The Amortization Elasticity of Mortgage Demand

Aarhus macro seminar series

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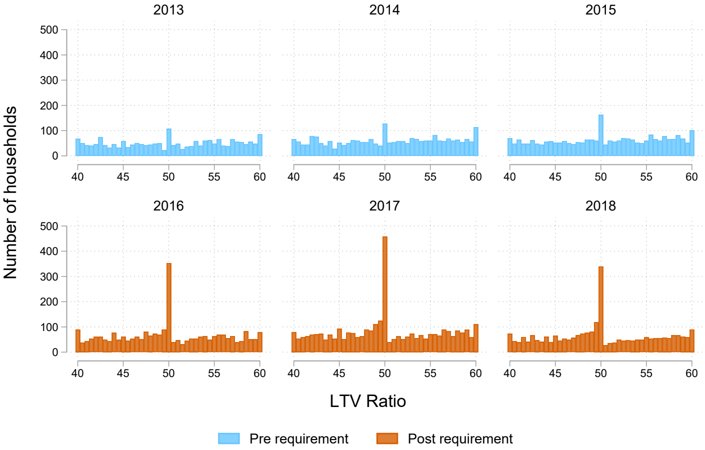


Introduction and research question

Motivation

Mortgage amortization schedules are among the largest savings plans in the world

- \$250-300 billion in 2016 in US; pension plans \$398 billion (Bernstein & Koudijs, 2021, WP)
- In Denmark, around 49 billion DKK in 2021
- Amortization payments $\approx$ 60 percent of first year mortgage payments

In theory, rational unconstrained borrowers can undo any mandatory amortization payments

- Borrow more (Svensson, 2016, WP), frequent refinancing (Hull, 2017, EER) or save less in other assets (Bernstein & Koudijs, 2021, WP)

This paper: Shows that unconstrained borrowers react strongly to higher amortization payments and uses a model to motivate why

This paper – the empirics

Motivation

We study a macroprudential policy introduced in Sweden in 2016, the amortization requirement

- Minimum mandatory mortgage payments have a discontinuous jump at two LTV thresholds

We find considerable bunching at the LTV thresholds

- Borrowers reduce their LTV ratios by ≈ 5 percent
- Little missing mass above the notch
- We rule out a number of other drivers (fees, interest rates, etc)

Unconstrained borrowers (74 %) respond more strongly than constrained borrowers (26 %)

- Active choice to do something different from standard consumption theory

This paper – the theory

Motivation

We extend Attanasio *et al.* (2012, RED) to include realistic mortgages (fully-amortizing or interest-only)

- Life-cycle model featuring income risk, credit constraints, and tenure choice

How can we explain bunching?

- Baseline model with mandatory amortization payments → No bunching
- Refinancing cost → Bunching, missing mass
- Disutility to amortization → Bunching, no missing mass

This paper – the takeaway

Motivation

We document new facts about how borrowers respond to mortgage amortization payments

- Similar behavior has been documented for unconstrained borrowers with car loans (Argyle *et al.*, 2020, RFS) and credit cards (Keys & Wang, 2019, JFE)

Response by unconstrained borrowers inconsistent with standard consumption theory

- Active choice to reduce borrowing in response to higher payments

We can rationalize bunching through various channels, but requires some behavioral assumptions

Roadmap

Institutional setting

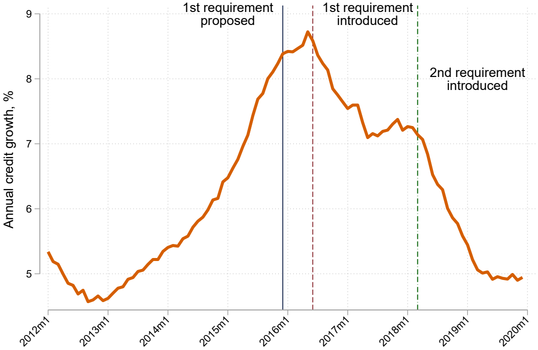
Swedish mortgage contracts prior to 2016

Background

- Adjustable rates or short fixed rate periods
- Linear repayment instead of annuity contracts
- Maturities 40-50 years
- LTV-cap at 85%
- Payment to Income (PTI) constraint
- Full recourse with lifetime garnishing

The amortization requirement

Background

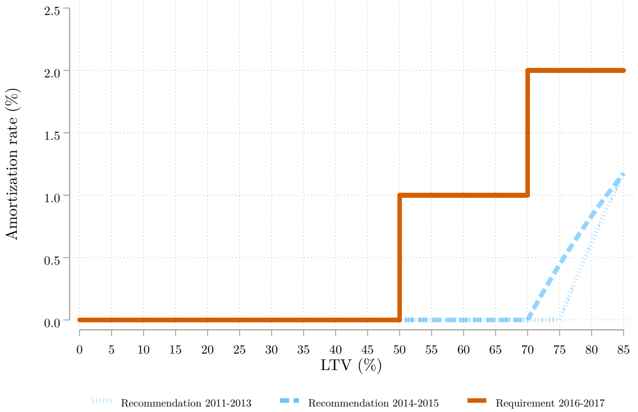


Swedish FSA (Finansinspektionen) introduced the amortization requirement to reduce debt levels over time

- House prices grew 31 percent between 2011 and 2015 House price growth
- Credit grew at 8 percent a year in 2015
- Amortization requirement went into effect for new mortgages in June, 2016

The amortization requirement

Background



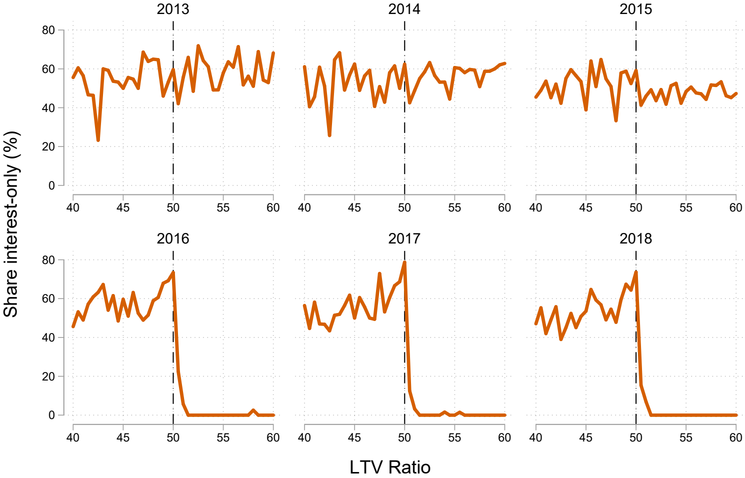
Mandatory amortization depends on loan-to-value (LTV) ratio:

- 1 percent of entire mortgage if LTV > 50%
- 2 percent of entire mortgage if LTV > 70%
- (From 1st of March 2018: additional 1 percent if debt-to-income > 4.5)

Once a borrower hits a threshold, they can lower their amortization payments

Sharp reduction in share of interest-only mortgages

Background



Roadmap

Methodology

Intuition behind empirical methodology

Methodology

We use the discontinuous jump in average payments at the requirement threshold(s) to identify the trade-off between borrowing and amortizing

- You can trade lower borrowing for lower payments by placing yourself at the threshold
- Example: House 500,000; mortgage 350,000: LTV $=$ 70% $\rightarrow$ Amortization (1%) $\approx$ 300/month
- Borrow 10,000 more: LTV $=$ 72% $\rightarrow$ Amortization (2%) $=$ 600/month

From bunching to LTV response

Methodology

Number of households bunching at the threshold $\overline{LTV}$:

$$B = \int_{\overline{LTV}}^{\overline{LTV}+\Delta LTV} g_{pre}(LTV)dLTV \approx g_{pre}(\overline{LTV})\Delta LTV$$

Marginal buncher would have borrowed $\overline{LTV} + \Delta LTV$ had there been no notch

Counter-factual distribution $\widehat{g_{pre}}(\overline{LTV})$ estimated using pre-requirement years

Estimated borrowing response: $\widehat{\Delta LTV} = \dfrac{\overbrace{\widehat{B} = \sum_{j=L}^{R}(n_j^{post} - n_j^{pre})}^{\text{Bunched loans}}}{\underbrace{\widehat{g_{pre}}(\overline{LTV})}_{\text{Counter-factual distribution}}}$

From LTV response to semi-elasticity

Methodology

$$e^{\alpha} = \frac{\overbrace{\Delta LTV}^{\text{From bunching}}}{\underbrace{\alpha^{*}(\overline{LTV} + \Delta LTV) - \alpha}_{\text{percentage point change in marginal amortization rate}}}$$

We convert the average amortization rate (1 or 2 percent) to the marginal amortization rate ($\approx$ 20 percent)

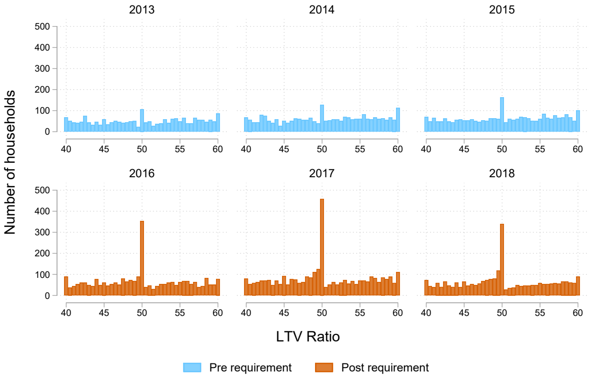
- Intuition: the percentage point change in amortization rate from moving just below the threshold $\overline{LTV}$ to the LTV for marginal buncher

Bunching estimate

Methodology

We use years prior to the requirement to estimate the counter-factual LTV distribution (g_{pre}) and compare it to the empirical (post-requirement) distribution

- Bunching estimate: The relative increase in percentage of households placing themselves at the threshold



Data

Methodology

- Microdata reported by 8 largest banks in Sweden from Swedish FSA's "Mortgage survey" *(Bolåneundersökningen)*, 2011 - 2018
  - Survey covers all newly issued mortgage loans within a two-week window during the period August - October
  - 15,000 - 30,000 households per year
- Variables:
  - Loan-level: amount, interest rate, amortization, collateral
  - Household-level: size, age, income, location, total debt (secured, unsecured)

Roadmap

Main results

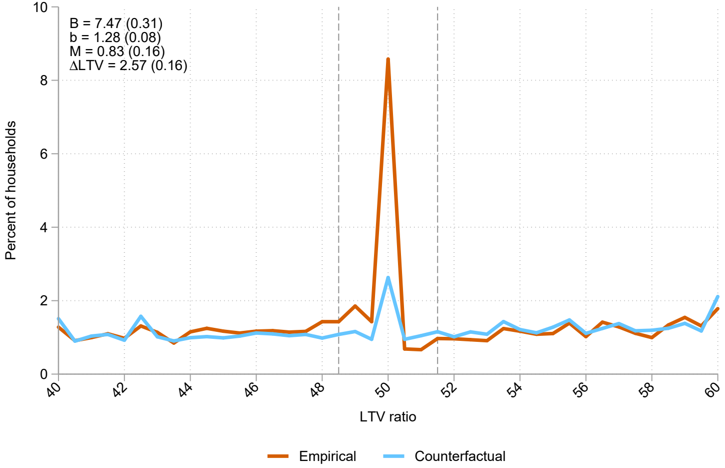
Bunching at lower threshold

Results

Summary of results:

- 8 percent of borrowers bunch
- Change in LTV = 2,57 / 50 = 5.14 %
- Little missing mass (11 % of B)

→ A one percentage point increase in the amortization rate decreases LTV ratios by 0.25 percent.



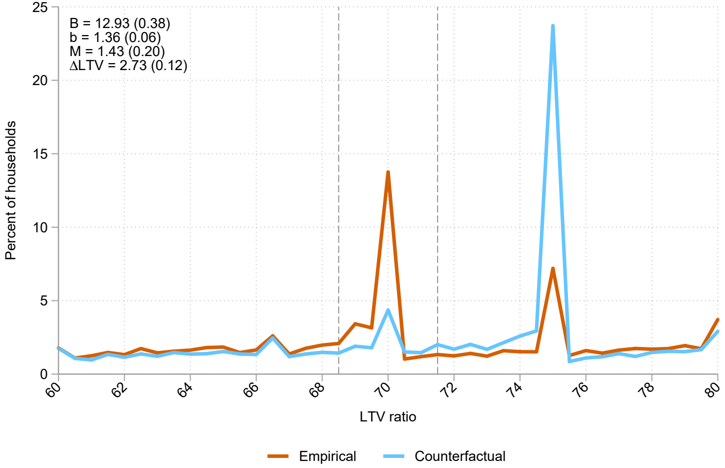
Bunching at upper threshold

Results

Summary of results:

- 12.93 percent of borrowers bunch
- Change in LTV = 2,73 / 70 = 3.9 %
- Little missing mass (11 % of B)

→ A one percentage point increase in the amortization rate decreases LTV ratios by 0.14 percent.



Threats to identification

Results

Estimation:

- Placebo test: estimate bunching using only pre-requirement data Placebo tests
- Standard approach with flexible polynomial gives very similar results but find it difficult to capture round-number bunching Polynomial approach
- Similar results if we estimate for homeowners vs homebuyers Bunching by valuation method

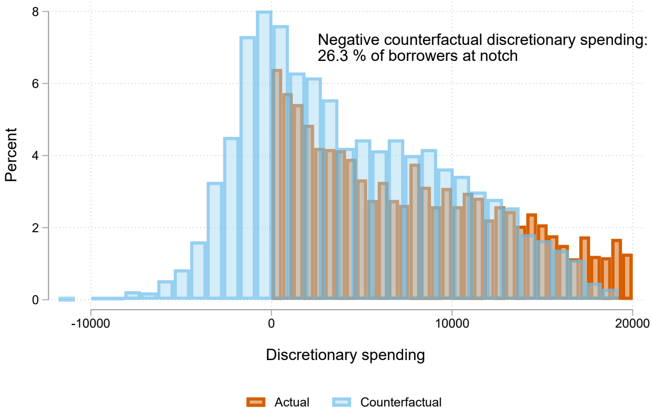
Maybe borrowers bunch for other reasons, not the amortization requirement?

- Interest rates around the thresholds are flat Interest rates
- Amortization rates higher above threshold only after requirement is in effect Amortization rates
- Borrowing more (Svensson, 2016) would not lead to bunching Svensson model
- We also argue against bank incentives, potential manipulation of collateral assessments, and salience

Constrained and unconstrained borrowers

Effect of payment-to-income constraint

Constrained and unconstrained borrowers



Borrowers lower amortization payments to comply with PTI constraints

- 26.3% of borrowers close to the threshold are unable to borrow more due to credit constraints

Importantly, this still leaves three quarters of borrowers who do not face binding constraints

Bunching by constrained and unconstrained borrowers

Constrained and unconstrained borrowers

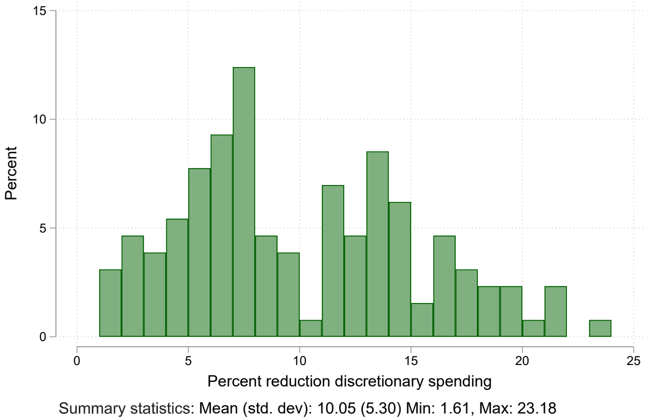
Part of the response is due to credit constraint imposed by Swedish banks – discretionary income limit

Counter-factual discretionary income = the discretionary income given your chosen LTV, minus the extra payments if you borrowed 1%-point more in LTV.

- Constrained = counter-factual discretionary income less than 5,000 SEK,
- Intermediate counter-factual discretionary income of 5,000-15,000 SEK
- Unconstrained = counter-factual discretionary income greater than 15,000 SEK

Liquidity effect of amortizing

Constrained and unconstrained borrowers



Higher amortization payments associated with a substantial reduction in liquidity.

Reduction in discretionary income for a one percentage point increase in LTV:

- Constrained: 80 percent
- Intermediate: 24 percent
- Unconstrained: 10 percent

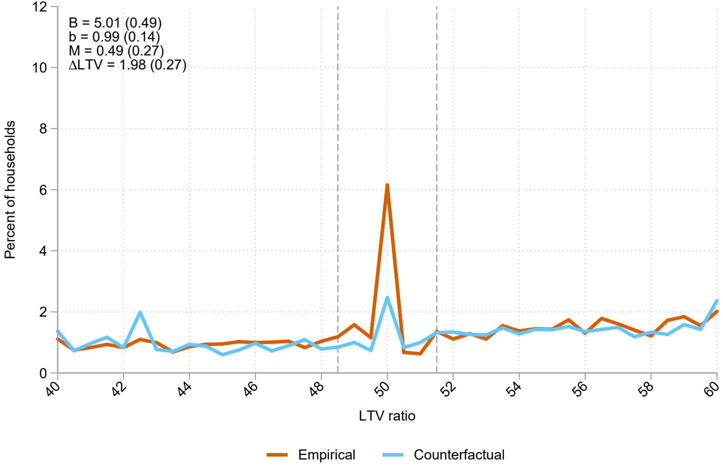
Bunching at lower threshold for Constrained group

Constrained and unconstrained borrowers

Constrained borrowers respond less strongly

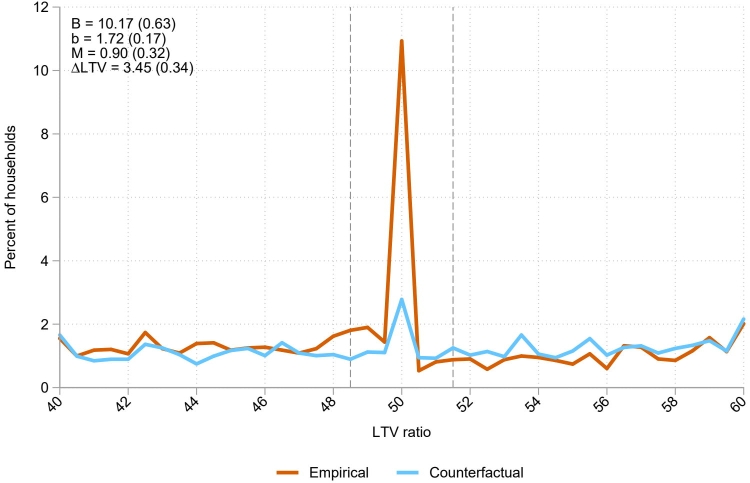
- Baseline result: B = 7.47
- Constrained borrowers: B = 5.01

A thought as to why: might be more in need of borrowing?



Bunching at lower threshold for Intermediate group

Constrained and unconstrained borrowers

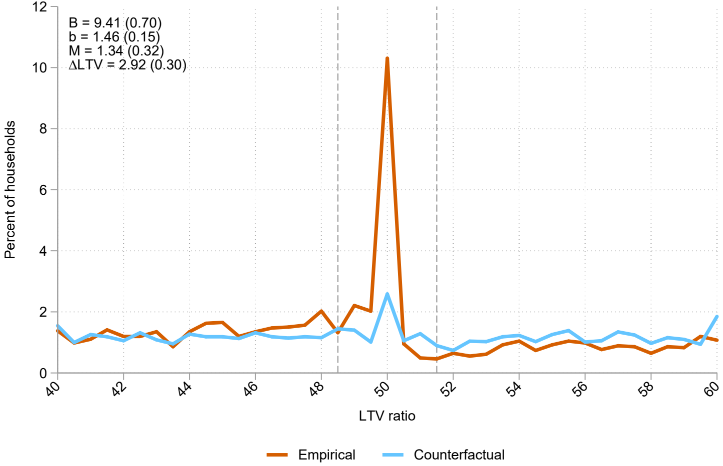


Bunching at lower threshold for Unconstrained group

Constrained and unconstrained borrowers

Unconstrained borrowers respond more strongly

- Baseline result: $B = 7.47$
- Unconstrained borrowers: $B = 9.41$



Bunching estimates by type of payment constraints

Constrained and unconstrained borrowers

PTI Constraint	Constrained	Intermediate	Unconstrained
Panel A: Notch at LTV=50			
Bunching	5.01	10.17	9.41
	(0.49)	(0.63)	(0.70)
Excess mass	0.99	1.72	1.46
	(0.14)	(0.17)	(0.15)
Missing mass	-0.49	-0.90	-1.34
	(0.27)	(0.32)	(0.32)
Δ LTV	1.98	3.45	2.92
	(0.27)	(0.34)	(0.30)
Elasticity	0.15	0.45	0.32
	(0.04)	(0.09)	(0.06)
Number of borrowers	13,350	10,471	10,182

Bunching estimates for LTV=70

Roadmap

Institutional setting

Methodology

Results

- Main results
- Threats to identification
- Constrained and unconstrained borrowers

Model

- Model setup
- Model results

Conclusions

Model

Why do unconstrained borrowers bunch?

Mechanisms

Theory suggests that there is little impact on borrowing:

- Higher required amortization payments make unconstrained borrowers should borrow more (Svensson, 2016)
- Borrowers can undo higher required amortization payments by refinancing (Hull, 2017, EER)
- Borrowers can substitute other savings for amortization payments (Bernstein & Koudijs, 2021)

Why do we find that unconstrained borrowers reduce their LTV ratios?

Life-cycle model of consumption, housing, and mortgages

Model

Households get utility from consumption and housing:

$$\max_{\{c_t, h_t, m_t\}_{t=0,..,T}} \mathbb{E}_0 \sum_{t=0}^{T} \beta^t U(c_t, h_t) \tag{1}$$

- Demographics: household live for T years, retired for final W years
- Households heterogeneous w.r.t. initial assets and income shocks
- Assets: liquid asset with return r, housing asset with return r^H, borrowing with long-term mortgage with rate $r * M$

Assets and Mortgages

Model

1. Liquid asset ($a_t \geq 0$)
2. Illiquid housing asset (h_t)
   - Discrete asset with N different sizes (flat, house, mansion, etc.)
   - Allowed to own or rent any unit, where rent $= \eta p_t$
   - Transaction cost: fraction f_1 of the house price
3. Long-term mortgages (m_t)
   - Maximum loan to value: $\bar{\psi}$ percent of the house price
   - Mandatory minimum repayment $\rho_t(M_t, P_t)$ each period depending on amortization rule (key policy instrument)
   - Possible to cash-out refinance: multiplicative cost f_2 and additive cost f_3

Amortization Policy

Model

We introduce two different amortization policies in the model

- Interest-only mortgages

$$\rho_t(M_t, P_t) = M_t * R^M$$

- Mandatory amortization policy that depends on LTV:

$$\rho_t(M_t, P_t) = M_t * R^M + \begin{cases} 0, & \text{if } {}^{M_t}/_{P_t} < 0.5 \\ 0.01 * M_t, & \text{if } 0.5 \leq {}^{M_t}/_{P_t} \end{cases}$$

Idiosyncratic Income Risk

Model

$$\ln y_{i,t} = \alpha_i + g_t + z_{i,t}$$

- α_i: household specific fixed effect
- g: deterministic age profile for income (second-order polynomial in age)
- $z_{i,t}$: idiosyncratic income component, AR(1) Markov process

$$z_{i,t} = \rho z_{i,t-1} + \varepsilon_{i,t}$$
$$\varepsilon_{i,t} \sim N(0, \sigma_\varepsilon^2)$$

- after retirement: fraction ω of last working period's income

Housing Preferences

Model

Functional form follows Attanasio et al (2012)

$$u(c_t, h_t) = \underbrace{\frac{c_t^{1-\gamma}}{1-\gamma}}_{\text{consumption utility}} \times \underbrace{e^{\theta\phi(h_t)}}_{\text{multip housing utility}} + \underbrace{\mu\phi(h_t)}_{\text{additive housing utility}}$$

Preference parameters

- γ: coefficient of relative risk aversion
- ϕ: relative utility of house choice h_t
- $\phi(h) = \log(h)$ if owner; $\phi(h) = \log(\zeta h)$ if renter
- ζ: disutility of renting

Housing Preferences

Model

Functional form follows Attanasio et al (2012)

$$u(c_t, h_t) = \underbrace{\frac{c_t^{1-\gamma}}{1-\gamma}}_{\text{consumption utility}} \times \underbrace{e^{\theta\phi(h_t)}}_{\text{multip housing utility}} + \underbrace{\mu\phi(h_t)}_{\text{additive housing utility}}$$

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- ζ: disutility of renting

Housing preferences parameters θ and μ

- θ: proportional scaling of the utility from consumption
- Additive term: consumption and housing are not homothetic

Model results

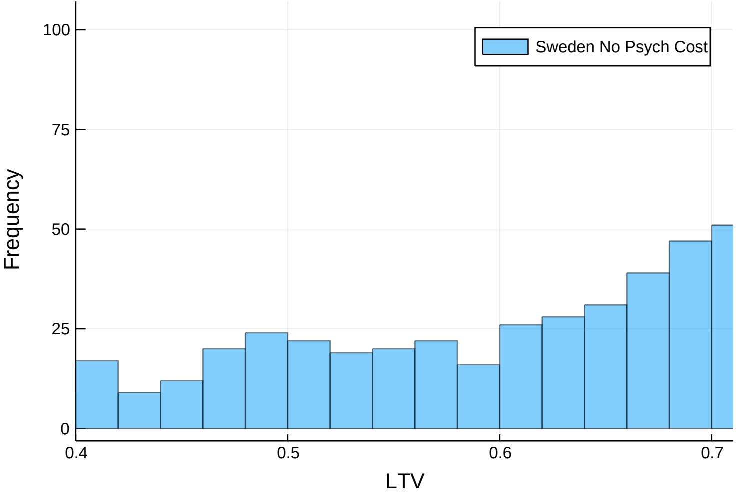
Baseline Model: Mandatory amortization does not cause bunching

Model

Baseline model features no bunching.

Borrowers can...

1. Make amortization payments and receive lower mortgage payments
2. turn off amortization payments once they get past the cutoff
3. extract equity when desired



Option 1: Fixed refinancing costs

Mechanisms

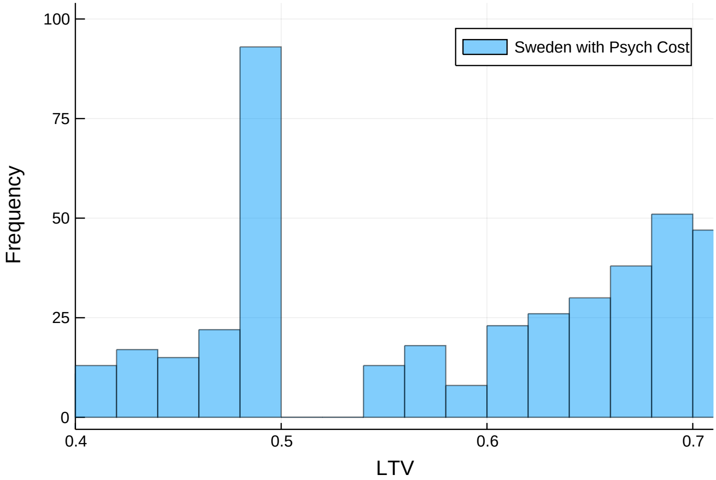
We introduce a utility cost to refinancing to an IO mortgage once you hit the threshold

Communication with banks reveal that financial barriers to lowering amortization rate are likely low:

- Lowering rate is free of charge for all except one bank
- Can be done online or with a phone-call
- No credit check or new contract required
- Is very rarely denied

Refinancing cost creates bunching + missing mass

Model



Value function with refinancing cost

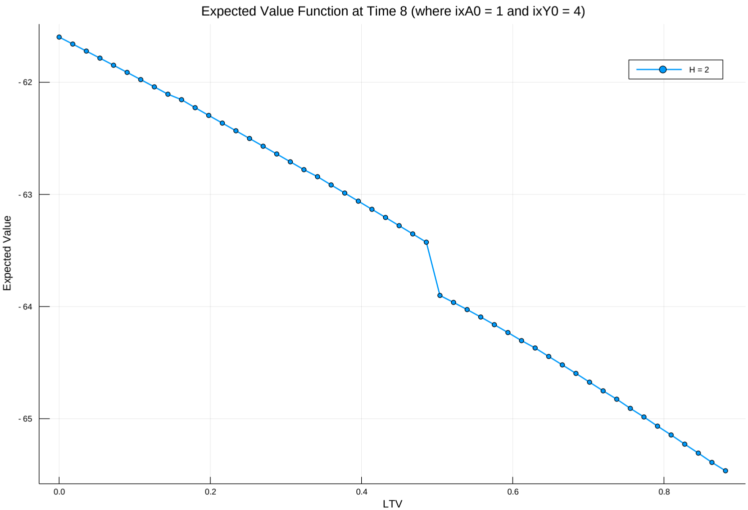
Model

Borrowers close to the threshold can avoid fixed refinancing costs by lower debt levels

- Fixed cost act as a notch in the utility function

Effect is local to the notch

- No effect at higher LTV values
- Fixed cost discounted at higher LTV values



Option 2: Disutility to amortizing

Mechanisms

We introduce a utility cost to amortizing for all borrowers

Borrowers mistake amortization payments for interest payments

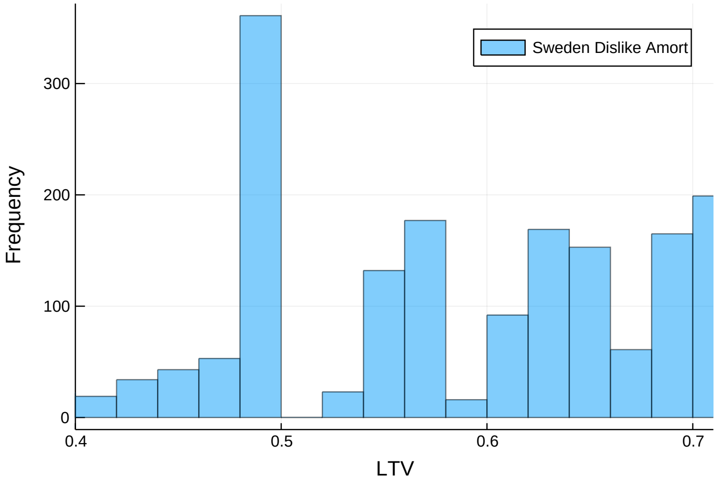
- Linked to levels of financial literacy in Sweden (Almenberg & Säve-Söderbergh, 2011, JPEF)
- 38% of survey respondents state that amortization payments are a cost (SBAB, 2018)

You could also get this cost if

- borrowers are unwilling to borrow more or refinance to undo amortization payments...
- and amortization payments are costly because of life-cycle motives (Cocco, 2013, JF) or portfolio allocation (Larsen *et al.*, 2018, MS)

Disutility to amortizing creates bunching

Model



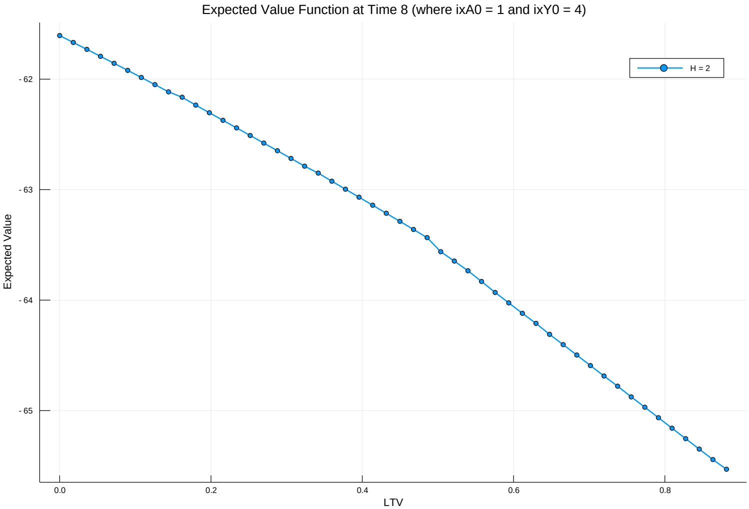
Value function with disutility to amortizing

Model

All borrowers above the notch are affected

- Slope of the value function changes at LTV = 50%

→ Disutility to amortizing create a kink in the value function



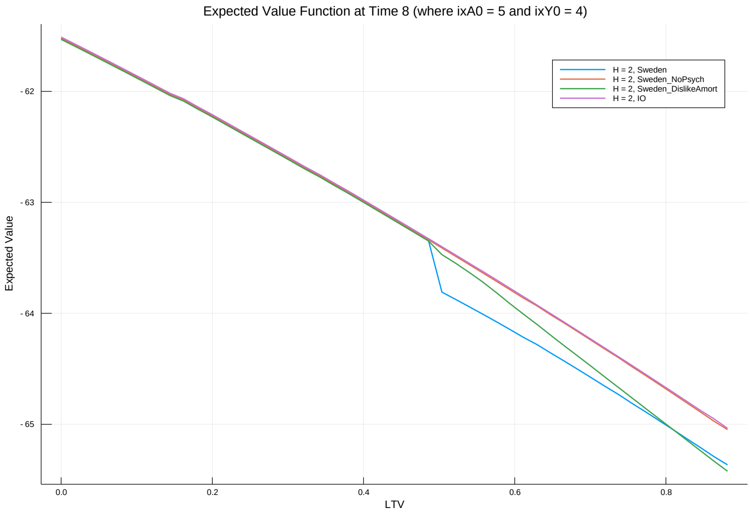
All value functions

Model

Baseline model with amortization requirement very similar to IO mortgage model

Refinancing cost creates notch but unchanged slope after

Disutility to amortizing changes the slope of the value function



Roadmap

Conclusions

Conclusion

We provide evidence that constrained and unconstrained borrowers avoid higher required amortization payments

- Similar behavior has been documented in the car loan market (Argyle *et al.*, 2020, RFS)
- Ganong & Noel (2020, AER) find that maturity extensions that reduce amortization payments (increase liquidity) have large effects on default

How can we explain bunching?

- Baseline model with mandatory amortization payments → No bunching
- Payment-to-income constraints → Bunching, missing mass
- Refinancing cost → Bunching, missing mass
- Disutility to amortization → Bunching, no missing mass

Conclusion, part 2

Implications for current and future macroprudential policies

- A new macroprudential tool in Sweden, the Netherlands and Norway
- Hull (2017, EER) and Svensson (2016, WP) show that higher amortization payments are ineffective in reducing debt
- We show that its effective in reducing debt, but mainly for unconstrained borrowers

An under-rated part of mortgage innovation and pre-financial crisis household debt?

- Mortgages with low(er) amortization payments constituted 52 percent of new origination in US in 2005 (Justiniano *et al.*, 2021, JPE), "complex mortgages" used by households with high income (Amromin *et al.*, 2018, RF)

Bernstein & Koudijs (2021) show that amortization payments are key to building wealth

Thank you!

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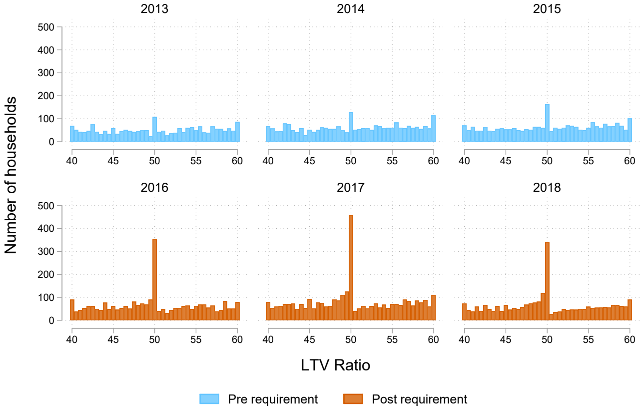
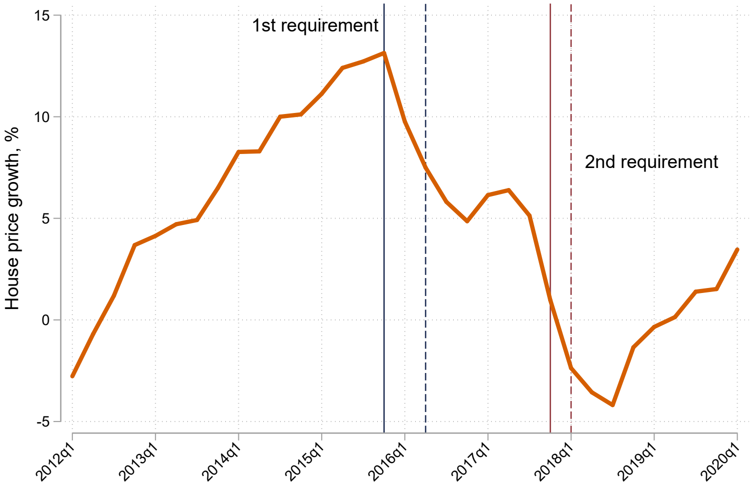


House price growth in Sweden

Background



Back

Bunching estimates by type of payment constraints

Results

PTI Constraint	Constrained	Intermediate	Unconstrained
Panel B: Notch at LTV=70			
Bunching	13.16	13.29	13.10
	(0.58)	(0.71)	(0.96)
Excess mass	1.42	1.46	1.29
	(0.10)	(0.11)	(0.12)
Missing mass	-1.28	-0.94	-2.15
	(0.32)	(0.40)	(0.42)
Δ LTV	2.84	2.92	2.57
	(0.20)	(0.22)	(0.24)
Elasticity	0.16	0.17	0.13
	(0.02)	(0.02)	(0.02)
Number of households	15,949	12,127	10,242

Back

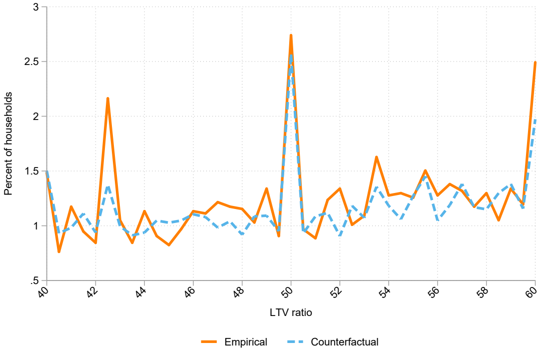
Bunching estimates by valuation

Results

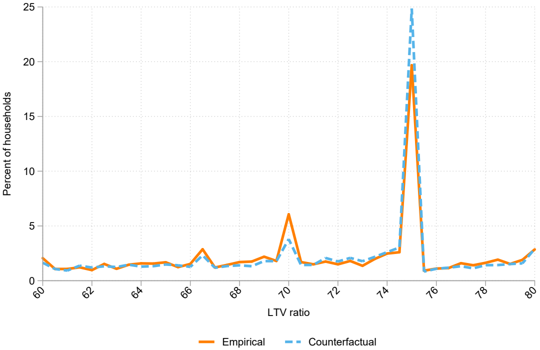
Valuation	Internal	External	Purchase price
Panel B: Notch at LTV=70			
Bunching	12.88	6.40	19.13
	(0.43)	(1.05)	(1.01)
Excess mass	1.36	0.58	2.68
	(0.07)	(0.11)	(0.32)
Missing mass	-1.38	-0.53	-1.68
	(0.24)	(0.66)	(0.54)
Δ LTV	2.72	1.17	5.36
	(0.13)	(0.23)	(0.63)
Elasticity	0.15	0.03	0.54
	(0.01)	(0.01)	(0.12)

Back

Empirical and Counter-factual distribution in 2014



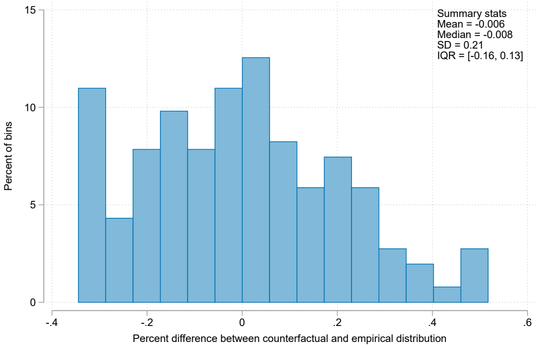
Lower threshold



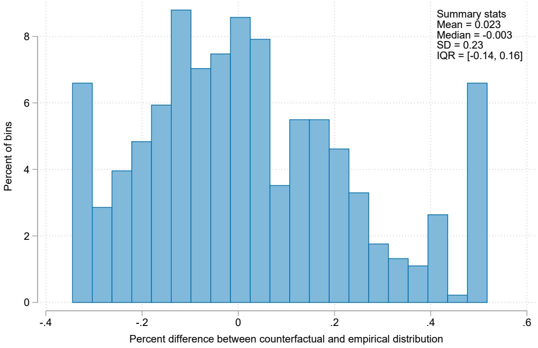
Upper threshold

Back

Ratio between counter-factual and empirical distribution in placebo years



Lower threshold

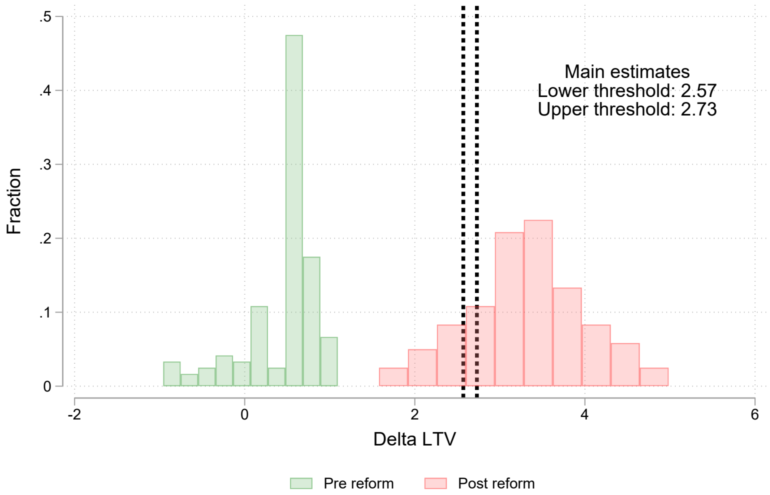


Upper threshold

Back

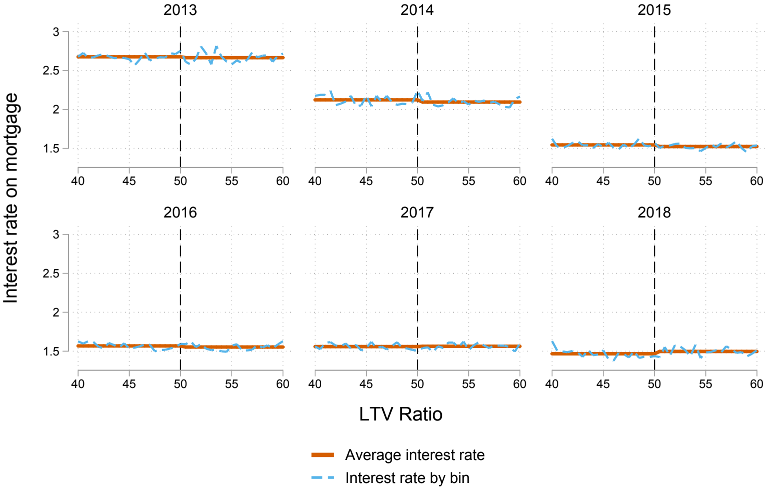
Estimates of ΔLTV using polynomial approach

Threats to identification Back



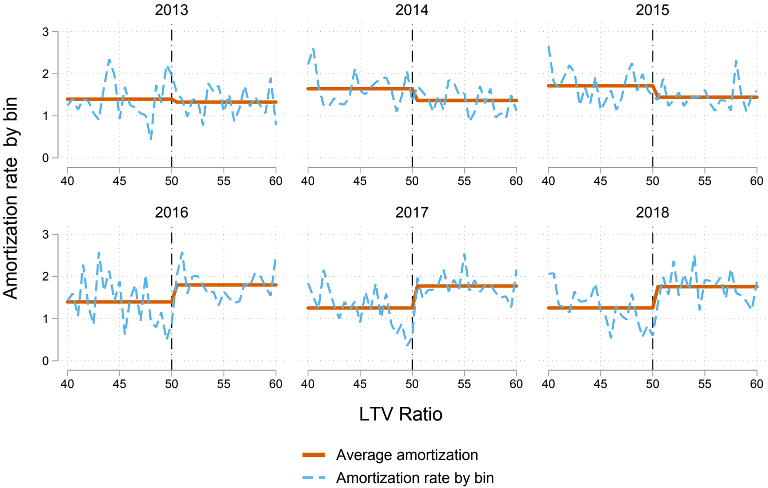
Interest rates by LTV ratio over time

Lower threshold Back



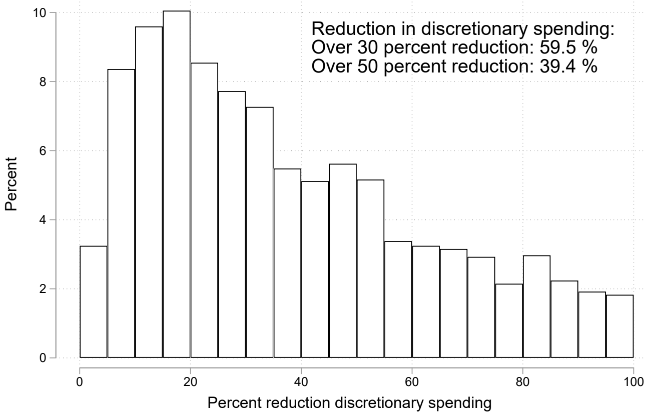
Amortization rates by LTV ratio over time

Lower threshold Back



Reduction in discretionary income

Credit demand



Higher amortization would entail a large reduction in discretionary income for many households

39.4 percent of borrowers would have a reduction of more than 50 percent

- Anecdotally, this also seems to explain reluctance to amortize

Reduction in LTV vs reduction in borrowing?

Endogenous housing demand response

There is a potentially endogenous housing demand response

- Results are for LTV ratios, but theory is for borrowing

We estimate bunching for existing homeowners and homebuyers

- Existing homeowners cannot adjust collateral values
- All the effect would come through the loan size
- Identify types through the valuation method used by banks

Back

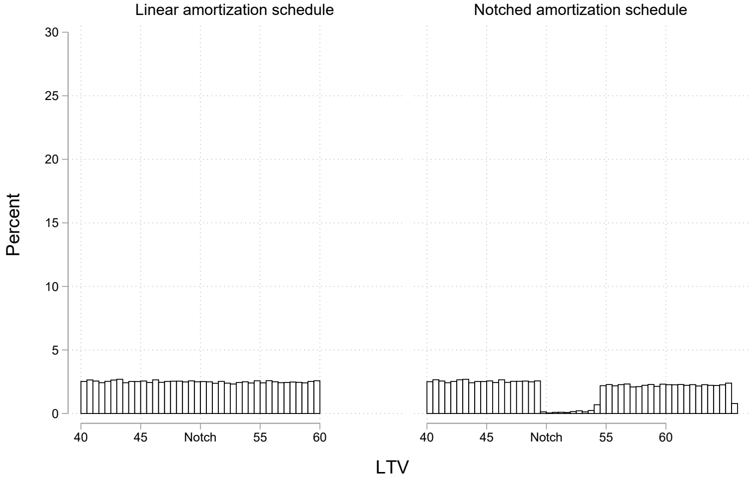
Results by valuation method

Endogenous housing demand response

Valuation	Internal	External	Purchase price
Panel A: Notch at LTV=50			
Bunching	7.10	7.38	9.30
	(0.34)	(0.88)	(1.46)
Excess mass	1.22	1.44	1.09
	(0.08)	(0.23)	(0.28)
Missing mass	-0.81	-0.81	-1.25
	(0.19)	(0.48)	(0.76)
Δ LTV	2.44	2.89	2.18
	(0.17)	(0.47)	(0.56)
Elasticity	0.23	0.32	0.18
	(0.03)	(0.10)	(0.09)

Bunching estimates for LTV=70

Svensson (2016) model



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