Mortgage Design, Repayment Schedules, and Household Borrowing

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Motivation

One of the most important features of a mortgage contract is the repayment schedule

 Mandatory saving through mortgage repayment – one of the largest savings plans in the world, similar in aggregate magnitude to pension contributions (Bernstein & Koudijs, 2023)

Active debate in many countries about whether to further regulate mortgage contract design

- In the US, interest-only mortgages surged in popularity during mid-2000s, jumping to 25% of originations pre crisis, before being de-facto banned
- In Europe, some countries continue to permit interest-only mortgages, while some countries are limiting access through macroprudential policies

Research question: How does the design of debt repayment schedules affect household borrowing?

Contribution: Empirical

Exploit a reform in Sweden that eliminated IO mortgages for borrowers with LTV ratios above 50%

- Substantial bunching below the threshold, as households reduce leverage to avoid amortization
- Results are driven by wealthy, unconstrained borrowers, ruling out credit-constraints as the primary explanation

Limited role for budget-constraint explanations

- Only 14% of bunching can be explained by credit constraints
- No evidence of other supply-side factors that could generate notches or kinks in the budget constraint

Contribution: Mechanism

We find that bunching is driven by households experiencing ongoing flow disutility to amortization

- Baseline life-cycle model does not generate bunching at the threshold
- If there's no kink or notch in the budget constraint, then there must be a kink or notch in preferences (Kleven, 2016)
- Identification is driven by the lack of missing mass, which indicates a kink rather than notch

How might this matter for the aggregate economy?

- Flow disutility implies "NPV neglect" ightarrow HHs may choose a mortgage that comes with a higher lifetime cost
- The introduction of IO mortgages may substantially increase borrowing, since many HHs do not internalize the lifetime costs of such loans

Roadmap

Institutional Setting

Empirical Analysis

Theoretical Framework Baseline Model Behavioral Wedges

Conclusion

Institutional Setting & Policy Reform

Swedish mortgage market

- Mainly adjustable rate mortgages (ARMs) with no set maturity
- Majority of mortgages were interest-only pre reform (around 60 percent)
- Linear repayment schedules (pre and post reform)

Sweden implemented a "mandatory amortization policy" in June 2016

- Prohibited interest-only repayment for new mortgages with LTV ratios > 50%
- Mandatory amortization of 1% of entire mortgage if $\mathsf{LTV} > 50\%$
- Mandatory amortization of 2% of entire mortgage if LTV > 70%
- After crossing below the threshold, borrowers can turn off amortization payments

How do borrowers respond to the policy?

Households face a trade-off between a larger down payment or higher amortization payments

- Discontinuous jump in mortgage payments at the requirement thresholds
- · Allows us to identify the response of borrowers to changes in repayment requirements

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Example: Household wants to borrow against a \$500k house. What down payment to choose?

- Down payment $250k: LTV = 50\% \rightarrow No$ amortization payments
- Down payment \$240k: LTV = 52% \rightarrow Amortization payments \approx \$200/month

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- Administrative micro data reported by 8 largest banks in Sweden, 2011 2018
 - Covers all newly issued mortgages within a two-week window
 - 15,000 30,000 households per year
- Variables:
 - Loan-level: amount, interest rate, amortization, collateral, valuation method
 - Household-level: size, age, income, location, total debt (secured, unsecured)

Sharp reduction in share of interest-only mortgages



Percent of households

Bunching at the 50% threshold

8 percent of borrowers bunch

- Reduction in LTV = 5.14%
- Little missing mass (11% of B)
- 86% of bunching borrowers face no binding borrowing constraints

In the paper, we find no evidence that various supply side mechanisms (e.g. interest rates) explain our results



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Life-cycle model of consumption, housing, and mortgages

Households get utility from:

- Consumption
- Housing

Heterogeneity and risk:

- Initial assets
- Initial income
- Income shocks

Model

Households choose:

- Consumption
- Liquid assets
- Housing
- Mortgage debt

Mortgage contracts:

- Long-term mortgages
- Mandatory minimum payment $ho_t(m_t, p_t)$
- Possible to cash-out refi (for a fee)

Model Results

- 1. Baseline model: Households do not bunch below cutoff to avoid amortization
 - Why? No kink or notch in expected discounted utility



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Why do households want to avoid amortization?

We augment household preferences to feature two types of behavioral wedges (Mullainathan et al., 2012)

Option 1: One-off disutility that applies when borrowers turn off amortization payments

- Psychic renegotiation cost to call the bank and turn off amortization payments, once eligible
- Alternative: reference-dependent preferences (if the threshold creates a goal that households try to achieve)

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Option 2: Ongoing flow disutility to amortization

- Psychic cost to amortization payments potentially driven by HHs viewing amortization as a cost
- "Mortgage illusion": HHs focus on monthly payment, not actual cost (Camanho & Fernandes, 2018)
- "Monthly payment targeting" as documented for auto loans (Argyle et al., 2020, RFS)

1. One-off disutility \rightarrow Notch



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HHs just above the cutoff make larger down payments to get IO loans. Bunching due to missing mass.



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$1. \ \text{One-off disutility} \rightarrow \text{Notch}$

HHs just above the cutoff make larger down payments to get IO loans. Bunching due to missing mass.

2. Ongoing flow disutility \rightarrow Kink

All HHs above cutoff make larger down payments and borrow less. Bunching without missing mass.



Disentangling the two different mechanisms

- In the data, we find little missing mass above the threshold
- Missing mass explains roughly 10% of the excess mass, robust across specifications
- Thus while both mechanisms may exist, we think *flow disutility* is more important

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- Flow disutility implies "NPV neglect" ightarrow HHs may choose a mortgage that comes with a higher lifetime cost
- The introduction of interest-only mortgages may substantially increase borrowing, since many HHs do not internalize the lifetime cost of such loans

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Conclusion

We show that households reduce borrowing to avoid amortization payments

- Only 14% of the bunching can be explained by credit constraints
- No evidence of other supply-side factors that could generate notches or kinks in the budget constraint

Most of the bunching comes from a kink in household preferences

- Identification comes from the fact that most excess mass is generated without a missing mass
- Households may experience "NPV neglect" when choosing between alternative mortgage contracts

Overall impact on financial stability also depends on how households use liquidity from IO mortgages

Thank you!

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Percent of households



Appendix

Year-by-year LTV distributions



Percent of households

Validation

Validating the empirical strategy

We confirm the validity of our empirical approach using a variety of different strategies:

- Placebo test: estimate bunching using only pre-requirement data
- Flexible polynomial \rightarrow similar results but difficult to capture round-number bunching
- Similar results if we estimate for refinancers vs homebuyers
- Amortization rates higher above threshold only after requirement is in effect



Placebo tests

Amortization rates



Mechanisms

- Most households near the 50% LTV threshold could increase their mortgage size substantially
- One exception: households constrained by payment-to-income (PTI) requirements

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- One exception: households constrained by payment-to-income (PTI) requirements



 $\label{eq:constraint} \begin{array}{l} \mbox{Discretionary income} = \mbox{income} - \mbox{mortgage payments} - \\ \mbox{"subsistence level of consumption"} \end{array}$

$$\label{eq:counterfactual} \begin{split} & \mbox{Counterfactual} = \mbox{discretionary income minus extra} \\ & \mbox{payments if borrowing 1 p.p more} \end{split}$$

26.3% of borrowers forced to lower LTV ratio to comply with PTI constraints

Split households into groups based on counterfactual discretionary income and distance from the PTI constraint:

- Near = less than \$6,000
- Intermediate = \$6,000-\$18,000
- Far = over \$18,000

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Still observe substantial bunching for borrowers far from the PTI constraint

PTI Constraint	Near	Intermediate	Far
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 Bunching figures

Model

Life-cycle model of consumption, saving, housing, and mortgages

Model: Extend Attanasio et al. (2012) to include realistic mortgages

Households get utility from consumption and housing

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

- Demographics: household live for T years, retired for final W years
- · Households heterogeneous w.r.t. initial assets and income shocks

Calibrated based on Swedish data and previous literature





Parameter values

Assets and Mortgages

- 1. Liquid asset ($a_t \ge 0$), return r
- 2. Illiquid housing asset (h_t) , return r^h
 - Discrete asset with N different sizes (flat, house, mansion, etc.)
 - Allowed to own or rent any unit, where rent = ηp_t
 - **Transaction cost:** fraction f_1 of the house price
- 3. Long-term mortgages (m_t) , at interest rate r^m
 - Maximum loan to value: $\bar{\psi}$ percent of the house price
 - Mandatory minimum payment $\rho_t(m_t, p_t)$ each period depending on amortization rule
 - Possible to cash-out refinance: multiplicative cost f_2 and additive cost f_3

Mortgage Payments

We consider two different policies, which broadly reflect the policy framework in Sweden before/after the reform:

Interest-only mortgages

$$\rho_t(m_t, p_t) = m_t * r^m$$

• Mandatory amortization policy that depends on LTV:

$$\rho_t(m_t, p_t) = m_t * r^m + \begin{cases} 0, & \text{if } m_t/p_t \le 0.5\\ 0.01 * m_t, & \text{if } m_t/p_t > 0.5 \end{cases}$$

Preferences

Functional form follows Cocco (2005)

$$u(c_t, h_t, \delta_t) = \frac{\left(c_t^{1-\theta}\phi(h_t)^{\theta}\right)^{1-\gamma}}{1-\gamma} - \delta_t$$

Preference parameters

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

Behavioral wedge

- $\delta_t = 0$ in baseline model
- Explore alternatives later

Option 1: Notch in household preferences

We introduce a utility cost when households turn off amortization:

$$\delta_t = -\Delta_n \times 1_{\mathrm{amort}_t = 0, \ \mathrm{amort}_{t-1} > 0}$$

- Renegotiation cost to "call the bank" and turn off amortization payments, once eligible
- Psychic cost investigated potential monetary costs, but for banks in our sample, no monetary cost
- Cost to refinancing studied in e.g. Agarwal et al. (2016), Keys et al. (2016), Andersen et al. (2020), ...
- Alternative: reference dependence, e.g. policy creates a target that HHs try to achieve

Renegotiation cost creates notch in value function

Borrowers above the threshold pay psychic cost to turn off amortization

• Creates notch in utility function

Effect is local to the notch

 No change in slope at higher LTV values



Households reduce borrowing to avoid amortization

Households reduce borrowing to avoid amortization

- Dominated region directly above the 50% threshold
- Excess mass just below cutoff comes from missing mass above
- Local effect around the cutoff



Option 2: Kink in Household Preferences

Suppose instead that households get disutility from amortization payments:

$$\delta_t = -\Delta_k \times 1_{\mathsf{amort}_t > 0}$$

Various ways to think of such a wedge:

- "Mortgage illusion": HHs focus on monthly payment, not actual cost (Camanho & Fernandes, 2018)
- "Monthly payment targeting" as documented for auto loans (Argyle et al., 2020, RFS)
- Borrowers may mistake amortization payments for interest payments
- Survey evidence: 38% of Swedish respondents state that amortization payments are a cost (SBAB, 2018)

Dislike of amortization generates a kink in value function

All borrowers above the notch are affected

- Slope of the value function changes at LTV = 50%
- $\rightarrow\,$ Disutility to amortizing create a kink in the value function



The kink creates bunching without a missing mass



Disentangling the two different mechanisms

In the data, we find little missing mass above the threshold

- Missing mass explains roughly 10% of the excess mass, robust across specifications
- Thus while both mechanisms may exist, we think the kink is more important



Why might this matter for the aggregate economy?

The two theories have different implications for overall borrowing:

- Notch: response only comes from borrowers directly above the threshold
- Kink: response comes from all borrowers above threshold

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How might the introduction of interest-only mortgages affect overall borrowing?

- Kink implies "NPV neglect" ightarrow households may choose a mortgage that comes with a higher lifetime cost
- The introduction of interest-only mortgages may substantially increase borrowing, since HHs do not internalize the true cost of these loans

Everything else

House price growth in Sweden

Background



38/39

Sharp reduction in share of interest-only mortgages (Back

Background



Percent of households

Bunching at upper threshold (Back)

Summary of results:

- 12.93 percent of borrowers bunch
- Change in LTV = 3.9%
- Little missing mass (11 % of B)
- ightarrow 1pp increase in amortization rate decreases LTV by 0.14 percent



Bunching estimates by distance from payment constraints

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

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)



Empirical and Counter-factual distribution in 2014





Ratio between counter-factual and empirical distribution in placebo years



I ower threshold



Upper threshold



39/39

Bunching estimate using polynomial approach





Estimates of ΔLTV using polynomial approach

Threats to identification





Amortization rates by LTV ratio over time

Lower threshold





Reduction in discretionary income (Back)

Constrained and unconstrained borrowers



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

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
- Results are similar across types



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 at lower threshold for Constrained group (Back)

Constrained and unconstrained borrowers



Bunching at lower threshold for Intermediate group (Back)

Constrained and unconstrained borrowers



Bunching at lower threshold for Unconstrained group (Back)

Constrained and unconstrained borrowers



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

$$egin{aligned} & z_{i,t} =
ho z_{i,t-1} + arepsilon_{i,t}, \ & arepsilon_{i,t} \sim N(0,\sigma_arepsilon^2) \end{aligned}$$

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

Calibration parameters (Back)

Model

Parameter	Symbol	Value	Source
Income process:			
Income persistence	ρ	0.97	Kovaes & Moran (2021)
Std dev income shocks	a.	0.180	Kovacs & Moran (2021)
Income constant	d_0	8.2007	Kovaes & Moran (2021)
Income Age effect	d1	0.1378	Kovaes & Moran (2021)
Income Age^2 effect	d2	-0.0019	Kovaes & Moran (2021)
Income Age^3 effect	da	0.000007	Kovacs & Moran (2021)
Initial conditions:			
Std Dev Initial Income	σ_0	0.410	Kovaes & Moran (2021)
Share with zero initial assets	alero	0.433	Kovaes & Moran (2021)
Cond. mean initial assets	μ_{n_0}	7.117	Kovaes & Moran (2021)
Cond. std dev initial assets	σ_{a_0}	1.972	Kovaes & Moran (2021)
Preferences:			
Time preference	6	0.96	Coreo (2005)
Risk aversion	2	5.0	Cocco (2005)
Housing utility share	é	0.1	Cocco (2005)
Disutility of renting	c	0.03	Leombroni et al. (2020)
Flow Disutility of Amortization	Å.	0.08	Author's calibration
One-Off Disutility of Amortization	Δ_n	0.35	Author's calibration
Assots			
Real return on liquid asset		0.0181	Swedish 3 month T.bill
Real return on housing	T ^H	0.02953	Statistics Sweden
Mortgage interest rate	-M	0.0087	Statistics Sweden
Multiplicative cost of refinancing	fa	5.0%	Federal Reserve Board (2008)
Additive cost of refinancing	fa	\$3000	Federal Reserve Board (2008)
Liquid borrowing constraint		0.0	Cocco (2005)
Maximum Loan-to-Value Ratio	1-0	0.85	Swedish law
Financial cost to moving homes	f_1	0.05	OECD (2011)
Domographics:			
Age at labor market entry	t = 0	22	Attanasio et al. (2012)
Age of retirement	W	65	Attanasio et al. (2012)
Age of certain death	T	120	Statistical life tables
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