribution of Churning-up to Increase in Mortgage and Housing: (Percent)

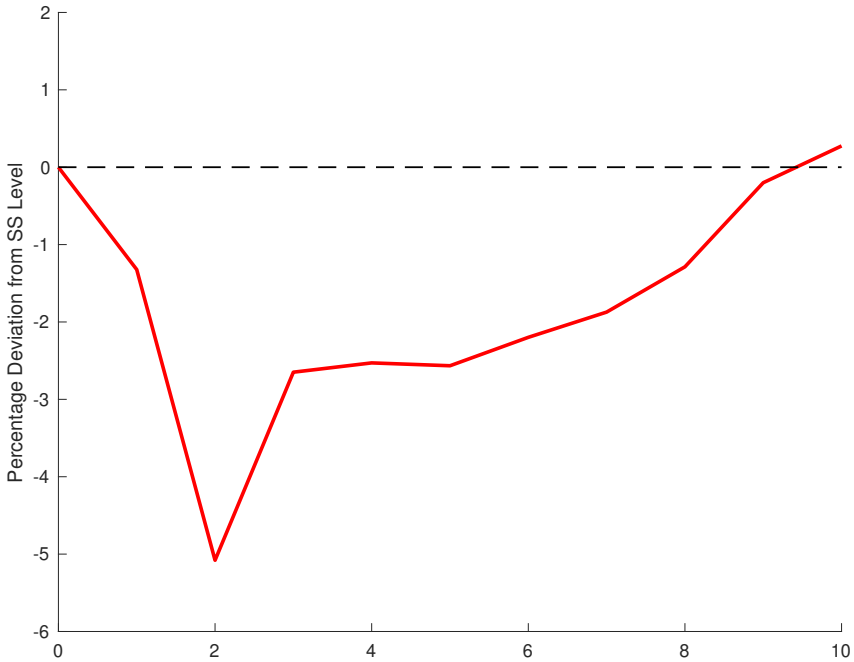
	Mortgage Amount	Mortgage Number	Housing Demand
1st House	49.31%	91.39%	53.97%

Table: The Contribution of Churning-up (1st H) by Age-Education: (Percent)

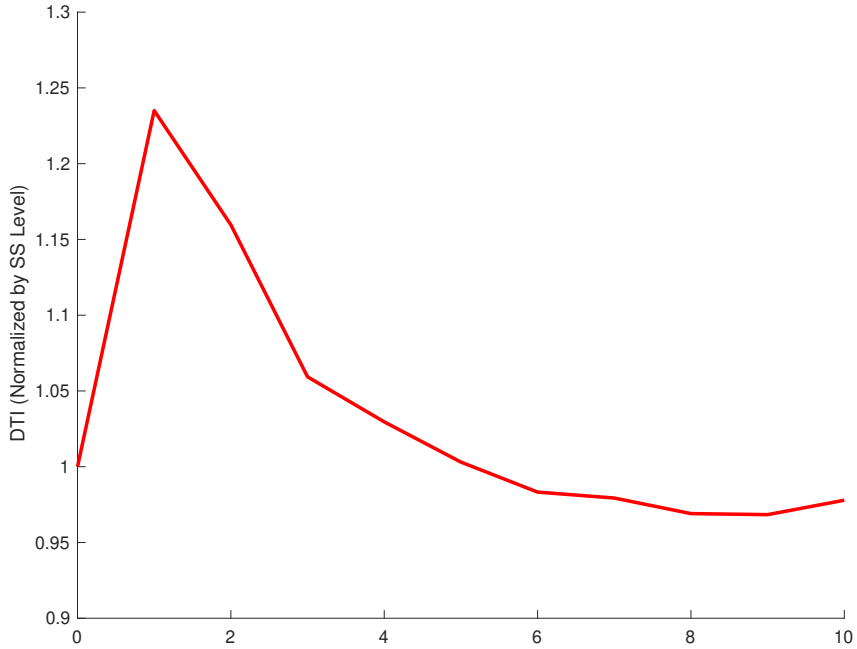
	Mortgage Amount		Mortgage Number		Housing Demand	
	L Edu	H Edu	L Edu	H Edu	L Edu	H Edu
Young	3.92%	5.99%	6.84%	18.11%	4.33%	6.55%
Middle-Aged	13.78%	25.61%	27.91%	38.52%	15.07%	28.03%
Old	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Long-run Impacts

Consumption: Middle-aged High-educated



Debt-to-income Ratio: Middle-aged High-educated



Counterfactual Experiment: λ_1 increase to 0.8

Table: Changes in Mortgage Share and Consumption by Age and Education

	Share Change				Growth Rate	
	Mortgage Amount		Mortgage Number		Consumption	
	L Edu	H Edu	L Edu	H Edu	L Edu	H Edu
Young	0.02%	4.41%	-0.59%	0.78%	-15.21%	-4.47%
Middle-aged	-4.31%	3.65%	-1.57%	3.68%	-0.36%	1.42%
Old	-0.56%	-3.21%	-0.29%	-2.01%	-6.24%	-0.39%

Welfare Implications

- Consumption Equivalent Variation

$$\Delta\tilde{c}_j = \left[\left(V_j^{TR}/V_j^{SS}\right)^{\frac{1}{1-\sigma}} - 1\right] \times 100\%$$

Table: Welfare Effects of Baseline Policy Experiment

	All	Non-homeowners	Existing homeowners
All	-0.53	-4.30	0.24
Young	-1.92	-4.14	0.18
Middle-aged	0.22	-3.21	0.43
Old	-0.64	-4.86	0.09

	All		Non-homeowners		Existing homeowners	
	L Edu	H Edu	L Edu	H Edu	L Edu	H Edu
Young	-2.87	-0.51	-4.66	-2.68	-0.17	0.49
Middle-aged	0.08	0.42	-3.38	-2.49	0.37	0.50
Old	-1.14	0.12	-5.11	-1.21	0.03	0.15

Welfare impacts of LTV Policy Change: Constant Housing Price

Table: Welfare Effects of Baseline Policy Experiment: Constant Housing Price

	All	Non-homeowners	Existing homeowners
All	0.08	-0.00	0.09
Young	0.07	-0.00	0.14
Middle-aged	0.17	-0.00	0.18
Old	0.00	0.00	0.00

	All		Non-homeowners		Existing homeowners	
	L Edu	H Edu	L Edu	H Edu	L Edu	H Edu
Young	-0.00	0.18	-0.00	-0.00	-0.00	0.26
Middle-aged	0.01	0.40	-0.00	-0.00	0.01	0.41
Old	-0.00	0.01	0.00	0.00	-0.00	0.01

Concluding Remarks

- We find empirically that a relaxation of LTV policy has significant aggregate and distributional impacts:
  - stimulate the mortgage loan by middle-aged high-educated households at the sacrifice of young households.
  - slowdown consumption growth of middle-aged, high-educated household.
- We build a dynamic OLG equilibrium model with household heterogeneity to account for the empirical findings.
  - Our theory highlights a novel channel for changes in credit conditions to affect housing demand via equilibrium housing prices.
  - The relaxation of LTV policy is quantitatively important for the increase in housing prices (mortgage credit) during the boom.
  - This policy generates unintended welfare loss, especially for those low-educated young households, by crowding them out from the housing market.

Appendix

Literature on housing booms and busts

- Empirics with micro data: Mian and Sufi (2009, 2011); Foote, Loewenstein and Willen (2016) and Adelino, Schoar and Severino (2017), Albanesi, De Giorgi and Nosal (2017)
- Transmission channel: Stein (1995), Ortalo-Magne and Rady (2006)
- Quantitative housing theory: Landvoigt, Piazzesi and Schneider (2015), Favilukis, Ludvigson, and Van Nieuwerburgh (2017); Kiyotaki, Michaelides and Nikolov (2011), Kaplan, Mitman and Violante (2017), Greenwald (2018), Greenwald and Guren (2019)
- Effects of housing prices on consumption via housing wealth effects: Mian, Rao and Sufi (2013), Berger, Guerrieri, Lorenzoni and Vavra (2017), Beraja et. al (2018), Guren et. al (2018)

Distributional Impacts on 1st-House Mortgage

Table: Changes in Mortgage Share for 1st Houses by Age and Education

	Share Change			
	Mortgage Amount		Mortgage Number	
	L Edu	H Edu	L Edu	H Edu
Young	-3.09%	-1.11%	-8.22%	1.98%
Middle-aged	-1.64%	7.94%	1.07%	5.80%
Old	-0.26%	-1.85%	-0.16%	-0.46%

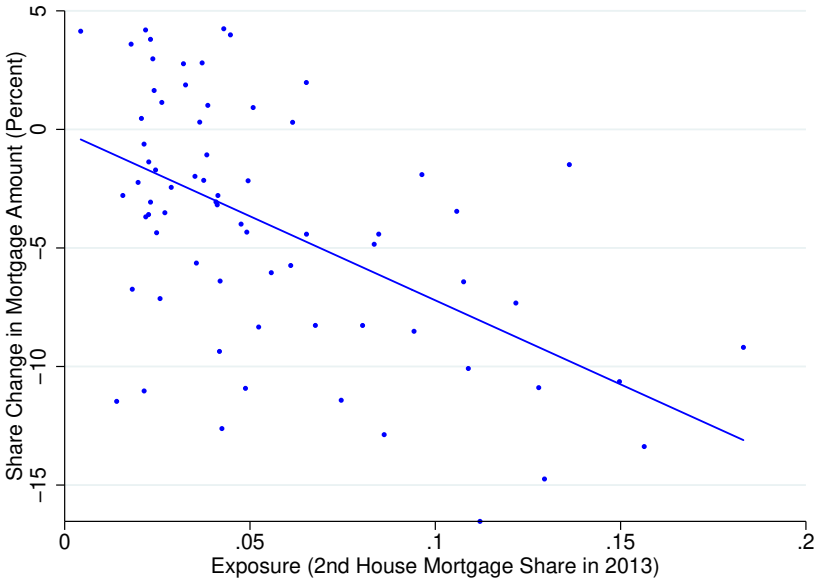
Counterfactual Experiment: Interest Rate Cut by 1.5%

Table: Changes in Mortgage Share and Consumption by Age and Education

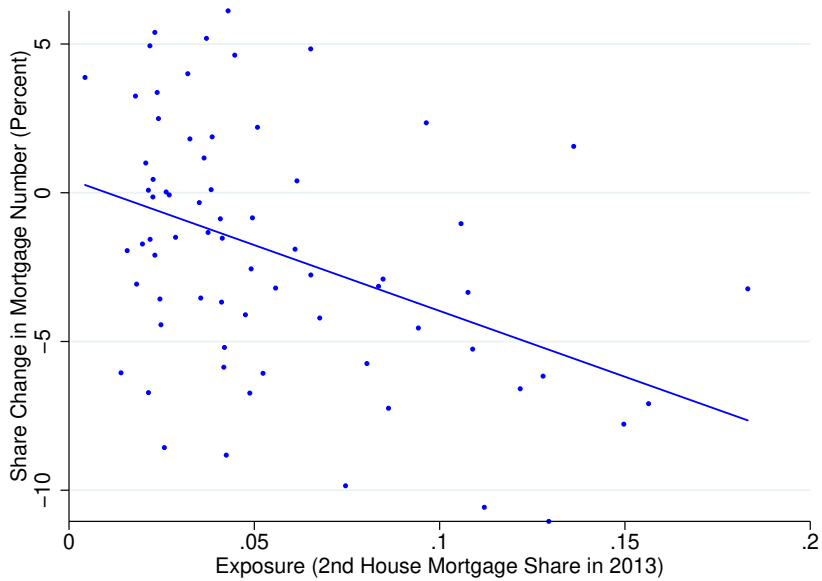
	Share Change				Growth Rate	
	Mortgage Amount		Mortgage Number		Consumption	
	L Edu	H Edu	L Edu	H Edu	L Edu	H Edu
Young	-1.35%	-1.21%	-6.28%	0.44%	6.62%	-3.41%
Middle-aged	0.06%	2.25%	0.32%	4.90%	6.08%	3.54%
Old	0.39%	-0.14%	0.27%	0.34%	2.58%	4.95%

Mortgage Share Change (2013-2015) vs Exposure: Young

Mortgage Origination Amount

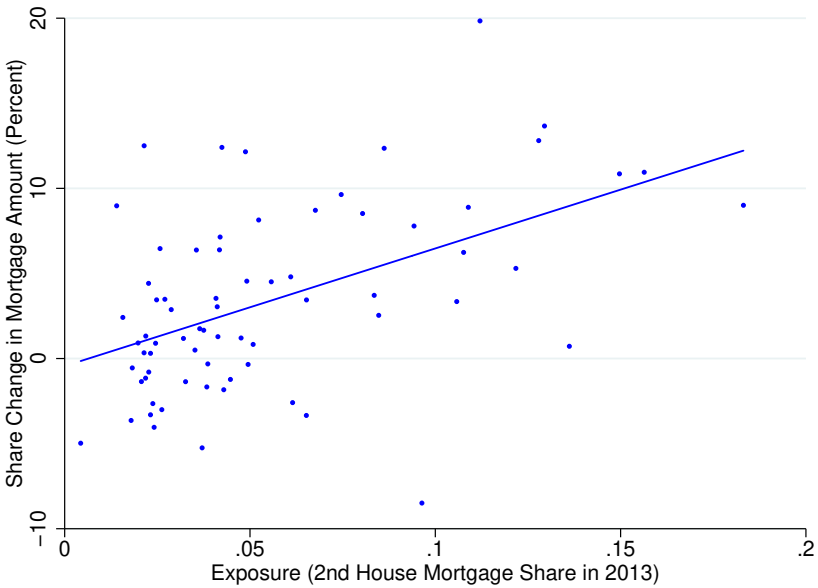


Mortgage Origination Number

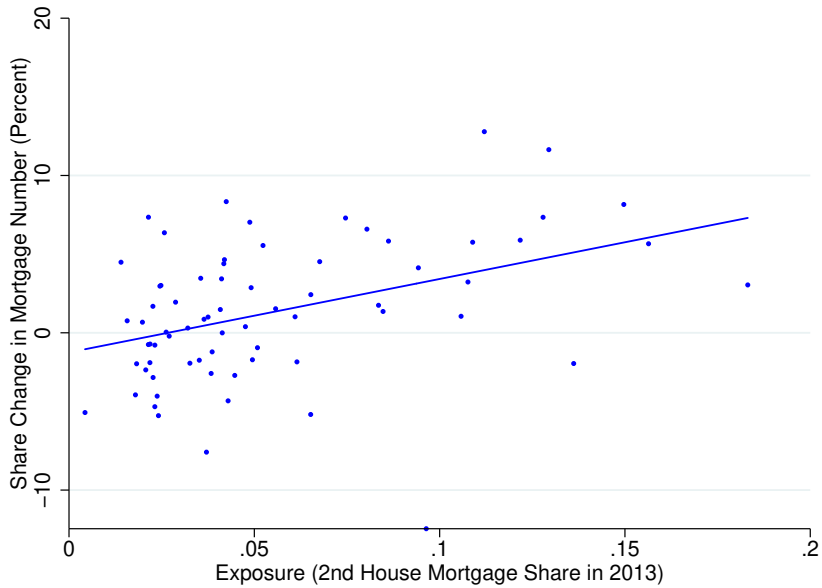


Mortgage Share Change (2013-2015) vs Exposure: Middle-Aged

Mortgage Origination Amount

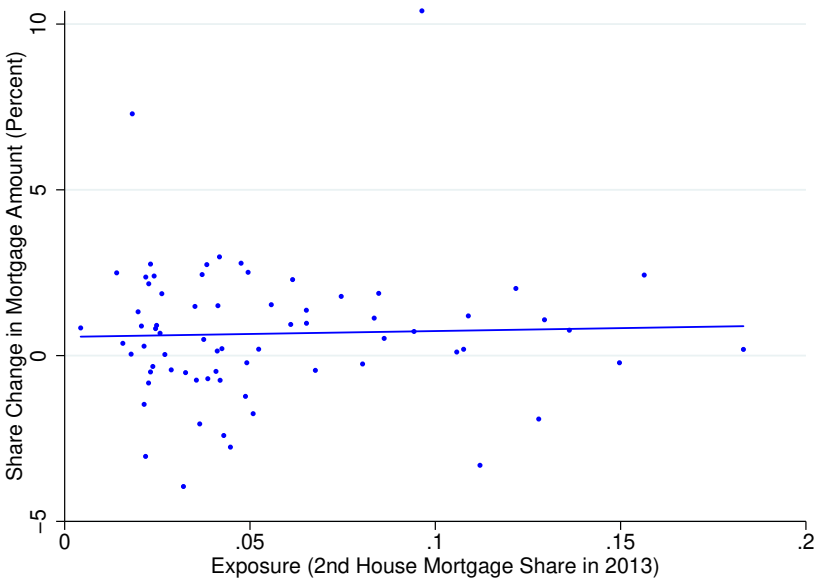


Mortgage Origination Number

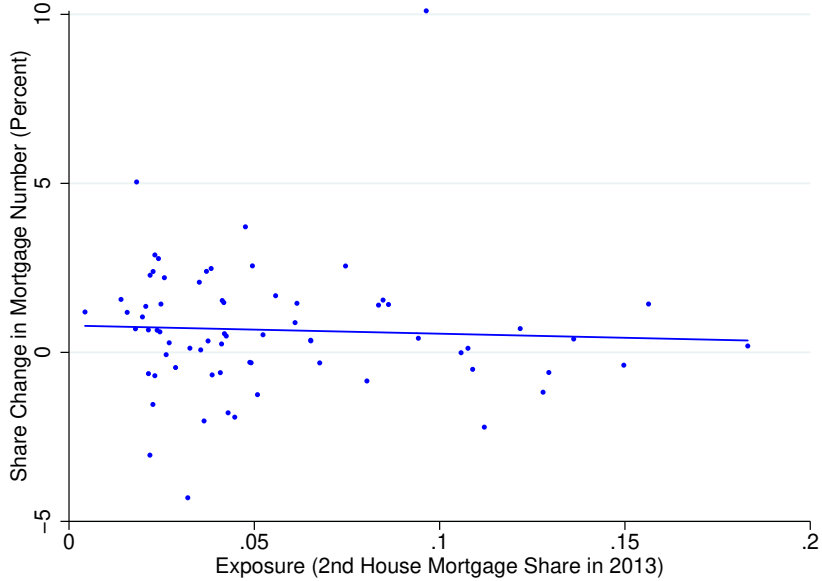


Mortgage Share Change (2013-2015) vs Exposure: Old

Mortgage Origination Amount

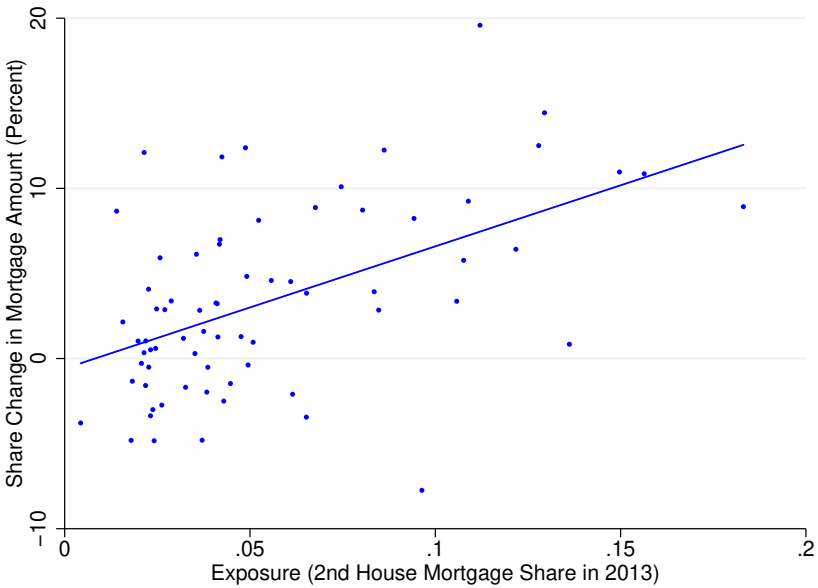


Mortgage Origination Number



Mortgage Share Change (2013-2015) vs Exposure: Middle-Aged High-Educated

Mortgage Origination Amount



Mortgage Origination Number

