Housing, Debt, and the Marginal Propensity to Consume

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Motivation

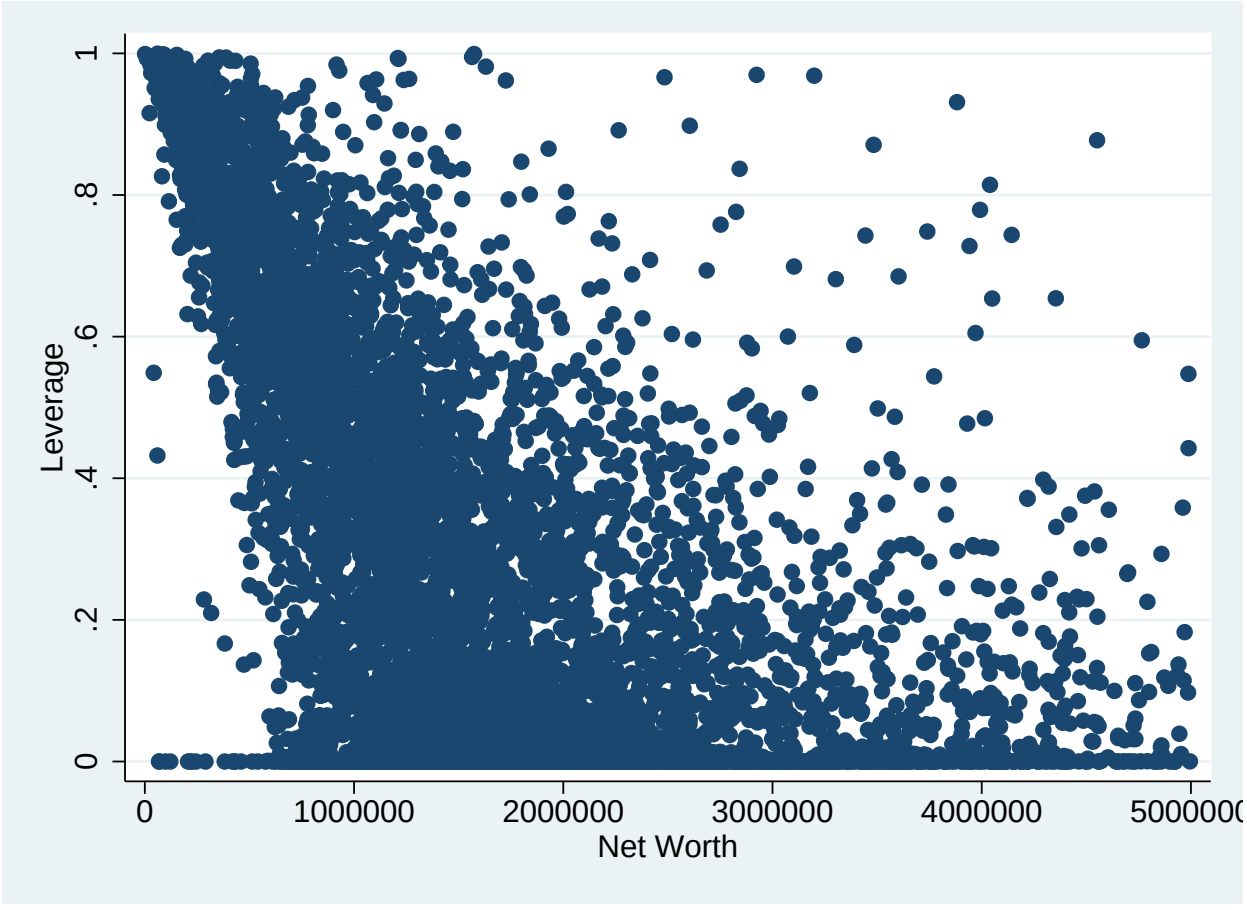
- What determines the marginal propensity to consume (MPC)?
  - Fundamental in macroeconomics
    - Aggregate demand
  - Highly policy relevant
    - Household debt overhang
    - Effect of stimulus policy and austerity
- How important are household balance sheets for the MPC?

▸ Heterogeneity

Heterogeneity in Housing Leverage

0.2% Random Sample of the Data

▸ Leverage



$$lev_t = \frac{B_t}{H_t}$$

Balance sheets and the MPC

- Existing Theory
  - Buffer stock saving models (Carroll (1992; 1997))
    - MPC declines monotonically in wealth (concavity)
    - Key: degree of impatience, income uncertainty
  - Two-asset models (Kaplan & Violante 2014)
    - Wealthy hand-to-mouth (HtM)
    - Key: high-return illiquid asset
- Recent empirical evidence
  - Mian & Sufi (2013): ZIPs with more levered HH had higher MPC
  - Kaplan & Violante (2014): 30% of U.S. HH are wealthy HtM

Our Paper

- Lessons from recent evidence
  - MPC seems declining in wealth and related to leverage
  - Housing seems important
    - A substantial fraction of wealth, but illiquid
- Gap: a micro-founded model with credible implications about MPC
  - useful for quantitative evaluation of macro questions with micro data e.g. the effect of credit contraction/expansion
- Contribution of this study:
  - new evidence about leverage and MPC at the micro level
  - a consumption-saving life cycle model with endogenous leverage
    - matches the life cycle profiles of household balance sheets
    - generates the relation between MPC and leverage seen in the data

Literature

- Debt and consumption
  - Dynan (2012), Mian et al (2013)
  - Eggertsson and Krugman (2012), Guerrieri and Lorenzoni (2011)
- Excess sensitivity
  - Baker (2014; 2015); Parker (2015)
  - Carroll et al (2014), Kaplan and Violante (2014)
- Life cycle choices
  - Gourinchas and Parker (2002), Cagetti (2003)
  - Fernandez-Villaverde and Krueger (2011), Yang (2009)
- Solving dynamic stochastic optimization problem
  - Carroll (2006)
  - Iskhakov et al (2014), Hintermaier and Koeniger (2010)

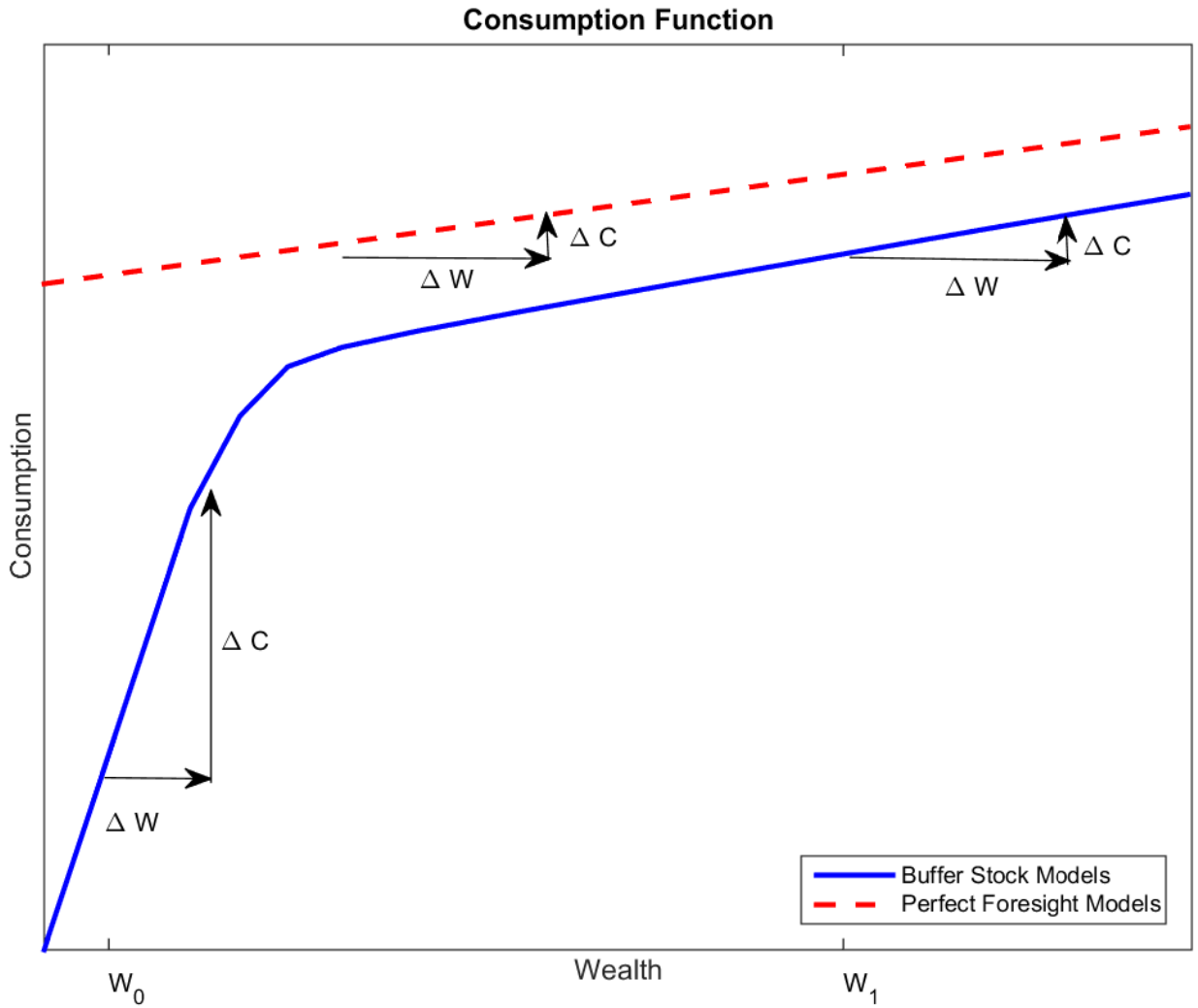
Road Map

- Leverage and MPC in micro data
  - Data
  - Leverage and consumption response to wealth changes
- A consumption-saving life cycle model
  - explicit modeling of housing and debt
  - liquid and illiquid assets (cf. Kaplan and Violante 2014)
- Model vs. data and implications for MPC
- Policy implications
  - A sudden credit contraction
  - A permanently lower LTV-limit

Data

- Norwegian registry data 2005-2011
  - Household level data in normal times
  - Knowledge about the structure and the dynamics of balance sheets (not available in PSID)
- Full balance sheet
  - Housing
  - Debt
  - Financial assets
    - Deposits
    - Bonds
    - Stocks
    - Mutual funds
  - Income
- Imputed consumption
- Detailed household characteristics
  - Area, education, marital status, family type and size, etc

Concavity of Consumption Function



Mian-Rao-Sufi Type Regressions on Micro Data

- Regression equation

$$\begin{aligned}\Delta C_{it} &= \beta_0 + \beta_1 \Delta W_{it} + \beta_2 W_{it-1} + \beta_3 \Delta W_{it} \times W_{it-1} \\ &\quad + \beta_4 lev_{it-1} + \beta_5 \Delta W_{it} \times lev_{it-1} + \text{control variables} + \epsilon_{it}\end{aligned}$$

- From simple buffer-stock theory:
  - $\beta_3 < 0$
  - $\beta_5 = 0$

Mian-Sufi Type Regressions on Micro Data

Fixed Effect

- Regression equation

$$\Delta C_{it} = \beta_{0,i} + \beta_{1,i}\Delta W_{it} + \beta_2 W_{it-1} + \beta_3 \Delta W_{it} \times W_{it-1}$$
$$+\beta_4 lev_{it-1} + \beta_5 \Delta W_{it} \times lev_{it-1} + \text{control variables} + \epsilon_{it}$$

- Fixed effect in slopes (FEIS)
  - Unobserved household heterogeneity (preference, expectations, etc)
  - Parker (2015): MPC a persistent household trait, related to impatience

Mian-Rao-Sufi Type Regressions on Micro Data

Dep.Var:	ΔC_t			
	(1)	(2)	(3)	(4)
ΔW_t	0.595***	0.445***	0.531***	.
	(0.002)	(0.002)	(0.106)	
W_{t-1}	-0.012***	-0.060***	-0.096***	0.121***
	(0.000)	(0.000)	(0.001)	(0.004)
$\Delta W_t \times W_{t-1}$	-0.015***	0.003***	0.008***	0.064***
	(0.001)	(0.001)	(0.001)	(0.007)
lev_{t-1}		-0.194***	-0.337***	-0.747***
		(0.001)	(0.001)	(0.008)
$\Delta W_t \times lev_{t-1}$		0.197***	0.226***	0.375***
		(0.002)	(0.002)	(0.022)
Year#	X	X	X	X
$\bar{Y}$#			X	X
CHAR#			X	X
FEIS				X
adj. R^2	0.281	0.309	0.346	0.231
N	1,346,844	1,346,844	1,346,264	1,191,995

Mian-Rao-Sufi Type Regressions on Micro Data

Aggregation

Dep.Var:	ΔC_t			
Agg. Level:	Household	Household	Municipality	County
	(1)	(2)	(3)	(4)
$\Delta W_t \times lev_{t-1}$	0.226***	0.375***	0.348***	0.390
	(0.002)	(0.022)	(0.054)	(0.595)
Baseline W_{t-1}	X	X	X	X
Year#	X	X	X	X
Age#	X	X	X	X
CHAR#	X	X		
FEIS		X		
adj. R^2	0.291	0.231	0.939	0.950
N	1,346,844	1,191,995	2,147	95

Mian-Rao-Sufi Type Regressions on Micro Data

Alternative Specification

- Controlling for wealth-to-income ratio

$$\begin{aligned}\Delta C_{it} &= \beta_0 + \beta_1 \Delta W_{it} + \beta_2 \frac{W_{it-1}}{Y_{it-1}} + \beta_3 \Delta W_{it} \times \frac{W_{it-1}}{Y_{it-1}} \\ &\quad + \beta_4 lev_{it-1} + \beta_5 \Delta W_{it} \times lev_{it-1} + \text{control variables} + \epsilon_{it}\end{aligned}$$

Mian-Rao-Sufi Type Regressions on Micro Data

Alternative Specification

- Controlling for wealth-to-income ratio

$$\Delta C_{it} = \beta_{0,i} + \beta_{1,i}\Delta W_{it} + \beta_2 \frac{W_{it-1}}{Y_{it-1}} + \beta_3 \Delta W_{it} \times \frac{W_{it-1}}{Y_{it-1}}$$
$$+\beta_4 lev_{it-1} + \beta_5 \Delta W_{it} \times lev_{it-1} + \text{control variables} + \epsilon_{it}$$

Mian-Rao-Sufi Type Regressions on Micro Data

Dep.Var:	ΔC_t			
	(1)	(2)	(3)	(4)
ΔW_t	0.659***	0.521***	0.804***	.
	(0.001)	(0.002)	(0.107)	
$\frac{W_{t-1}}{Y_{t-1}}$	0.001***	-0.013***	-0.012***	0.006***
	(0.000)	(0.000)	(0.000)	(0.001)
$\Delta W_t \times \frac{W_{t-1}}{Y_{t-1}}$	-0.017***	-0.010***	-0.010***	-0.002
	(0.000)	(0.000)	(0.000)	(0.002)
lev_{t-1}		-0.201***	-0.253***	-0.864***
		(0.001)	(0.001)	(0.007)
$\Delta W_t \times lev_{t-1}$		0.167***	0.206***	0.299***
		(0.002)	(0.002)	(0.021)
Year#	X	X	X	X
$\bar{Y}$#			X	X
CHAR#			X	X
FEIS				X
adj. R^2	0.283	0.306	0.335	0.224
N	1,346,844	1,346,844	1,346,264	1,191,995

Mian-Rao-Sufi Type Regressions on Micro Data

Aggregation

Dep.Var:	ΔC_t			
Agg. Level:	Household	Household	Municipality	County
	(1)	(2)	(3)	(4)
$\Delta W_t \times lev_{t-1}$	0.206***	0.299***	0.306***	0.667
	(0.002)	(0.021)	(0.083)	(0.597)
Baseline $\frac{W_{t-1}}{Y_{t-1}}$	X	X	X	X
Year#	X	X	X	X
Age#	X	X	X	X
CHAR#	X	X		
FEIS		X		
adj. R^2	0.335	0.224	0.936	0.949
N	1,346,264	1,191,995	2,147	95

The Role of Housing Leverage

- $\beta_5 > 0$
  - Statistically significant
  - Economically important
    - Consider a household who moved from a small apartment to a big house

$$lev_{t-1} = 0.3 \longrightarrow lev_t = 0.8$$

$$\Delta \left(\frac{dC_t}{dM_t} \right) \approx 0.10$$

- Leverage is related to MPC over and above wealth
- WHY?

The Role of Housing Leverage

- In the presence of housing
  - total wealth is not a good proxy for the proximity to the liquidity constraint
  - but leverage is

- Housing plays several roles in affecting consumption
  - Illiquid wealth
    - In the short run, consumption is more affected by liquid wealth
    - (S,s)-rule over housing
  - Consumption good
    - complementarity with non-housing consumption
  - Collateral

- Will a consumption-saving model with housing generate similar portfolio choices over the life cycle as in the data?
  - And what will it say about the link between leverage and MPC?

Ingredients

- Two assets
  - Housing H and financial wealth M
  - No asset price uncertainty
- Consumption $\tilde{C}(C, S)$
  - Non-housing consumption C and housing service flow S
  - Renters purchase S, homeowners derive utility from owning $S = \zeta H$
- Housing transaction cost
  - Purchase κ_p
  - Sale κ_s
- Other ingredients
  - Income profiles: growth $\{\Gamma_a\}_{a=27}^{90}$ and idiosyncratic risk $\{\sigma^2_{\xi,a}\}_{a=27}^{90}$, $\{\sigma^2_{\psi,a}\}_{a=27}^{90}$
  - Borrowing constraint μ_V, μ_Y, μ_U
  - Conditional probability of survival $\{p^S_a\}_{a=27}^{90}$
  - Family composition $\{N_a^{Adult}\}_{a=27}^{90}$, $\{N_a^{Children}\}_{a=27}^{90}$
  - Bequest motives

Setup
Preferences

- CES consumption index

$$\tilde{C}_a = \left[\alpha_a^{\frac{1}{\theta}} C_a^{\frac{\theta-1}{\theta}} + (1-\alpha_a)^{\frac{1}{\theta}} S_a^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}$$

- Weight on non-housing consumption

$$\alpha_a \propto \alpha \exp\{f_a N_a^{Adult} + f_c N_a^{Children}\}$$

- CRRA utility

$$u(\tilde{C}_a) = \frac{\tilde{C}_a^{1-\rho}}{1-\rho} \qquad \rho > 1$$

- Bequest

$$u^b(W_{a+1}) = \varphi \frac{W_{a+1}^{1-\rho}}{1-\rho},$$

▸ Parameters

Setup
Income Process

- Permanent-transitory type of income process

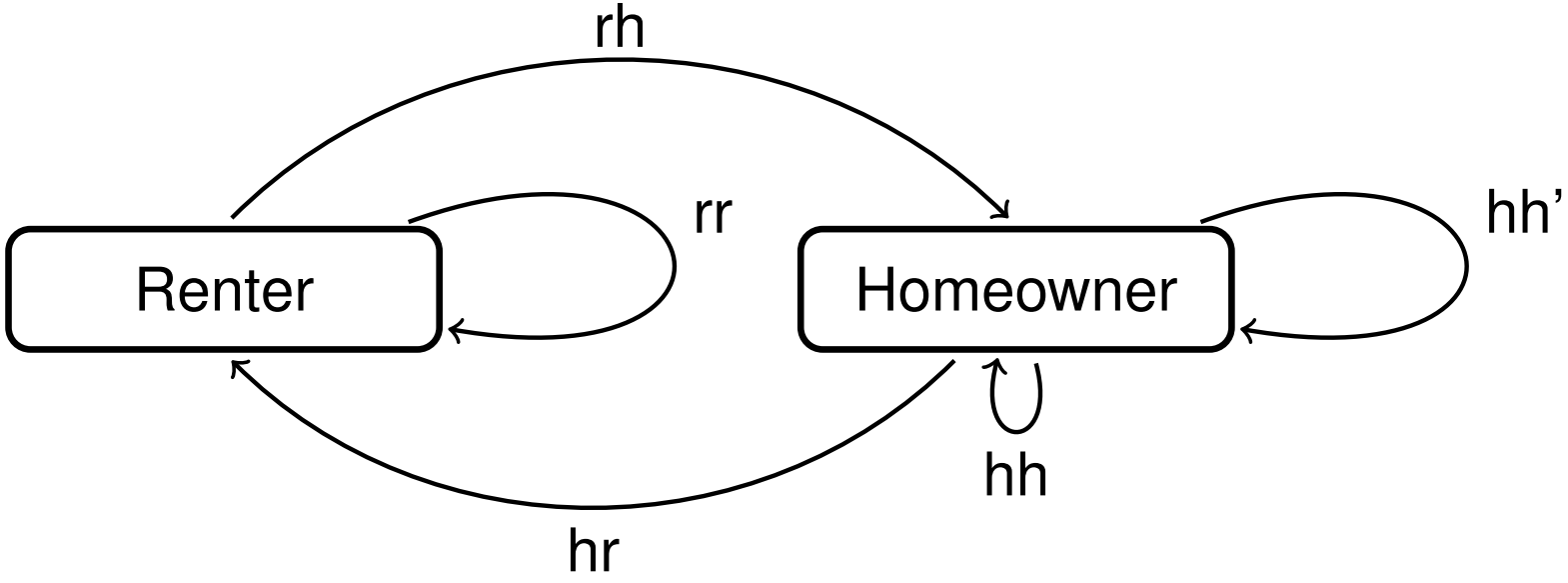
$$\begin{aligned} Y_a &= P_a \Xi_a \\ P_a &= \Gamma_a P_{a-1} \Psi_a \end{aligned}$$

- Notation
  - Y_a – after-tax income
  - P_a – permanent component of income
  - Ξ_a – transitory component of income
  - Γ_a – deterministic growth rate
  - Ψ_a – shock to permanent income
- Permanent and transitory shocks are log-normal

$$\begin{aligned} \xi_a &= \log \Xi_a \sim N(-\sigma^2_{\xi,a}/2, \sigma^2_{\xi,a}) \\ \psi_a &= \log \Psi_a \sim N(-\sigma^2_{\psi,a}/2, \sigma^2_{\psi,a}) \end{aligned}$$

Setup
Renters and Homeowners

- Discrete choices: rr, rh, hr, hh, hh'



- Transaction costs related to housing
  - κ_p, κ_s – Transaction costs of housing purchase and sale

Setup
Borrowing Constraints

- Loan to value
$$A_a \geq -\mu_V H_{a+1}$$
- Loan to income
$$A_a \geq -\mu_Y PV_a$$
where PV_a is expected income in the future
- Unsecured borrowing
$$A_a \geq -\mu_U P_a$$
- Borrowing rate $r_b >$ Risk free rate r

Setup
Households' Problem

$$\max u(\tilde{C}_{a_0}) + E_{a_0}\left[\sum_{a=a_0+1}^{T} \beta^{a-a_0}\left(p_a^S u(\tilde{C}_a) + (1-p_a^S)u^b(W_a)\right)\right]$$

subject to

$$A_a = \begin{cases} M_a - C_a - S_a & rr \\ M_a - C_a - S_a - (1+\kappa_p)H_{a+1} & rh \\ M_a - C_a + (1-\kappa_s-\delta)H_a & hr \\ M_a - C_a + (1-\kappa_s-\delta)H_a - (1+\kappa_p)H_{a+1} & hh' \\ M_a - C_a \quad (H_{a+1} = (1-\delta)H_a) & hh \end{cases}$$

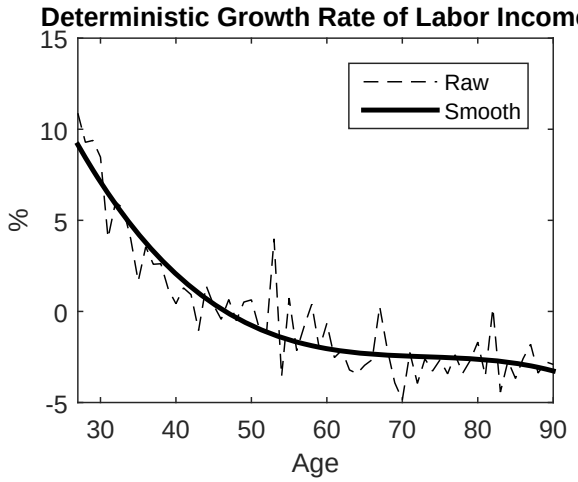
$$M_{a+1} = \begin{cases} (1+r)A_a + Y_{a+1} & A_a \geq 0 \\ (1+r_b)A_a + Y_{a+1} & A_a < 0 \end{cases}$$

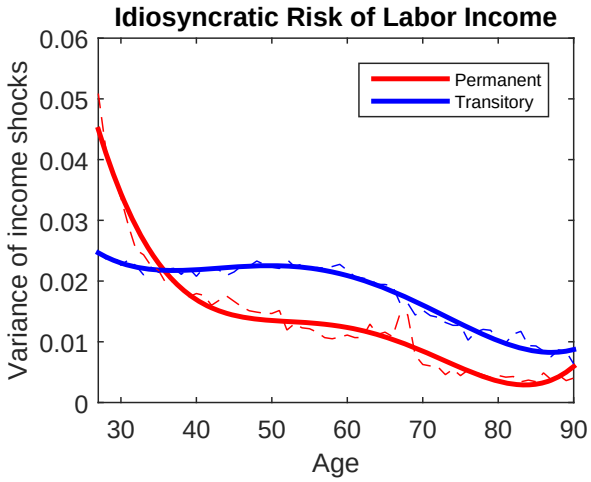
$$W_a = M_a + H_a$$

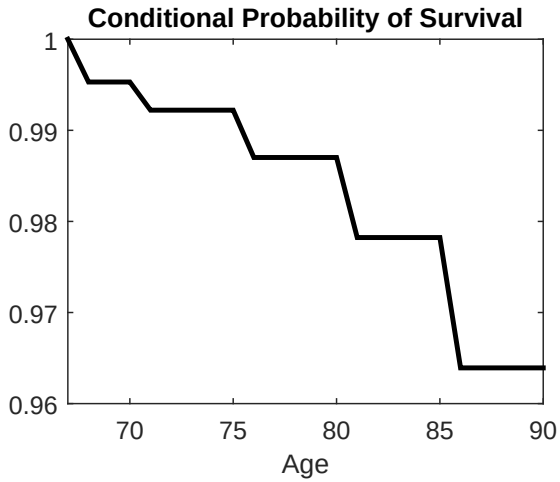
Estimation

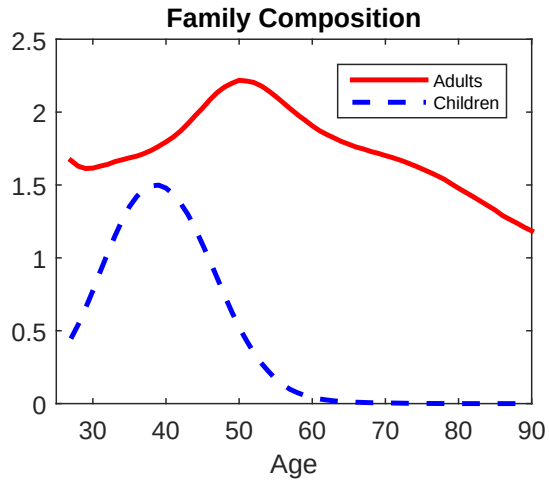
- First step (external calibration)
  - Income process
    - Deterministic growth rate
    - Age-varying idiosyncratic risk ▸ BPP
  - Conditional probability of survival
  - Household composition
  - Transaction cost, interest rates, minimum housing, depreciation rate
  - Initial distribution of balance sheets ▸ Initial Dist
- Second step (preference estimation)
  - Preference parameters: ρ, β, θ, α, ζ, φ, f_a, f_c
  - Simulated method of moments

External Calibration









First Step Parameters

Estimates	Parameter	Value	Target/Source
First Step			
Demographics			
Lifespan	T	90	
Conditional probability of survival	$\{p_a^S\}$		SSB
Income process			
Permanent income growth rate	$\{\Gamma_t\}$		SSB
Variance of permanent income	$\{\sigma_{\Psi,t}\}$		SSB
Variance of transitory income	$\{\sigma_{\Xi,t}\}$		SSB
Borrowing			
Risk free rate	r	0.016	Norges Bank
Borrowing rate	r_b	0.054	Norges Bank
Maximum loan to value ratio	μ_V	0.90	Norges Bank
Maximum debt to lifetime income ratio	μ_Y	0.25	
Housing market			
Depreciation rate	δ	2%	
Transaction cost of purchase	κ_p	0.025	
Transaction cost of sale	κ_p	0.025	
Minimum housing	$\underline{h}$	8.2	SSB

Estimation
Second Step

- Target (64×3 moments):
  - Median net worth $\{A_a\}_{a=27}^{90}$
  - Housing $\{H_a\}_{a=27}^{90}$
  - Homeownership rate $\{O_a\}_{a=27}^{90}$

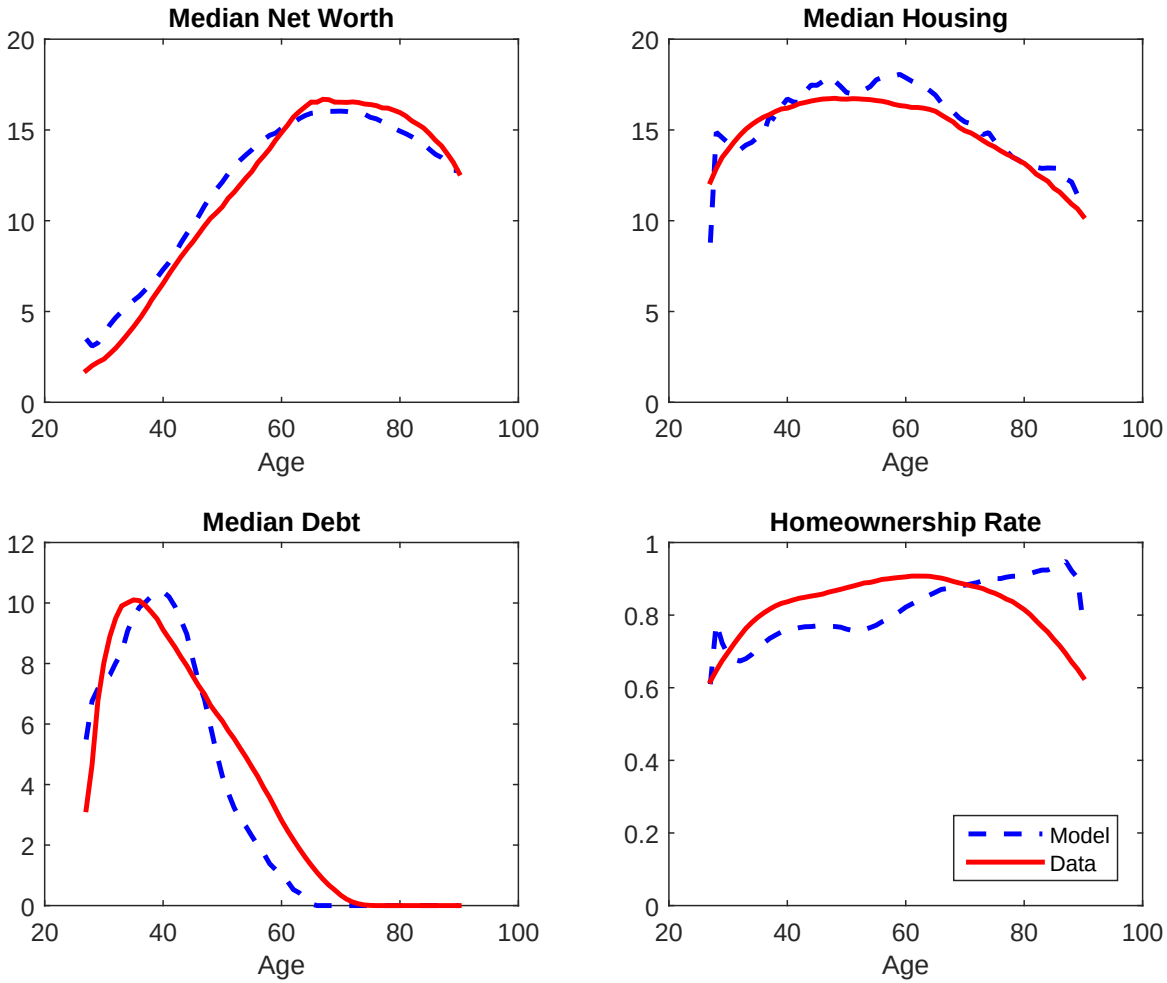
- Method (8 parameters): method of simulated moments
  - Simulated profiles $\{A_a^s\}_{a=27}^{90}$,$\{H_a^s\}_{a=27}^{90}$,$\{O_a^s\}_{a=27}^{90}$
  - Distance between the profiles in the data and in the simulated data is the smallest

Second Step Parameters

Estimates	Parameter	Value
Second Step		
Preference		
Initial weight on consumption	α	0.55
Adults' impact on consumption weight	f_a	0.47
Children's impact on consumption weight	f_a	0.12
Discount factor	β	0.93
Coefficient of relative risk aversion	ρ	1.20
Elasticity of substitution	θ	0.49
Utility of owning	ζ	0.09
Bequest weight	φ	12.3

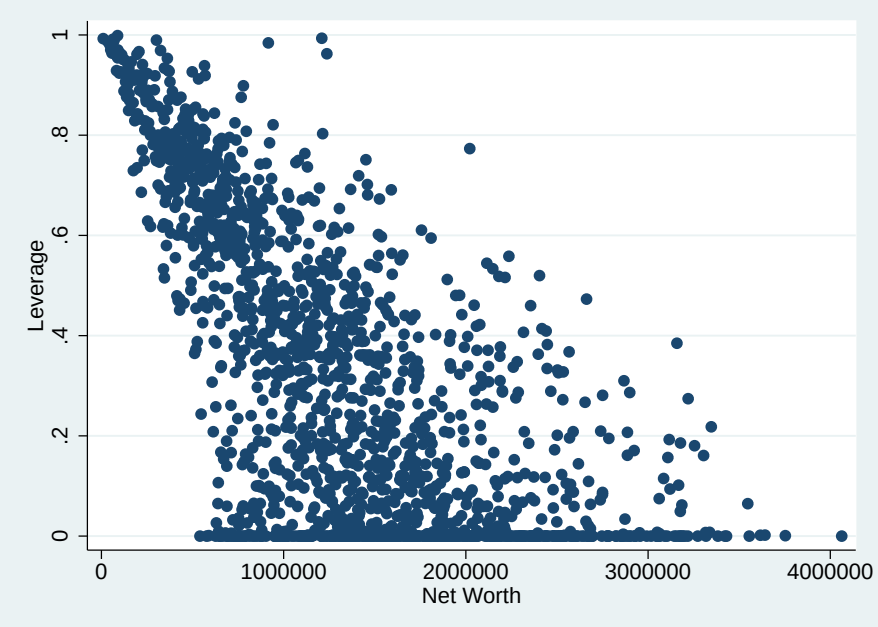
Life Cycle Profiles

Model vs. Data

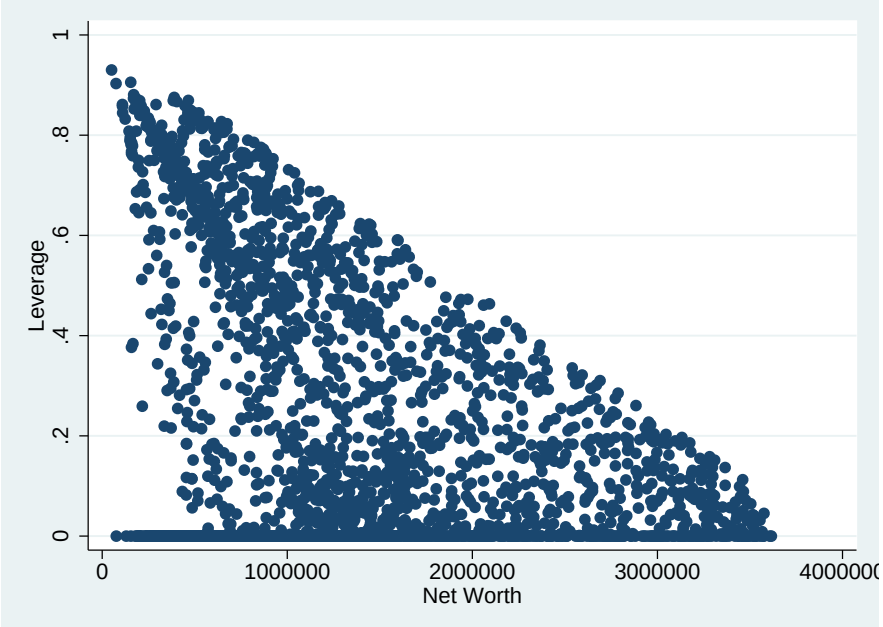


Heterogeneity in Leverage

Model vs. Data



(a) Data



(b) Simulation

MPC and Leverage

Why would leverage affect the MPC in this model?

- Housing wealth is extremely liquid here:
  - Nothing prevents the household from borrowing more against its housing wealth
- But housing wealth is still somewhat illiquid: There are moving costs.
- The liquidity of housing wealth depends on proximity to the LTV-limit

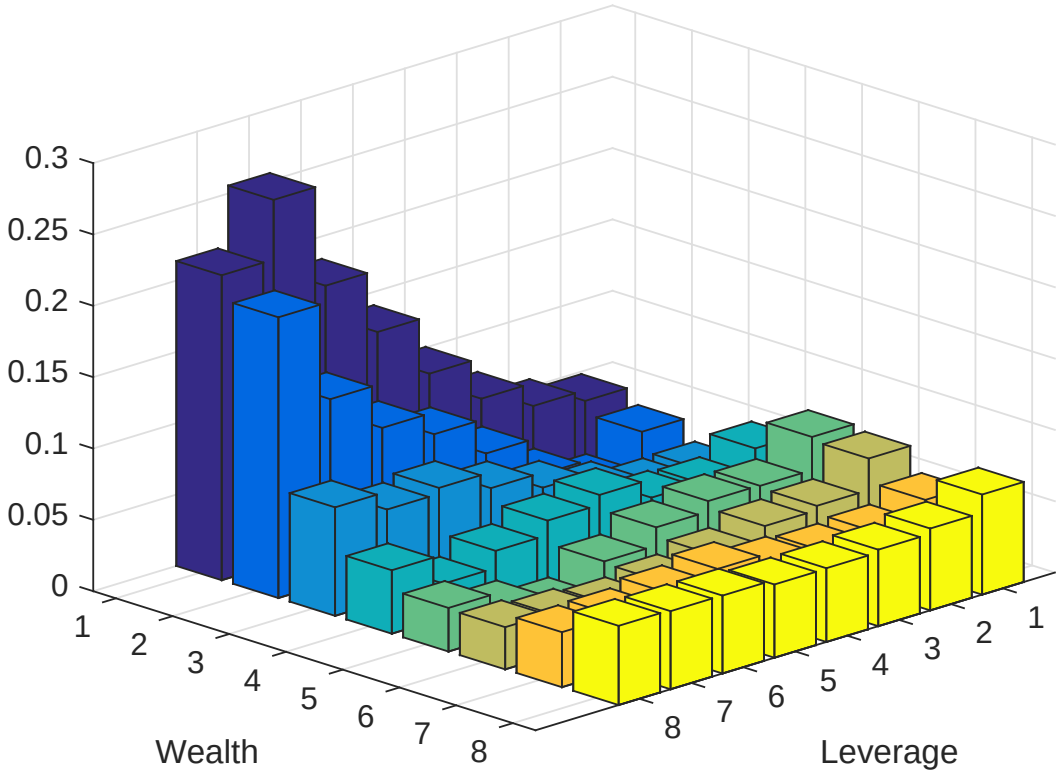
  $\Rightarrow$ Leverage measures the liquidity of housing wealth

The Role of Housing Leverage

Model vs. Data

Dep.Var:	ΔC_t			
	(1) Simulation	(2) Data	(3) Simulation	(4) Data
ΔW_t	0.527***	0.531***	0.203***	0.804***
	(0.042)	(0.106)	(0.042)	(0.107)
W_{t-1}	-0.004***	-0.096***		
	(0.000)	(0.001)		
$\Delta W_t \times W_{t-1}$	-0.000	0.008***		
	(0.000)	(0.001)		
$\frac{W_{t-1}}{Y_{t-1}}$			0.034***	-0.012***
			(0.000)	(0.000)
$\Delta W_t \times \frac{W_{t-1}}{Y_{t-1}}$			0.017***	-0.010***
			(0.000)	(0.000)
lev_{t-1}	-0.091***	-0.337***	0.147***	-0.253***
	(0.005)	(0.001)	(0.005)	(0.001)
$\Delta W_t \times lev_{t-1}$	0.200***	0.226***	0.259***	0.206***
	(0.005)	(0.002)	(0.004)	(0.002)
Year#		X		X
$\bar{Y}$#	X	X	X	X
CHAR#	X	X	X	X
adj. R^2	0.316	0.346	0.346	0.335
N	144,246	1,346,264	144,246	1,346,264

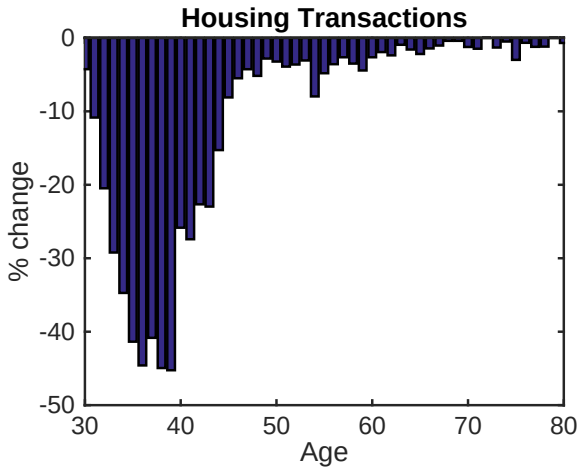
MPC by Wealth and Leverage in the Model

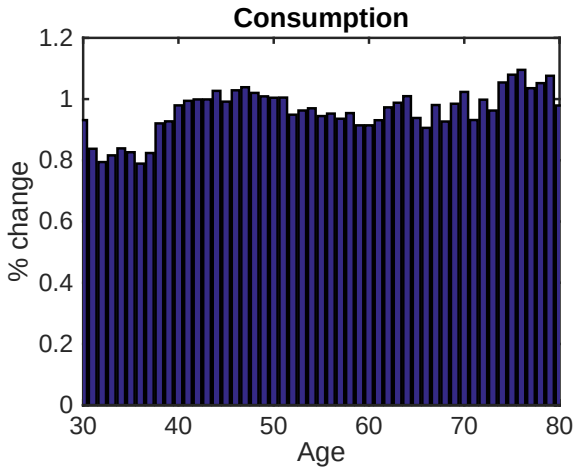


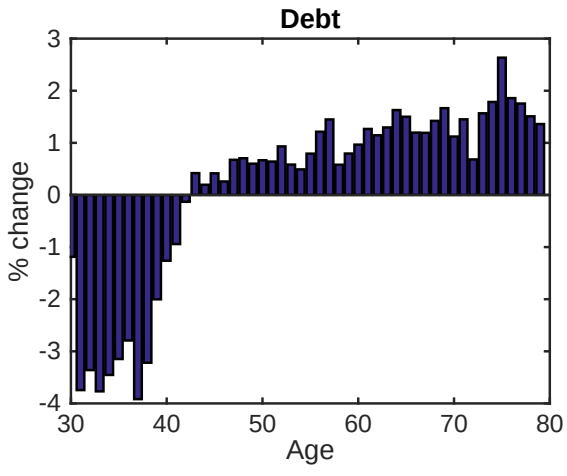
Policy Implications
A Sudden Credit Contraction

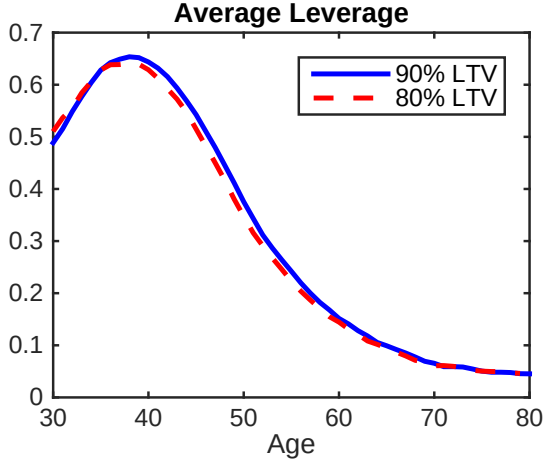
- Eggertsson & Krugman (2012), Guerrieri & Lorenzoni (2011)
  - Reduction in credit limit
  - Constrained households are forced to reduce consumption
  - No leverage
- Problem: very stylized
- Our exercise
  - A sudden change in LTV requirement
    - Geanakopoulos (2008,2011,2014)
  - Compare households' reaction with and without the policy change
  - Caveat: no general equilibrium effect

Policy Implications
A Sudden Credit Contraction









Policy Implications

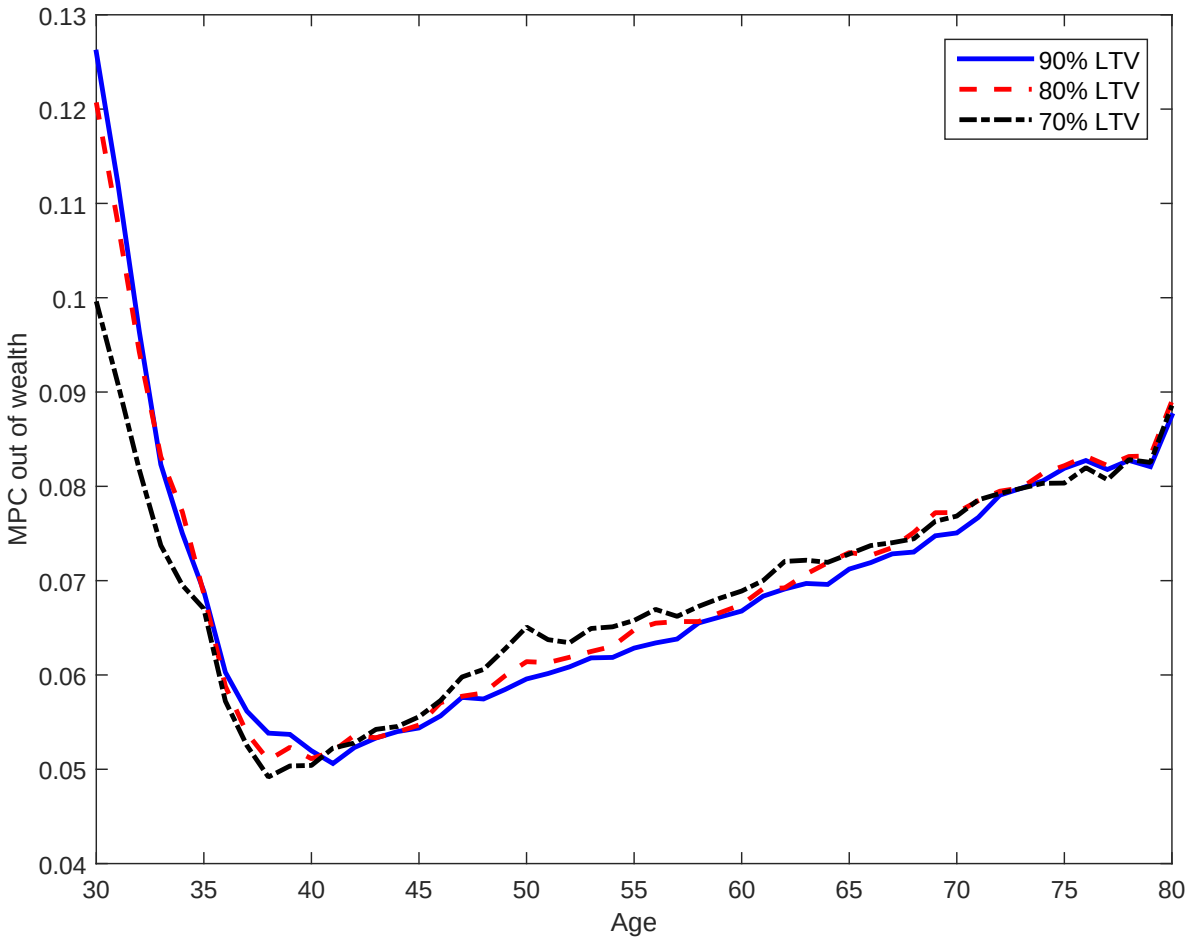
A Permanent Tightening of Lending Standards - Low LTV

- A widespread narrative of the Great Recession: Shocks amplified due to high household leverage
  - Supportive Evidence: Mian, Rao and Sufi (2013), Baker (2014)
- Does this motivate tighter restrictions on lending?
  - Macroprudential policy tool: LTV-limit
    - Already implemented in New Zealand, Norway, ++
- Our exercise
  - Compare to economies that differ only by their LTV-limits
  - Steady state comparison
  - Ask: Will a lower LTV-limit reduce the marginal propensity to consume out of wealth changes?
    - Wealth change of a **given size**

Policy Implications

A Permanent Tightening of Lending Standards - Lower LTV

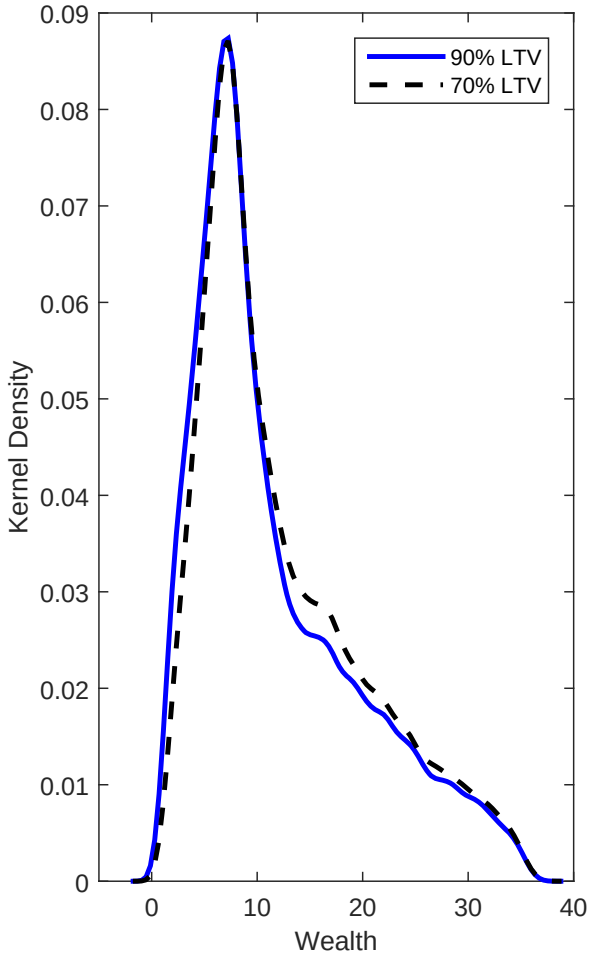
Effect on the MPC pr age group:

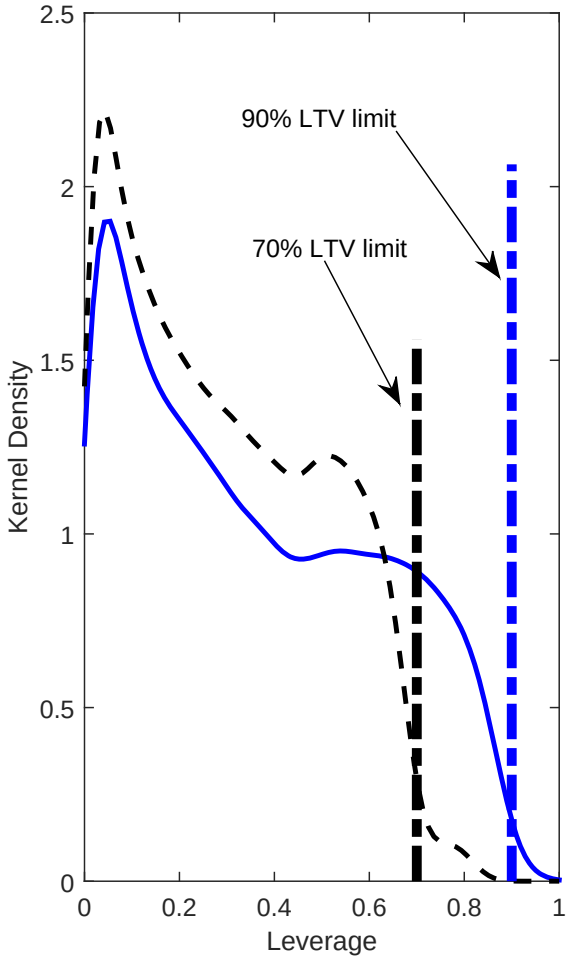


Policy Implications

A Permanent Tightening of Lending Standards - Lower LTV

Distributional consequences:





Policy Implications

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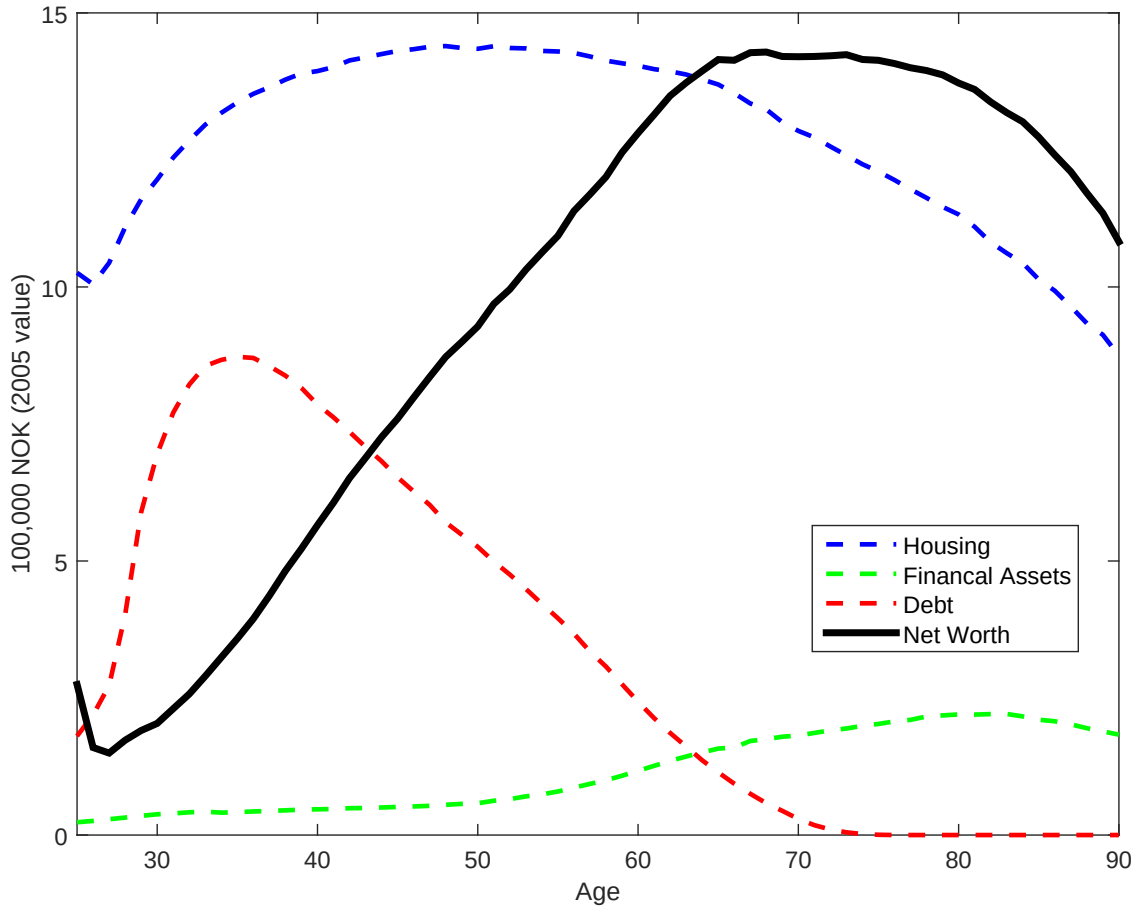
Upshot:

- MPC out of given wealth change largely unaffected
- Intuition: LTV tightening reduces both leverage and the leverage level that generates illiquidity.
- Interpretation: Permanent LTV-lowering is only likely reduce volatility if it reduces the magnitude of wealth shocks
  - In particular: Reduce the effect of house price changes on wealth (ignored in our study)

Conclusion

- Mian-Sufi association between consumption response to wealth changes and leverage confirmed at the micro level
- A model that matches life cycle profiles of households' balance sheets implies a similar association between leverage and the MPC out of wealth as in the data
- Housing key to understanding the MPC and the role of leverage
- Down payment requirements have little effect on the MPC out of given wealth changes
  - Postpones the home ownership choice
  - To be effective, the influence must be to dampen the magnitude of wealth shocks (not in our model)

Median Household Balance Sheet: Data



Parameters

▸ Preferences

- a – age a
- $\tilde{C}_a$ – consumption index
- p_a^S – conditional probability of survival
- C_a – real non-housing consumption
- S_a – housing service flow
- α_a – weight on non-housing consumption
- β – the discount factor
- ρ – the coefficient of relative risk aversion
- θ – the elasticity of substitution
- f_a – impact of adults on non-housing consumption
- f_c – impact of children on non-housing consumption

Income Growth and Idiosyncratic Risk

External Calibration

- Residual Income Growth

$$\log Y_{ia} = f_i + Z_{ia}\beta + y_{ia}$$

- Idiosyncratic risk

$$\Delta y_{ia} = \psi_{ia} + \Delta \xi_{ia}$$

$$\sigma^2_{\psi,a} = Cov(\Delta y_{ia}, \Delta y_{ia-1} + \Delta y_{ia} + \Delta y_{ia+1})$$

$$\sigma^2_{\xi,a} = -Cov(\Delta y_{ia}, \Delta y_{ia+1})$$

Initial Distribution of Net Worth, Housing, and Income

▸ External Calibration

Group	Net Worth	Income	Housing	Homeownership
1	-16.87	3.06	15.64	0.25
2	-7.03	3.01	13.33	0.55
3	-3.44	2.33	13.33	0.36
4	-2.27	1.97	13.24	0.22
5	-1.52	2.06	13.72	0.20
6	-0.86	2.10	13.78	0.19
7	-0.27	1.99	13.76	0.17
8	0.01	1.25	14.04	0.04
9	0.24	1.99	13.92	0.16
10	1.05	2.56	14.24	0.49
11	2.66	2.82	14.45	0.83
12	4.68	2.76	15.49	0.95
13	6.78	2.57	15.70	0.98
14	8.98	2.53	16.32	0.99
15	11.27	2.32	16.83	1.00
16	13.75	2.21	18.07	1.00
17	16.56	2.09	19.70	1.00
18	20.02	2.13	22.40	1.00
19	25.73	2.12	27.71	1.00
20	51.66	2.56	43.14	0.99