Essays in Household Finance and Macroeconomics

PhD Thesis Defense

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Overview of the thesis

The home is the largest purchase most households ever make

- The mortgage that finances it is the largest debt they ever take on
- The house itself is the largest asset in their wealth

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I study the role of housing in household financial decisions

- How households pay for housing — saving up for it, borrowing, repaying — shapes how they consume and save
- And how they respond to shocks, like a job loss or a rise in interest rates

Three chapters, combining theory and empirics

Liquidity constraints in housing and mortgages studied with quantitative modelling and household micro data

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1 · Mortgage Structure, Saving Rates and the Wealth Distribution

Strict repayment schedules lead homeowners to save more of their income, but leave the young with little cash savings

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2 · The Cost of Homeownership

Standard affordability measures miss the saving effort for the downpayment; counting it, the effective cost of homeownership in the US rose 32% since 2000

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3 · How Does Monetary Policy Affect Household Portfolios?

After a rate rise, households' portfolios lose value and become less risky; the wealthier and more sophisticated instead take advantage of lower prices

Related literature and contributions

Ch. 1 · Mortgage Structure, Saving Rates and the Wealth Distribution *household finance + distributional macro*

Amortization, consumption, and saving — Bernstein & Koudijs (2024); Backman & Khorunzhina (2024); Larsen et al. (2024)

Life-cycle mortgage design — Campbell & Cocco (2015); Gete & Zecchetto (2018, 2024); Backman et al. (2025)

Wealthy hand-to-mouth — Kaplan & Violante (2014); Boar, Gorea & Midrigan (2022); Aguiar, Bils & Boar (2025)

This paper: welfare and distributional effects of rigid repayment — a wealthy hand-to-mouth mechanism

Ch. 2 · The Cost of Homeownership *household finance + housing economics / real estate*

Housing-affordability indexes — NAR HAI; Gan & Hill (2009); Biljanovska et al. (2023)

User-cost approaches — Poterba (1984); Himmelberg, Mayer & Sinai (2005); Díaz & Luengo-Prado (2008); Bishop et al. (2023)

Entry and downpayment constraints — Ortalo-Magné & Rady (2006); Chambers et al. (2009); Molloy et al. (2022)

This paper: a microfounded cost of becoming an owner, covering the saving-up phase the indexes miss

Ch. 3 · How Does Monetary Policy Affect Household Portfolios? *household finance + empirical macro / monetary policy*

Portfolio composition and transmission — Kaplan, Moll & Violante (2018); Kekre & Lenel (2022); Melcangi & Sterk (2025)

Household-level monetary transmission — Auclert (2019); Holm et al. (2021); Andersen et al. (2023)

Risk-taking and portfolio adjustment — Calvet et al. (2009, 2014); Fagereng et al. (2017); Gomes et al. (2025)

This paper: population-wide data shows persistent differences matter in HH portfolio responses to MP

CHAPTER 1

Mortgage Structure, Saving Rates and the Wealth Distribution

Job Market Paper

How do fixed repayment schedules in mortgages affect saving and wealth?

Mortgage debt repayments are a large fraction of household *saving* flows

- $\sim$ 30% of Euro area aggregate saving (similar in US)

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Mortgages often mandate fixed repayment schedules, e.g. annuity loans amortizing vs. IO

- Fixed at origination; deviating is costly (refinancing, late penalties, ...)
- New homeowners are constrained: hand-to-mouth + high debt, expected income growth

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This chapter: fixed repayments increase overall saving ($\downarrow C$), but crowd out liquid saving

- Reduced consumption smoothing, increase share of hand-to-mouth
- Effects concentrated at bottom of wealth distribution
- Approach: combine a life-cycle model with household data from a Dutch policy reform

Model framework

Standard incomplete markets model + mortgage debt

- First-time homebuyer life-cycle, origination to maturity: home worth P_0 (normalized), 30-year fixed-rate mortgage with balance M_0, initial financial wealth A_0
- Two assets: **liquid safe asset** (a_t, risk-free rate r) vs. **mortgage debt** (m_t, rate $r^m > r$); housing fixed
- Idiosyncratic income risk (permanent + transitory); CRRA utility over non-housing consumption (separable, Campbell–Cocco 2015)
- Each period, choose consumption c_t and mortgage repayment d_t; cannot increase mortgage debt ($d_t \geq 0$)

Key addition: mortgage contract transaction costs

- Mandatory amortization: schedule $D^*(m_{t-1}, t)$ from standard annuity formula
- Deviating from schedule ($d_t < d_t^*$) incurs a cost to delay mandatory amortization: $\tau_t \geq 0$
- If default, lose house and keep low consumption $\underline{c}$ until end

Model framework: the household problem

The household solves, choosing consumption c_t and repayment d_t:

$$V(t, s_t) = \max_{\{c_k, d_k\}_{k=t}^{T}} \mathbb{E}_t \left[\sum_{k=t}^{T-1} \beta^{k-t} \frac{c_k^{1-\gamma}}{1-\gamma} + \beta^{T-t} B(a_T - m_T) \right], \text{ s.t.}$$

$$\begin{aligned}
a_{t+1} &= (1+r)\left[a_t + y_t - (r+s)m_t - d_t - \tau_t - c_t\right], \\
m_{t+1} &= m_t - d_t \\
\tau_t &= \tau \cdot \max\{0, d_t^* - d_t\}, \quad a_t \geq \theta^a, \quad m_t \geq 0, \quad d_t \geq 0
\end{aligned}$$

- Terminal condition: bequest motive $B(a_T - m_T) = b_0 \frac{(a_T - m_T + b_1)^{1-\gamma}}{1-\gamma}$
- Imposes mortgage fully repaid by retirement, so bequest is net wealth $a_T - m_T$
- Solved via deep-learning algorithm (Duarte et al. 2022; Barrera & de Silva 2024)

Data from the Netherlands and calibration strategy

HFCS: harmonized Euro-area survey, three waves (2013–21)

Detailed household balance sheets, income, consumption, and **mortgages**

A 2013 reform raised the cost of repayment flexibility for new buyers

- Before 2013: flexible repayment, large interest-only at no extra cost — median HH amortizes $\sim$10% of income in EA, 2.5% in NL

amortization histograms

- From 2013: interest deduction restricted to the **conforming** part — eliminating the rebate $\approx \uparrow$ 2x cost of carrying non-conforming debt

Policy change identifies repayment rigidity

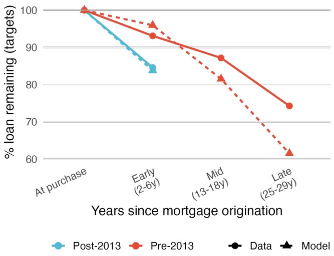
- Pre-2013 buyers (free flexibility) $\rightarrow$ full life-cycle identifies preferences (β, b_0, τ^{pre})
- Post-2013 buyers (costly) $\rightarrow$ change in early amortization identifies the friction τ^{post}
- Liquid wealth of post-2013 buyers **not targeted** $\rightarrow$ reproduces observed crowd-out (validation)
- Initial conditions drawn from empirical distributions, stable across cohorts

initial conditions

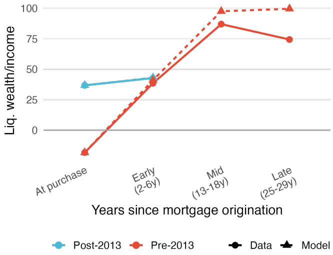
Model matches debt repayment and liquid wealth dynamics

Model vs. data: means over the loan life cycle

Debt repayment



Liquid wealth



Post-2013, higher penalty leads to faster early repayment (even with lower int. rates)

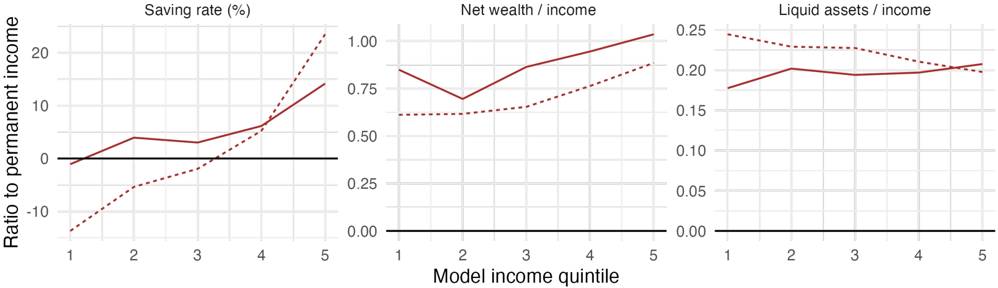
Pre-2013 calibration target, model fits well; post-2013 targeted only in identifying τ^{post}

Estimated friction: $\tau^{pre} = 0.01 \rightarrow \tau^{post} = 0.665$, i.e. $\Delta\tau \approx 0.66$ penalty on delayed repayment

estimated parameters | calibration

Income-poorer model HHs save more in total, but less into liquid wealth

Means of model population across income quintiles (conditional on age)



- Saving rate increases, but ↓ C, liquid savings ⇒ more exposed to shocks
- Matches saving rate differences in the data

saving rates: model vs. data

Amortization policy increases hand-to-mouth, with large costs for HH

Share of homeowners with liquid wealth < 1 month of income: $4\% \rightarrow 19\%$ HtM by income

- $\Rightarrow$ higher MPCs, C volatility; impact much larger at lower income groups

Median welfare loss higher for lower-income groups

- Importance of limits to self-insurance capacity

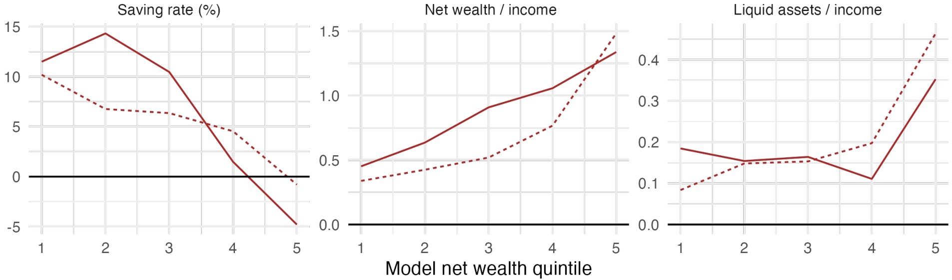
Education level	Median CEV (%)
Low education	$-\mathbf{2.82}$
High education	$-\mathbf{2.13}$

Households would need 2–3% permanent consumption increase to achieve pre-policy welfare

- $\approx$ working an extra year before retirement (given 40y working life)

Forced amortization increases saving rates at the bottom of wealth dist.

Implying effects on distribution of total and financial wealth



- Saving rates increase at the bottom of the wealth distribution
- $\Rightarrow \downarrow$ inequality in total wealth, but $\uparrow$ in financial wealth and share of hand-to-mouth

Conclusion

- This chapter: fixed repayment schedules crowd out liquid saving, limiting consumption smoothing
- Imposing amortization, through a 67% penalty on delayed repayment (Netherlands), leads to:
  - Consumption $\downarrow$ $\sim$10% of income early in the mortgage
  - Share of hand-to-mouth $\uparrow$ 4% $\rightarrow$ 19%
  - Welfare loss $\approx$ 2–3% of lifetime consumption ($\approx$ one extra working year)
- In the wealth distribution: a micro-foundation for the large share of "wealthy hand-to-mouth"
- Amortization requirements may have financial stability benefits, but carry large costs for homeowners
  - Younger, lower-income households seem to be excessively penalized by rigid structure
  - Some flexibility can go a long way (optimal level for future work!)

CHAPTER 2

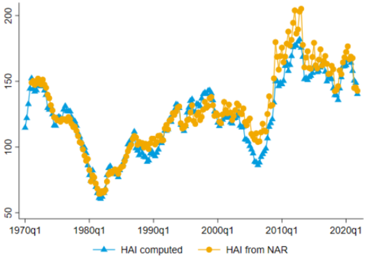
The Cost of Homeownership

with João B. Duarte and Francisco F. Rodrigues

Affordability indices say buying is as affordable as in 2000

The standard metric: the *Housing Affordability Index (HAI)* — mortgage payment to income

IMF (2023), Atlanta Fed



Higher = more affordable

- The HAI is at its early-2000s level — yet younger generations are increasingly less likely to own (Paz-Pardo, 2024)

For first-time buyers, standard measures miss part of the cost

Standard measures of housing affordability

- House price-to-income ratios
- Mortgage-payment-to-income ratios: the HAI

Both price the purchase itself — not the path to it

- Pre-purchase: saving up for a downpayment while paying rent
- Post-purchase: servicing the mortgage

This chapter: a microfounded measure of the 1st-time buyer cost

- Covers the whole buyer path: save for the downpayment $\rightarrow$ buy $\rightarrow$ repay the mortgage

Three features

1. Reflects the *intertemporal budget constraint*: rents, house prices, mortgage rates, LTV requirements
2. Measured in consumption-equivalent units
3. Independent of housing preferences

Minimal data requirements

- Prices, rents, mortgage rates, LTV caps and income suffice $\Rightarrow$ comparable over time and across regions or countries; policymakers can apply it
- Here: annual US series, 2000–2023, for the median household and by income quintile — directly comparable with the HAI

Model of the 1st-time buyer path

Household committed to buy house h at date t^*

- Consumption-saving decisions each period (month), with idiosyncratic income risk and a borrowing constraint
- Explicit housing expenditures, dependent on tenure status:
  - As *renter* ($t < t^*$): pay rent qh
  - As *buyer* ($t = t^*$): pay price ph, choose mortgage m subject to an LTV cap
  - As *owner* ($t > t^*$): pay maintenance and a fixed mortgage payment $x(m)$ (30-year fixed-rate)

The cost is financial: measured in other consumption given up

- Focus on foregone non-housing consumption, independent of how much the household values housing
- Modeling choice that delivers this: housing preferences separable from non-durable consumption

  Campbell and Cocco (2007, 2015), Greenwald and Guren (2025), Paz-Pardo (2024)

The Buyer Cost measure

Value of the committed buyer path — at purchase:

$$V_{t^*}(z, b, h) = \max_{c,\ b',\ m}\ u(c) + \beta \mathbb{E}_z \left[V^{\text{Owner}}_{t^*+1}(z', b', h, m) \right]$$

$$\text{s.t.}\ \ c + b' = z + (1 + r_b)b - qh - ph + m, \qquad b' \geq 0, \qquad m \leq \theta ph$$

A model-based value gap for the committed buyer path

- **Buyer:** rents h at q, saves for the downpayment, buys at p, repays the mortgage
- **Benchmark:** removes rent and purchase costs ($p = q = 0$)
  - The framework is meant to compare buying with other outside options too: staying with parents, renting permanently, and others

$$\text{Buyer Cost} = V_0^{\text{free-user}} - V_0^{\text{buyer}} \qquad \text{(value-function units)}$$

Welfare cost relative to the stated benchmark; a consumption-equivalent transformation is a separate step.

Calibration and data

Year-by-year, data-driven parameterization, US 2000–2023

- p_t, q_t: median house price and rent (US Census)
- r_t^m: 30-year fixed mortgage rate (Freddie Mac)
- θ_t: max LTV, 97.5% before 2010 and 90% after
- z: median income (US Census); b_0: liquid wealth to income (DFA, Federal Reserve Board)

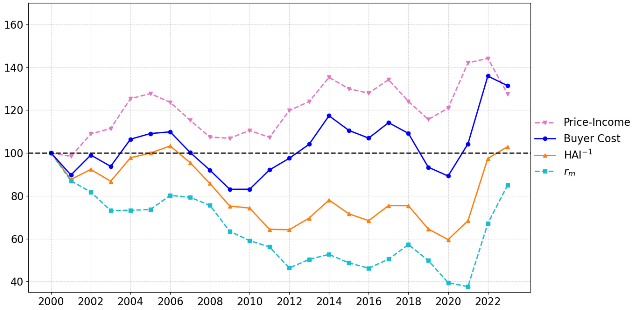
By income quintile

- Quintile-specific income z_i (Census Historical Income Tables), liquid wealth b_{0i} (DFA) and house size h_i (rent-to-income, SCF 2000)

Comparator: the HAI, inverted to preserve the cost interpretation

- $\text{HAI}^{-1} \equiv x(m = \theta ph;\ r_m) \,/\, z$ — mortgage payment to income

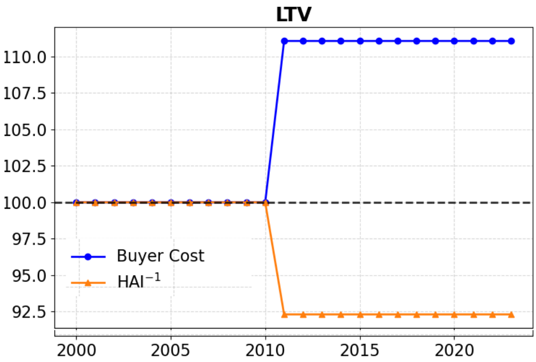
The Buyer Cost rose 32%; the HAI is essentially unchanged



Index, 2000 = 100

- The divergence opens after the 2010 LTV tightening: Buyer Cost +40% over 2010–2014, HAI at most +10%
- Buyer Cost tracks price-to-income; the HAI tracks mortgage rates

The LTV cap drives the divergence, with opposite signs



Index, 2000 = 100; other components at 2000 values

Only the LTV cap varies

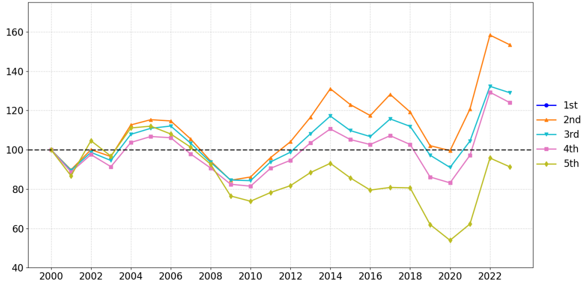
- Buyer Cost $+10\%$, HAI -7.5%
- HAI: larger downpayment $=$ smaller loan $\rightarrow$ reads as *lower* cost
- Buyer Cost: saving effort outweighs the lower payments

Other components

decomposition

- Prices raise the Buyer Cost more than the HAI
- Income and rates move the two together

The burden concentrates in the lower-middle income quintiles



Income quintiles, each with its own liquid wealth and house size; index, 2000 = 100

- 1st quintile: buying is prohibitively costly throughout (not shown)
- 2nd quintile: Buyer Cost $+58\%$, against a $\sim$8% rise in its HAI
- Top quintile: broadly unchanged — post-2018 liquid wealth mutes the downpayment effort

HAI by quintile

Conclusion

- Conventional metrics price the mortgage payment, not the burden of *saving up for the downpayment*
- Tighter LTV caps read as *lower* cost in the HAI, but raise the Buyer Cost by more than 10%; with rising house prices, the major driver
- +58% for the 2nd quintile, prohibitive for the 1st, broadly unchanged at the top

A portable tool for the entry margin

- Prices, rents, mortgage rates and LTV caps suffice — any country, any year; intended for *ex-ante* evaluation of macroprudential reforms

CHAPTER 3

How Does Monetary Policy Affect Household Portfolios?

with Tiago Bernardino, Pedro Brinca, Ana Melissa Ferreira, Hans A. Holter and Mariana N. Pires

Portfolio composition is central to monetary transmission

- Distribution of household **net wealth** is key for MP transmission
  - Share of constrained households $\Longrightarrow$ MPC $\Longrightarrow$ aggregate responses
- More recently: **portfolio composition** also plays an important role
  - Portfolio liquidity (Kaplan–Moll–Violante, 2018; Luetticke, 2021)
  - Portfolio risk exposure (Kekre–Lenel, 2022)
  - Stock market participation (Melcangi–Sterk, 2025)
- Yet there is a **lack of empirical evidence** covering the full population
  - Empirical MP literature focuses on consumption or income responses
  - Finance literature focuses on sophisticated investors
- **This chapter:** population-wide administrative wealth records + well-identified MP shocks
  - Trace responses across the household balance sheet and wealth distribution
  - Separate passive valuation effects from active investment decisions

data

We trace cumulative household responses over four years

We estimate cumulative impulse responses to a 1 p.p. **tightening** shock, using local projections at the household level (Jordà, 2005):

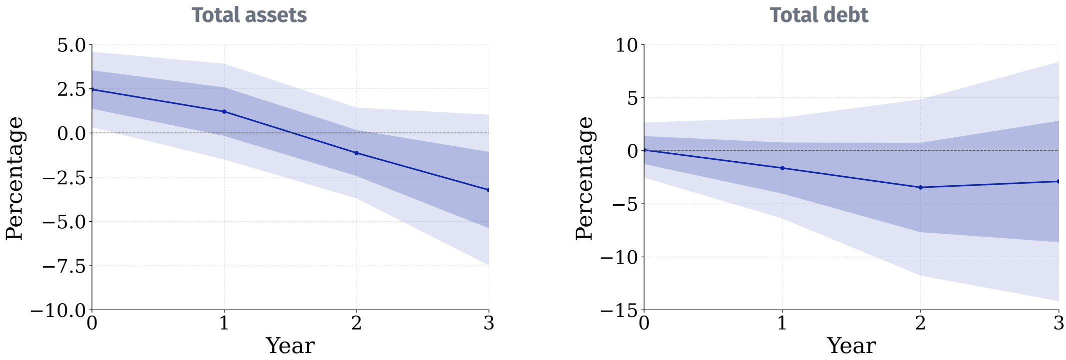
$$\frac{y_{i,t+h} - y_{i,t-1}}{\bar{y}_{t-1}} = \delta_i^h + \beta^h \cdot \epsilon_t^M + \sum_{k=1}^{K} \gamma_k^h \mathbb{X}_{i,t-k} + u_{i,t}^h \quad , \quad \text{for } h \in \{0, 1, 2, 3\}$$

where

- y is the variable of interest (e.g., private equity or housing)
- δ are household fixed effects
- ϵ^M is the series of monetary shocks
- $\mathbb{X}$ are controls: 3 lags of y and 2 lags of ϵ^M
- Sample: population-wide Norwegian administrative records, ≈2.9 million households, 1993–2019

Standard errors are clustered at the year level

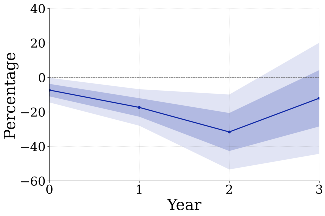
Total assets decline; debt shows no significant response



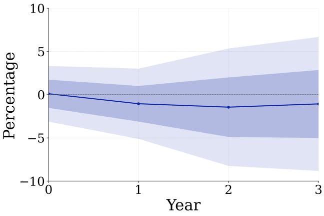
Total assets rise on impact and decline thereafter. Total debt shows no statistically significant response at any horizon: surprisingly, **no deleveraging on aggregate**.

Risky assets fall, safe assets stay flat, and housing reverses

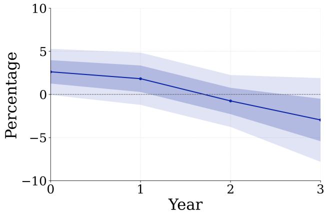
Stocks and bonds



Safe assets



Housing

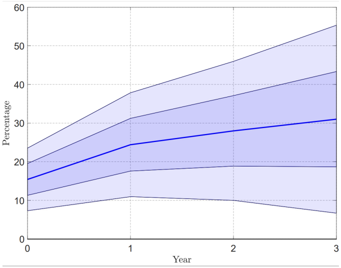


Stocks and bonds fall persistently, safe assets remain flat, and housing rises on impact before reversing.

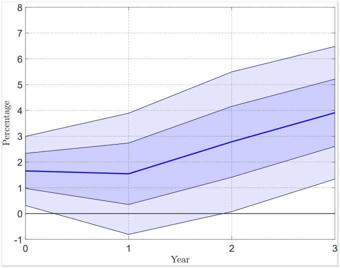
housing response

Are these changes due to active investment decisions?

Quantity of stocks



Quantity of private equity



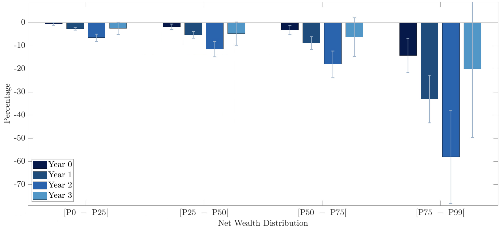
Among continuing holders, both public- and private-share quantities rise. With falling stock prices, this is consistent with households **increasing holdings in response to higher expected returns**; the private-equity response is smaller and less precisely estimated.

Which households drive these responses? $\Longrightarrow$ **heterogeneity analysis**

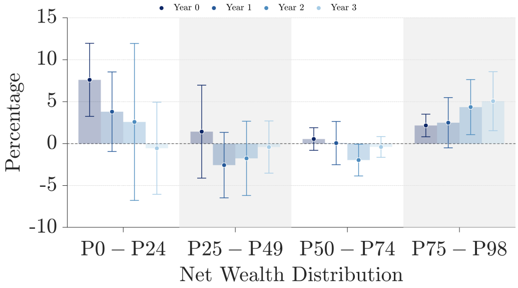
quantity specification | prices | theory

At the top, listed-risky values fall while private-equity quantities rise

Listed stocks and bonds: value



Private equity: quantity



Top-wealth households absorb the largest listed-risky value decline but expand private-equity holdings.

private-equity value

Which characteristics predict stronger portfolio responses?

Building on the grouped results, we estimate **joint marginal effects** for stocks and bonds and for housing

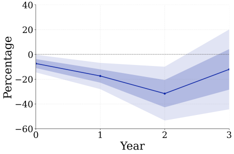
Related firm evidence: Cao et al. (2025)

$$\frac{y_{i,t+h} - y_{i,t-1}}{\bar{y}_{t-1}} = \delta_i^h + \beta^h \epsilon_t^M + \sum_{d=1}^{D} \beta_d^h \left(\epsilon_t^M \times z_{i,t-1}^d \right) + \sum_{d=1}^{D} \lambda_d^h z_{i,t-1}^d + \sum_{k=1}^{K} \gamma_k^h \mathbb{X}_{i,t-k} + u_{i,t}^h, \qquad h \in \{0, 1, 2, 3\}$$

- The six standardized initial characteristics in $z_{i,t-1}$ are net wealth, income, risky exposure, age, financial literacy, and indebtedness
- Household fixed effects; standard errors clustered at the year level

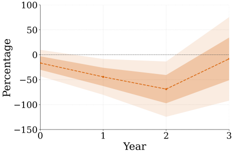
Which characteristics predict stronger risky-asset responses?

Risky assets: aggregate

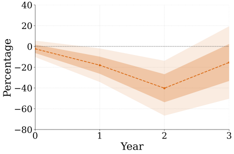


Aggregate response

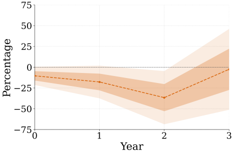
Marginal effect of each characteristic:



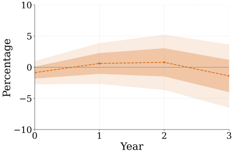
Net wealth



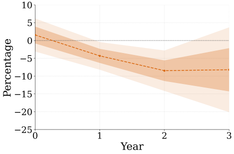
Income



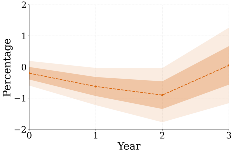
Initial risky exposure



Age



Financial literacy



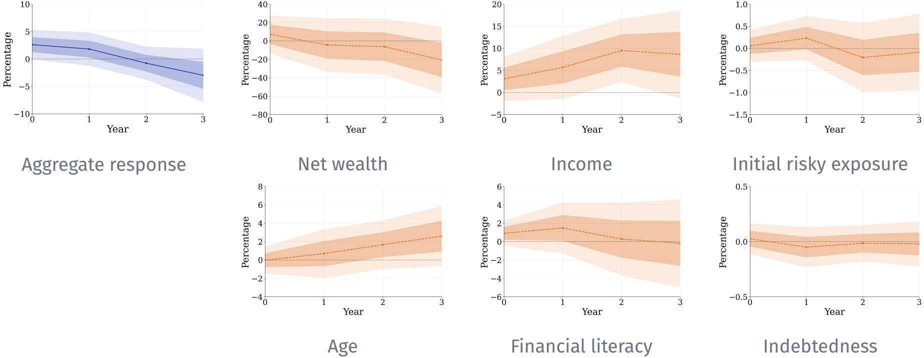
Indebtedness

- Stronger responses among households with higher **net wealth, income, initial risky exposure, and financial literacy**

mechanisms

Housing heterogeneity is consistent with a rush-to-buy channel

Housing: aggregate **Marginal effect of each characteristic:**



- At $h = 0$, higher **income and financial literacy** predict a stronger housing uptick, consistent with bringing purchases forward
- At longer horizons, **age and income** reduce exposure to the price decline, while higher **net wealth** increases it

Conclusion

We study the response of HH wealth portfolios in Norway to monetary policy.

We find a link between **risk exposure** and **portfolio composition response**:

1. Monetary policy tightening decreases the risk exposure of the **aggregate** HH portfolio
2. At the same time, households with greater income, net wealth and sophistication seem to **take advantage** of lower prices and higher expected returns to increase investments

Overall lesson from observing responses across the full population:

- Theories featuring persistent differences in net wealth, income, risk preferences or sophistication are clearly relevant
    - Especially as stock-market participation and education rise over time

Thank you

I look forward to your questions and comments

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Appendix

Contribution to the literature

Paper fits in literature modelling life-cycle and welfare effects of mortgage structure — Boar et al. (2022), Backman et al. (2025), Balke et al. (2024), Boutros et al. (2025), Ferreira et al. (2024), Gete & Zecchetto (2018, 2024), Greenwald et al. (2018), Karlman et al. (2021), Vestman (2018)

- Effects of amortization requirements on household consumption and saving — Andersen et al. (2021); Backman & Khorunzhina (2024); Backman et al. (2024); Bernstein & Koudijs (2024); Larsen et al. (2024)
  - This paper: crowding out of liquid wealth; long-run/life-cycle effects
- Wealth distribution and the high share of "wealthy hand-to-mouth" — Aguiar, Bils & Boar (2025); Boar, Gorea & Midrigan (2022); Kaplan & Violante (2014)
  - This paper: evidence of clear mechanism driving up WHtM share
- Optimal mortgage contract structure — Campbell and Cocco (2015); Campbell et al. (2018); Chambers et al. (2009); Gete (2018); Guren et al. (2018); Piskorski & Tchistyi (2010, 2011)
  - This paper: (heterogeneous) effects on household wealth and welfare of repayment rigidity

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Initial conditions drawn from empirical distributions, stable across cohorts

- Households simulated by drawing from the empirical joint distribution among **recent homebuyers**
- Composition stable; some drop in **interest rates** and **house prices**:

Time of purchase	Pre-2013	Post-2013
LTV at origination	1.05	1.00
Liquid wealth / income	-0.13	0.31
Age at purchase	32.14	32.95
House price / income	4.63	3.59
Mortgage interest rate (%)	4.56	2.36
High education (%)	69.15	73.59

- Reduced selection concerns; model allows to account for differences at purchase

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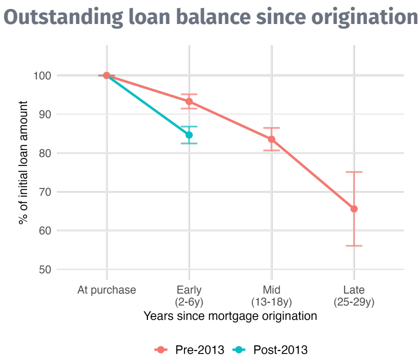
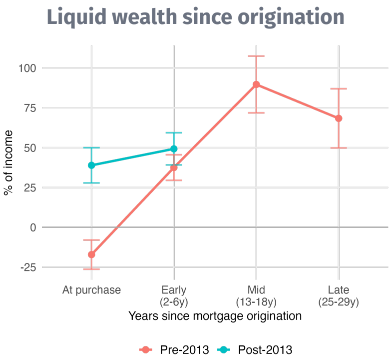
Stylized facts: cohort subject to policy repays faster, builds less liquid wealth





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Calibration: externally calibrated parameters

- Income process: moments of stochastic process from NL micro data (de Nardi et al. 2021) income process
  - Two permanent income types: college vs. lower education
- Other parameters:

Description	Value	Notes	Source
Life time in the model (T)	30	Standard maturity	HFCS and Hypostat (2019)
Risk aversion coeff., consumption (γ)	5	-	Duarte et al. (2020)
Risk aversion coeff., bequest (γ^b)	2	-	–
Permanent income life cycle path	-	Age-varying, by education level	HFCS
Persistence of permanent shocks	-	Age-varying	De Nardi et al. (2021)
Variance of transitory shocks (σ_y^2)	0.015	Earnings shocks (transitory)	De Nardi et al. (2021)
Variance of permanent shocks (σ_z^2)	0.01	Earnings shocks (permanent)	De Nardi et al. (2021)
Riskless rate (r)	0.0331	Long-run real safe rate	Jorda et al (2020)
Borrowing limit, liquid (θ^A)	-105%	Share of income	HFCS (1st percentile)
Borrowing rate, financial	0.08	Long-run average	ECB macro data
Borrowing limit, mortgage LTV (θ^M)	120%	Maximum common value in data	DHS, HFCS

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Estimated parameters

Parameter	Value	Interpretation
β	**0.987**	Annual patience
b_0	**3.9**	Value of liquid wealth post-retirement
τ^{pre}	**0.01**	Cost of delayed repayment pre-policy (small)
τ^{post}	**0.665**	Large penalty post-policy

$\Delta\tau \approx 0.66$: **effect of policy restricting repayment flexibility**

- Reflects tax penalty and potential changes in bank products
- Large enough to overcome the low-rate boost (post-2013 rates fell below liquid returns)
- Identified by sharp increase in early-stage repayment

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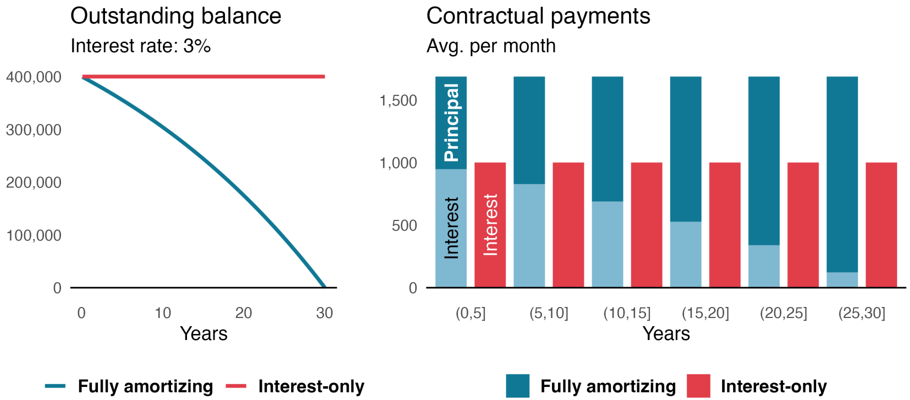
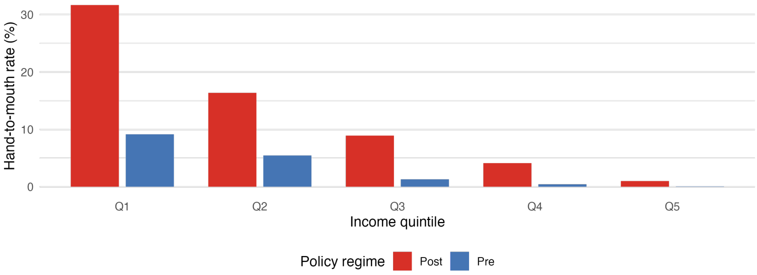
What is an interest-only mortgage?



Households are more exposed to shocks due to forced amortization

Share hand-to-mouth (liquid wealth $<$ 1 month of income) by income



- Share of homeowners with liquid wealth $<$ 1 month of income: $4\% \rightarrow 19\%$
  - $\Rightarrow$ higher MPCs, C volatility

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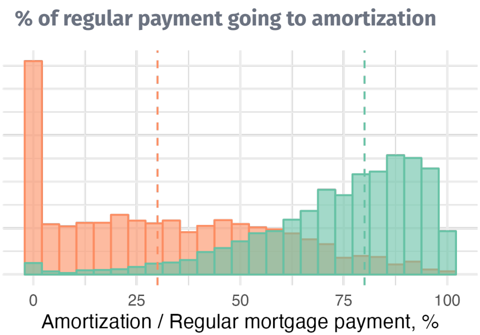
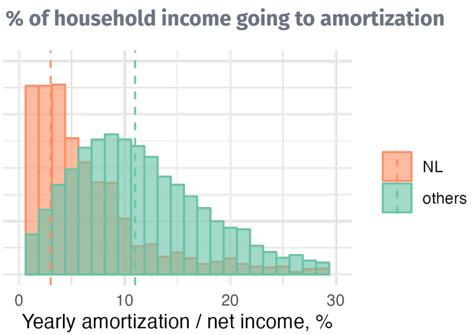
Data: mortgage amortization in the HFCS





Dashed lines indicate medians.

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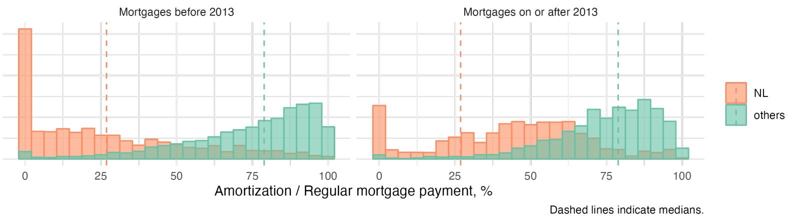
Amortization for mortgages before and after 2013



Percentage of obs. where amortization is less than 5% of the regular payment:

	NL	others
Mortgages before 2013	30.1	1.7
Mortgages on or after 2013	11.8	1.0

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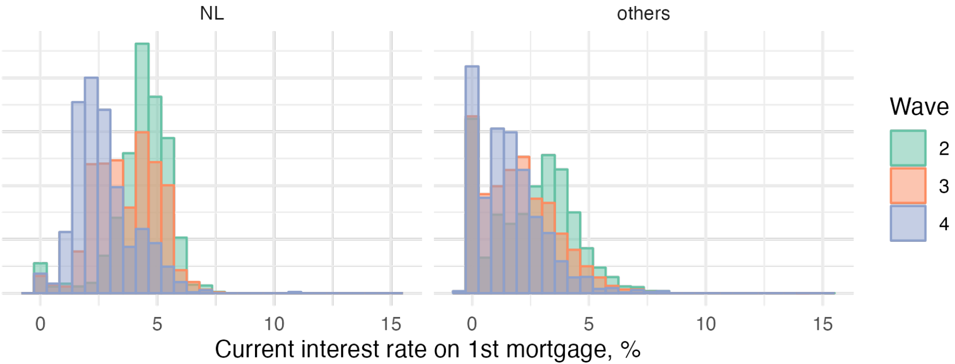
Interest rates



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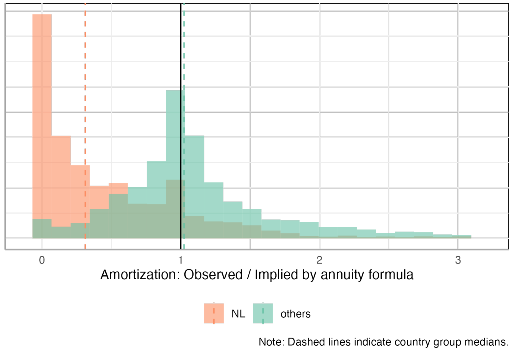
Amortization implied by annuity formula

- If mortgage is an annuitized loan, the amortization paid as part of the installment in period t is:

$$L \times r \times \left(\frac{1}{1 - \frac{1}{(1+r)^{T-t}}} - 1 \right)$$

where L is the outstanding amount, r the loan rate and T the residual maturity.

- This is what we observe for the median HH in the overall sample but not in NL:



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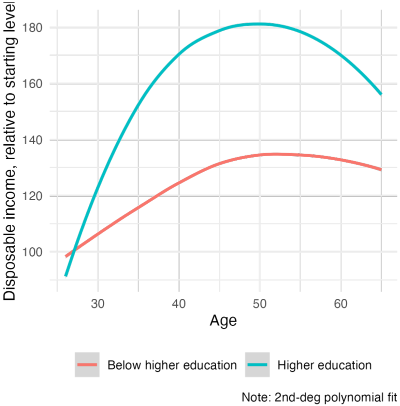
Income process

Inelastic labor supply yields earnings $Y_t = \Gamma_t Z_t \, \theta_t$, as standard (Carroll & Samwick, 1997)

- $\ln Z_t = \ln Z_{t-1} + \ln \psi_t$; $\ln \psi_t \sim N\left(-\frac{1}{2}\sigma_\psi^2, \sigma_\psi^2\right)$; $\ln \theta_t \sim N\left(-\frac{1}{2}\sigma_\theta^2, \sigma_\theta^2\right)$
- Life-cycle profile Γ from HFCS
- Moments of stochastic process from NL micro data (de Nardi et al. 2021)
- Two types: college vs. lower education
    - Different income levels and growth patterns
    - Different price/income ratios (but LTVs same)



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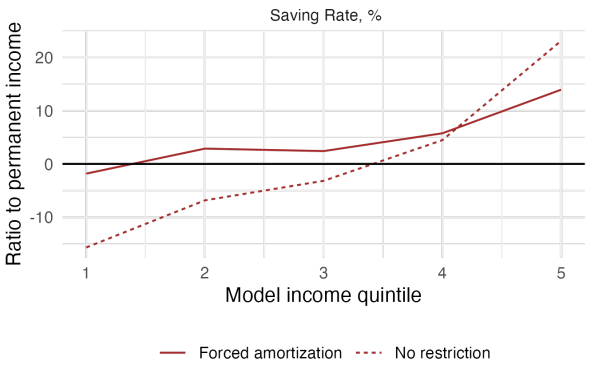
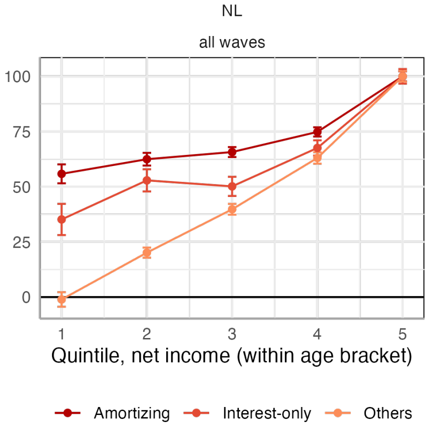
Flattening of saving rate differences reproduces pattern in the data





Saving rates increase for lower income (and younger ages)

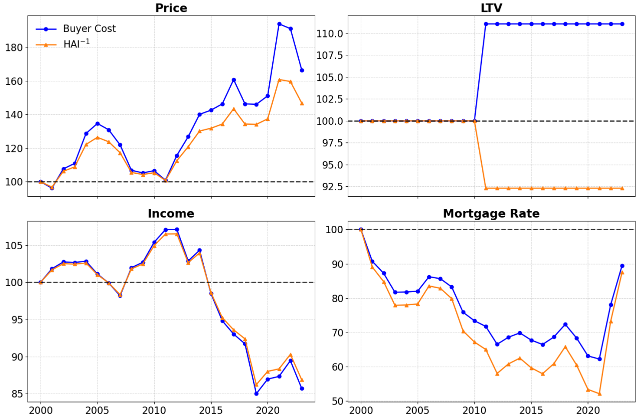
Data and calibration

Normalize house size h to 1. For each year, z_t tracks median income, and:

1. Set rental rate q_t to match model rent ($q_t h$) to data
2. Set unit price of housing p_t to match model house price ($p_t h$) to data
3. Set initial wealth b_0 to match the liquid-wealth-to-income ratio
    - Deposits, MM funds, gov-bonds, stocks (DFA)
4. Set r_m to historical mortgage-rate data (Freddie Mac); fixed-rate, fixed-payment, 30-year maturity
5. For each year, $\pi = 2\%$ and $r^b = 1.67\%$ (3-month T-Bill period average)
6. Maximum LTV θ_t of 97.5% before 2010, and 90% thereafter

Quintiles: permanent income z_i from Census Historical Income Tables; b_{0i} matches liquid-wealth-to-income per quintile (DFA); h_i matches rent-to-income (SCF, 2000); prices evolve as the median house price.

Single-component counterfactuals, all components



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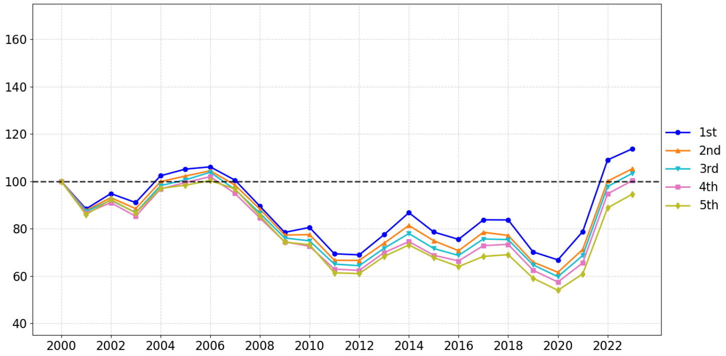
HAI by income quintile



Quintile-specific HAI indices show small variation across quintiles

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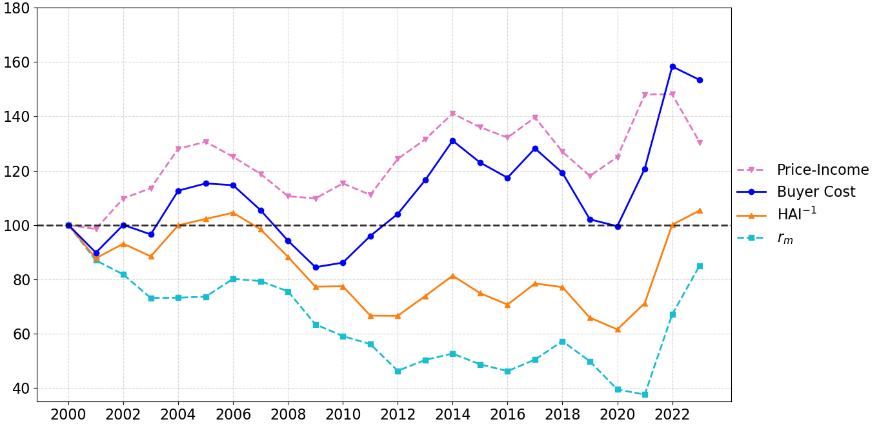
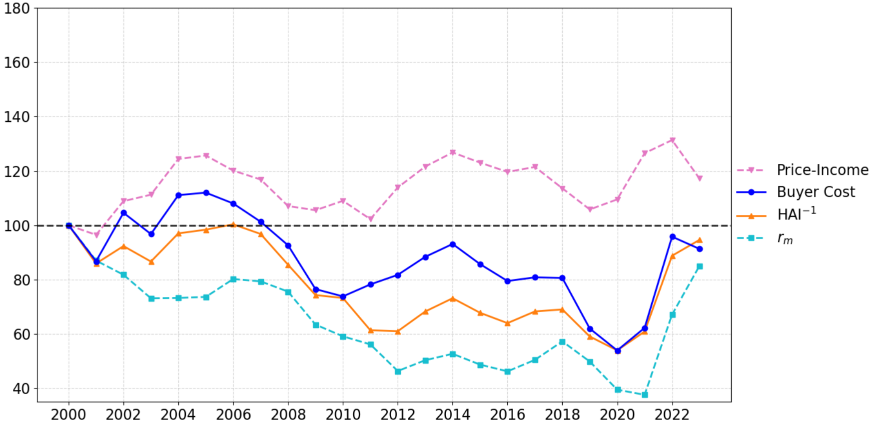
Buyer Cost vs HAI, 2nd quintile



Buyer Cost vs HAI, 5th quintile



Population-wide records meet well-identified monetary shocks

- **Administrative data from Norway**
  - Population registry + educational data + income & wealth tax records + shareholder registry; third-party reported (employers, financial institutions)
  - Aggregated to household level: sample of $\approx$ 2.9 million households
  - Annual panel, 1993–2019; shareholder quantities available from 2004
- **Monetary shocks**
  - Romer and Romer (2004) identification approach estimated in Holm et al. (2021)
  - MP shocks correspond to the residuals of a Taylor rule estimation
- **Empirical approach:** cumulative impulse responses to a 1 p.p. tightening shock, using local projections at the household level
  - Household fixed effects; standard errors clustered at the year level
  - Quantity data from the shareholder registry separate active choices from price effects

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Quantity specification

$$\log q_{i,t+h} - \log q_{i,t-1} = \delta_i^h + \beta^h \epsilon_t^M + \sum_{k=1}^{2} \rho_k^h \epsilon_{t-k}^M + \sum_{k=1}^{2} \gamma_k^h \Delta \log q_{i,t-k} + u_{i,t}^h, \qquad h \in \{0, 1, 2, 3\}$$

- The quantity sample covers 2004–2016
- The log specification identifies the intensive-margin response among households with positive holdings at both the baseline and response horizon
- Household fixed effects; standard errors clustered at the year level

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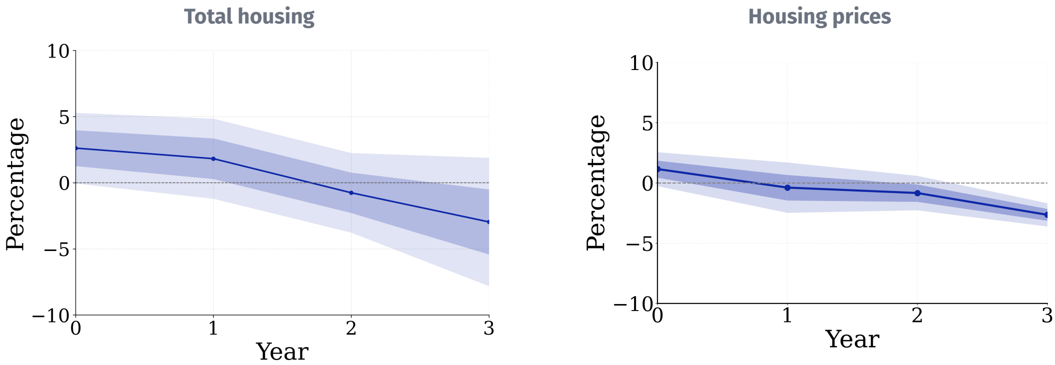
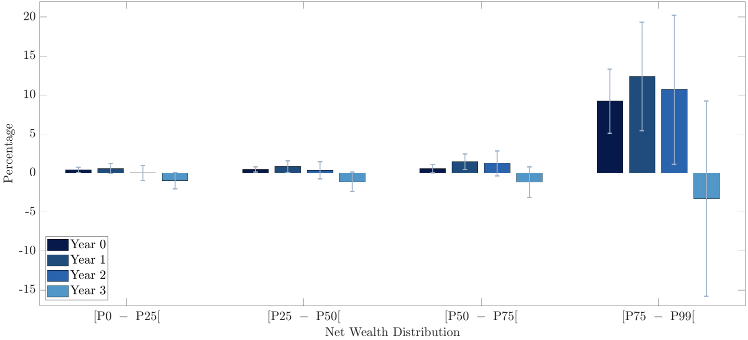
Housing rises before mortgage rates fully pass through



Housing values rise on impact and decline as the tightening transmits to mortgage rates. The on-impact rise exceeds the price response, consistent with a **rush to buy** before higher policy rates fully pass through.

Private equity rises at the top through year 2



In the 1993–2019 sample, private-equity values rise among top-wealth households through year 2, **diverging from listed risky assets**.

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MP channels and mechanisms

Dimension	Mechanism
Net wealth	Wealthy households have a higher MPI and rebalance more
Income	Earnings-heterogeneity channel: labor and profit earnings differ
Risk exposure	Households with high MPR rebalance more as risk premia change
Age	Conditional risky share declines toward retirement
Fin. literacy	Higher financial sophistication, less portfolio inertia
Indebtedness	Debtors' larger cash-flow exposure amplifies responses to rate changes

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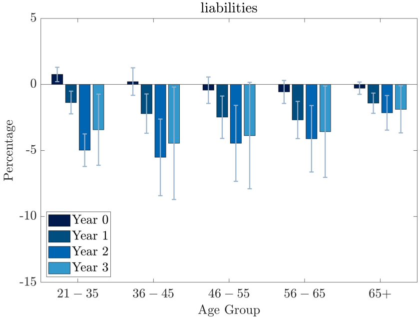
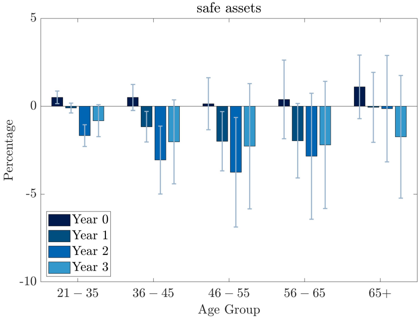
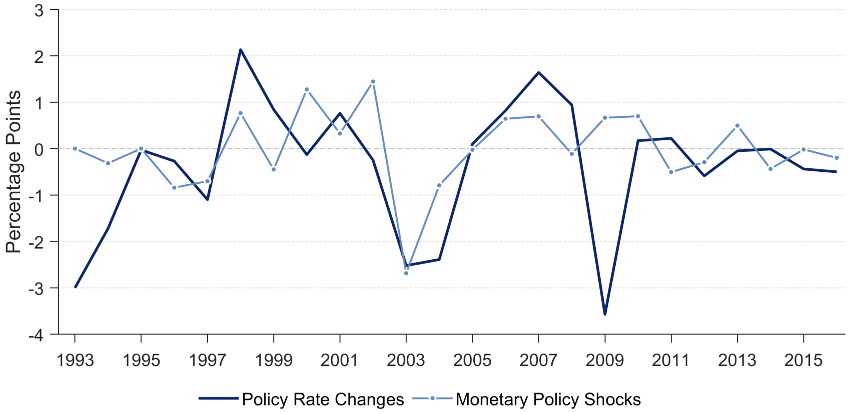
Working-age households deleverage and draw down liquid buffers



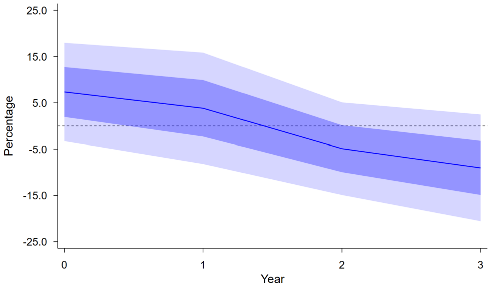


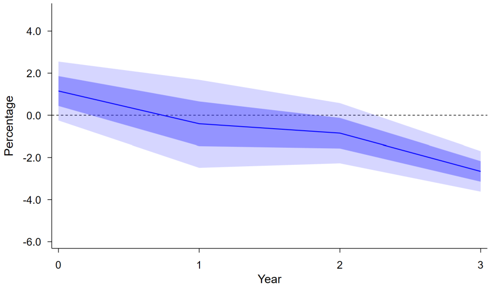
The decline in debt and safe assets is concentrated among working-age households. Greater mortgage-rate exposure leads them to **deleverage and use liquid buffers**.

Monetary policy surprise shocks



Stock and housing prices





Stock prices fall one to two years after the shock. Rising stock quantities against falling prices are consistent with households increasing holdings as expected returns rise (Calvet et al., 2009).

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Possible active responses, by theory class

Three possible responses to MP tightening, depending on type of theory:

Theory class	Behavior	Mechanism
Inertia	**Hold**	Stays invested despite market decline
Trend chasing	**Sell**	Reacts to recent performance
Contrarian trading	**Buy**	Buys during downturns

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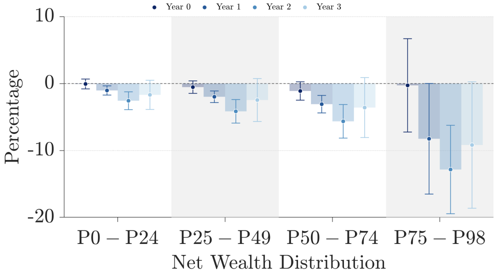
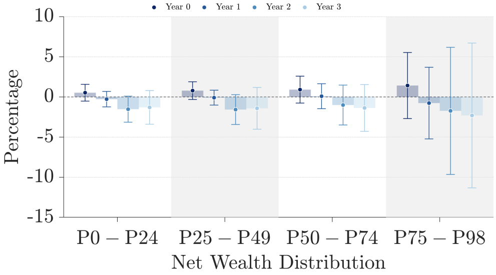
Risky assets and safe assets by net wealth





Risky-asset declines concentrate at the top. Lower and middle wealth groups reduce safe assets, while the top-quartile response is not precisely estimated.