Mortgage structure, household saving, and the wealth distribution*

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Abstract

Mortgage repayments account for 25% of household saving flows in the Euro area. Much of this saving is not deliberate but arises from rigid mortgage structures: fixed amortization schedules induce wealth accumulation but limit consumption smoothing. I develop a life-cycle model where deviating from scheduled repayment is costly, generating large shifts in consumption and saving behavior, especially among younger and lower-income homeowners. In Euro area data, these households save substantially more than comparable renters, driven by principal repayment – except in the Netherlands, where flexible interest-only loans are available. I calibrate the model to Dutch data spanning a 2013 policy that tightened amortization requirements, exploiting this change to identify the repayment friction. The model replicates observed debt and wealth patterns across income groups and delivers three main results. First, mandatory amortization raises total saving but crowds out liquid wealth accumulation. Second, it increases the share of hand-to-mouth households by about 15 percentage points, amplifying consumption volatility and marginal propensities to consume. Third, welfare losses are substantial—equivalent to 2-3% of lifetime consumption—and concentrated among younger, lower-wealth households who value payment flexibility most. While mandatory amortization may promote financial stability, it does so at significant costs to household welfare.

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1 Introduction

In this paper, I show that fixed repayment schedules, an unavoidable feature of mortgage contracts in most countries, force households, especially early in the life cycle, to cut their consumption and reduce their liquid wealth buffers. Saving rates and total wealth, which respectively include debt repayments and home equity, increase, but at a significant cost to homeowners' welfare. Their reduced ability to self-insure against income shocks leads to higher consumption volatility. While the total wealth distribution is flattened, liquid wealth becomes more skewed, with the share of households living-hand-to-mouth increasing substantially. The benefits of rigid amortization schedules for financial stability must be weighed against their high costs for households, especially younger and lower-income homeowners, who are highly penalized by such rigidities.

Mortgage debt repayment is a large component of household saving flows: it accounts for 30% of aggregate household saving in the Euro area and about 25% in the US (Table 1), comparable in size to pension contributions. The standard mortgage contract includes a strict repayment schedule, fixed at origination, that ensures principal is regularly paid down until maturity. If deviating from this schedule is costly and home equity is illiquid – as in most countries, especially in Europe – then mortgages function as a mandated saving plan, with potentially large implications for consumption and saving over the life cycle.

	Mortgage debt repayment	Gross saving	Share %
Euro area	271.8 bi €	894.3 bi €	30%
USA	292.7 bi $	1190.9 bi $	25%

Table 1: Aggregate mortgage debt repayment and gross household saving, 2017
Source: HFCS, CEX and national accounts

A recent wave of empirical studies has robustly shown that amortization requirements in mortgages have powerful negative effects on consumption, relative to more flexible repayment schemes (Backman and Khorunzhina, 2024; Bernstein and Koudijs, 2024; Larsen et al., 2024; Vihriala, 2023). But three key questions remain open: (i) can these large effects be rationalized by standard models of consumption and saving? (ii) Are households substituting between assets, merely reallocating their saving from liquid to illiquid forms? Or does mortgage design increase overall wealth accumulation? (iii) What are the aggregate and distributional implications for consumption and saving, namely on consumption volatility, household welfare, and the distribution of wealth?

In this paper, I develop a model of consumption and saving where homeowners face uninsurable income risk and illiquid housing wealth. Mortgages feature mandatory repayment schedules, from which deviating is costly. The mechanism is straightforward: fixed schedules divert cash flow into illiquid equity precisely when liquidity is most valuable. Because underpaying is costly and home equity cannot be accessed, households cut consumption and liquid saving to meet the schedule, or underpay and bear a penalty. Anticipating future binding constraints, even unconstrained households build larger liquid buffers. The response is strongest for young and lower-income owners, negligible for older or wealthier households.

These implications guide the quantitative analysis. Relative to flexible repayment, mandatory amortization raises total saving for young and lower-income mortgagors but lowers liquid wealth and increases hand-to-mouth households, implying higher MPCs and greater consumption volatility. For older or wealthier owners the effects are small. Once mortgages are repaid and equity becomes accessible, liquid buffers rebuild and consumption rises.

I bring forward novel evidence from the Euro area consistent with these predictions. In most of the region, homeownership is prevalent and attained early. Conditional on age and income, young owners face higher payment-to-income burdens than renters, yet their user-cost proxy (interest/income) is lower than rent/income, consistent with ownership being individually optimal despite tight liquidity constraints. Three stylized facts emerge from the data.

First, the saving rate of mortgaged homeowners is much higher than non-mortgaged households at the beginning of the life cycle and the bottom of the income and wealth distributions, while for older, richer groups there is no difference. Second, the burden is highly uneven: households in the bottom income quintile dedicate up to three times more of their income to mortgage repayment than those in the top quintile. Third, in the Netherlands, where interest-only mortgages are common, saving rate heterogeneity among interest-only borrowers resembles non-mortgaged households rather than their counterparts paying off amortizing mortgages.

A quantitative version of the model reproduces these patterns. The framework is a standard incomplete markets model where homeowner households face rich uninsurable earnings risk, use a liquid financial asset to smooth consumption, and decide how to repay mortgage debt, with contracts featuring varying flexibility in amortization. Five key results emerge.

First, mandatory amortization reduces consumption sharply, especially early in life. The average 30-year-old homeowner cuts consumption by roughly 10% of income, with effects persisting through middle age. This forced saving accumulates: net wealth at age 60 is close to 25% higher under mandatory amortization. However, liquid wealth falls substantially in the early mortgage years, increasing the share of hand-to-mouth households and raising average MPCs among young homeowners (ages 30-40). Despite accumulating more total wealth, households facing mandatory schedules are more exposed to income shocks.

Second, over the life cycle households under mandatory amortization accumulate more of both asset types: not only illiquid home equity but also liquid financial savings increase. While early-stage liquid wealth drops due to binding repayment constraints, households eventually build larger precautionary buffers to compensate. The lifecycle profile of saving shifts fundamentally: rather than smoothly accumulating assets while slowly paying down debt, constrained households front-load debt repayment and backload liquid saving. This pattern rationalizes both the short-run consumption cuts in the reduced-form literature and the elevated saving rates among young, liquidity-constrained homeowners in European cross-sections.

Third, the effects are highly heterogeneous across the income distribution. The wealth-to-income ratio for households in the bottom income quintile increases by approximately 25 percentage points under mandatory amortization, while the effect for the top quintile is just 5 percentage points. Lower-income households face larger increases in saving rates and more severe liquidity constraints. This differential response flattens the saving rate gradient: lower-income households save substantially more under forced amortization, while high-income households are largely unaffected. The model closely reproduces this flattening pattern observed in Dutch survey data.

Fourth, mandatory amortization has opposing effects on wealth inequality. It compresses the distribution of total wealth, as lower-wealth households accumulate faster. But it simultaneously increases financial wealth inequality and the prevalence of hand-to-mouth status, since constrained households hold more illiquid home equity at the expense of liquid buffers. Balance sheets strengthen, but financial fragility rises.

Fifth, these costs are substantial. The median household would require a permanent consumption increase of 2-3% to achieve pre-policy welfare levels, with losses slightly larger for lower-education households (2.82%) than higher-education households (2.13%). These welfare losses reflect both reduced consumption and increased exposure to income risk from lower liquidity buffers. While lower post-reform borrowing rates could partially offset these costs, observed movements in interest rate spreads were modest.

Restricting repayment flexibility is the norm in Europe, for financial stability policy goals. My findings show these potential benefits must be traded off against sizeable costs for young households, for whom such rules reduce consumption smoothing and crowd out investment in financial assets, widening financial wealth inequality and discouraging homeownership (similar to down payment rules). These findings also suggest that the large effects of amortization requirements found in recent empirical literature may not apply to the US, where accessing home equity is relatively frictionless. Finally, by raising both the prevalence and the MPCs of liquidity-constrained homeowners precisely where mortgage balances are large, amortization rules can amplify the transmission of macroeconomic shocks, and contribute to explaining the large, persistent share of 'wealthy hand-to-mouth' households in many countries.

Related literature and contribution

This paper directly extends the household finance literature on the effects of mortgage contract design, complementing recent empirical work demonstrating that amortization requirements can substantially decrease household consumption. Bernstein and Koudijs (2024) exploit a 2013 policy reform in the Netherlands that increased the cost of interest-only mortgages, until then the prevalent contract form. The mandated amortization lead to a one-for-one increase in saving among first-time homebuyers, mainly financed by cuts in consumption. Backman and Khorunzhina (2024) and Larsen et al. (2024) examine the introduction of interest-only mortgages in Denmark in 2003, documenting strong take-up and positive effects on consumption, consistent with an important role for liquidity constraints. Additional evidence from Finland (Vihriala, 2023) and Sweden (Backman et al., 2024) corroborates these results. [1] My paper rationalizes these findings in a standard model

[1]The literature has also found positive effects of relaxing down payment requirements on young homeowners' consumption and housing purchases (Engelhardt and Mayer, 1998; van Horen and Tracey, 2022).

of household consumption and saving, leaving a smaller role for behavioral biases driving the results. Further, it traces out the long-run implications of this effect for wealth accumulation by different households, which the empirical literature, mostly based on short time windows of data around policy changes, has not been able to do. My structural modelling approach also allows me to show the implications of this effect for the distribution of financial and housing wealth.

Two recent papers follow a similar approach, deploying rich heterogeneous-agent life-cycle models, to examine related effects of mortgage design on household saving and portfolio decisions. However, they look at different aspects of mortgage structure; and they look at the US/Canada markets, where refinancing and home equity extraction are cheap and frequent, unlike in the Euro area. Balke et al. (2024) show that tighter loan-to-value ceilings mainly shift when households start accumulating a down-payment, whereas Boutros et al. (2024) show that letting borrowers switch among fixed- and variable-rate contracts mainly reallocates interest-rate risk across balance-sheet positions. This paper isolates a different margin. I demonstrate that the amortisation schedule embedded in the mortgage is a powerful, often binding liquidity constraint for young, low-income, low-wealth homeowners.

My paper also contributes to two other strands of the literature. First, it adds a new channel to the wealth inequality literature e.g. Benhabib et al. (2017, 2019); Hubmer et al. (2021), which shows that wealth inequality dynamics are driven by a combination of income inequality, heterogeneity in returns on wealth, and heterogeneity in saving rates. While previous work has established the role of housing in shaping the distribution of returns (Jorda et al., 2019; Kuhn et al., 2020; Martinez-Toledano, 2023), I introduce a channel that connects housing with saving rate heterogeneity, as amortization requirements raise the saving rate of homeowners at the bottom of the wealth distribution, but do not affect the top.

Second, my paper follows up on a theoretical literature that has been considering the optimal design of mortgage contracts, mainly from the perspective of macro-financial stability (Greenwald, 2018; Campbell et al., 2021; Guren et al., 2021). I demonstrate that, through their effects on saving behavior, the impact of mortgage structure on household consumption and saving is both large and highly heterogeneous. My results suggest that optimal mortgage design must take into account this heterogeneity, and also have potential implications for the literature on designing policies for mandatory retirement contributions.

Finally, my findings also speak to the origins of wealthy hand-to-mouth households: those with substantial illiquid wealth but minimal liquid assets. It is now well-known from the HANK literature that their high MPCs amplify monetary and fiscal transmission (Kaplan and Violante, 2014). Empirically, the wealthy hand-to-mouth share is large and persistent across countries (Kuhn et al., 2020), yet its origins remain debated Aguiar et al. (2024). Attanasio et al. (2023) link mortgages to hand-to-mouth status but require behavioral frictions—present bias or financial inattention—to rationalize the pattern. My model generates wealthy hand-to-mouth households without behavioral assumptions: mandatory amortization mechanically diverts cash flow into illiquid equity while binding liquidity constraints suppress liquid buffers.

Structure of the paper Section 2 presents the model framework, explaining the key mechanism at play that drives large effects of amortization requirements. Section 3 presents the data and a series of stylized facts on mortgages and saving rates consistent with mandatory amortization pushing up saving by younger, poorer homeowners. In Section 5, I present the quantitative model and its results on consumption and saving over the life cycle, and the implications for the wealth distribution. Section 6 concludes.

2 A model of consumption, saving and mortgage repayment

This section develops a life-cycle model to understand how mortgage repayment schedules affect household consumption and saving decisions. The model serves three purposes. First, it provides a unified framework for interpreting the stylized facts documented in Section 3, clarifying the economic mechanisms through which mandatory amortization influences household behavior. Second, it allows us to quantify the welfare costs of reduced payment flexibility, distinguishing between the direct cash-flow burden and the indirect effects on precautionary saving. Third, I use the 2013 Dutch policy to identify repayment rigidity and run counterfactuals that isolate the causal effect of mandatory amortization from confounding factors such as interest rate changes and compositional shifts.

I build on the standard incomplete-markets life-cycle framework (Carroll, 1997; Gourinchas and Parker, 2002), augmented with two key features. First, I model the mortgage contract explicitly, capturing both the liability (outstanding debt) and the scheduled repayment path. Second, I introduce a friction that makes deviations from the mandated schedule costly, parameterized by τ^-.[2] This friction encompasses refinancing costs, administrative penalties, and behavioral factors such as habit formation or mental accounting that lead households to follow prescribed payment plans.

Our focus is on the typical life-cycle of a first-time homebuyer. These households begin with high leverage, reflecting typically high loan-to-value ratios (often above 100%) in the Netherlands, and thin liquid buffers, having exhausted savings for the down payment. This initial condition makes the trade-off between mortgage repayment and liquidity accumulation particularly stark: every euro allocated to mandatory principal reduction is unavailable for precautionary saving or consumption smoothing. The model abstracts from housing consumption choices, refinancing decisions, and mobility, allowing us to isolate the saving and consumption implications of repayment inflexibility conditional on homeownership.

The remainder of this section proceeds as follows. I first describe the household problem, specifying preferences, income risk, and the mortgage contract structure. I then illustrate the core mechanism through which mandatory amortization affects behavior, showing how the interaction between payment obligations, liquidity constraints, and income uncertainty generates hetero-

[2] I allow asymmetric costs (\tau^+,\tau^-). In the mechanism and calibration I set \tau^+=0 and identify \tau^- ('repayment rigidity'). For brevity, I later refer to this single parameter as \tau."

geneous responses across households. Finally, I briefly derive testable predictions that guide our empirical analysis in Section 3, and the quantitative model in Section 4.

2.1 Setup

Time is discrete, with each period t representing one year since mortgage origination. The model spans J periods corresponding to the mortgage maturity (typically 30 years). Households earn labor income throughout this horizon and desire to leave wealth at period J, captured through a bequest motive. This specification focuses the analysis on the mortgage repayment phase, abstracting from post-repayment and retirement decisions.

Households maximize expected lifetime utility with time-separable preferences, discounting future utility by factor β.

Consumption. As in Campbell and Cocco (2015), household preferences are separable in housing services and non-housing consumption, and each household consumes a fixed amount of housing h_i. Each period, households derive utility from non-housing consumption:

$$U(c_{it}) = \frac{c_{it}^{1-\gamma}}{1-\gamma},$$

where γ is the coefficient of relative risk aversion. Under these assumptions, housing can be disregarded in the household's optimization problem.[3] Households take housing consumption as given, allowing us to focus on the allocation problem between non-housing consumption, liquid saving, and mortgage repayment. As explained in Campbell and Cocco (2015), this specification is appropriate when housing mobility costs are large and housing adjustments are infrequent relative to other financial decisions.

At the end of period J, households leave a bequest b, deriving utility from the wealth remaining in the final period. The utility from bequests follows the standard form introduced by De Nardi (2004) :

$$U(b_{it}) = b_0 \frac{(b_{it} - b_1)^{1-\gamma} - 1}{1-\gamma},$$

where b_0 measures the strength of the bequest motive, and b_1 reflects the extent to which bequests are a luxury good. As the model represents only the mortgage repayment phase, the bequest captures the desired wealth accumulation for the post-mortgage life cycle, including retirement. The bequest corresponds to remaining financial assets net of any outstanding mortgage debt; this amounts to imposing that households must fully repay the mortgage by period J.

[3]This is because the above preferences are consistent with $U(C_{it}, H_{it}) = \frac{C_{it}^{1-\gamma}}{1-\gamma} + \Lambda_i \frac{H_{it}^{1-\gamma}}{1-\gamma}$ where Λ_i measures the relative importance of housing consumption.

Income. Households receive exogenous labor income throughout the J periods of mortgage repayment. Income evolves according to:

$$Y_{it} = \Gamma_t Z_{it} \theta_{it}$$

where Γ_t captures the deterministic life-cycle profile of earnings, Z_{it} is the persistent component, and θ_{it} is the transitory component.

Following Carroll and Samwick (1997), as standard in the literature, the persistent component evolves stochastically as $\log Z_{i,t} = \log Z_{i,t-1} + \log \psi_{i,t}$, where $\log \psi_{i,t} \sim \mathcal{N}(-\sigma_\psi^2/2, \sigma_\psi^2)$. The transitory component is i.i.d., with $\log \theta_{i,t} \sim \mathcal{N}(-\sigma_\theta^2/2, \sigma_\theta^2)$. This specification captures both permanent shocks (job loss, promotions, industry changes) and transitory fluctuations (bonuses, overtime, temporary layoffs) typical of labor market risk.

The life-cycle profile Γ_t is deterministic and reflects the typical hump-shaped earnings pattern over the working life, with income rising in early career and plateauing in mid-career. Households cannot insure against either permanent or transitory income shocks, motivating precautionary saving.

Initial conditions and assets. Households enter the model at mortgage origination ($t = 0$) owning a house with market value P_{i0}, financed by a mortgage with initial balance M_{i0}, i.e. with a loan-to-value ratio of M_{i0}/P_{i0}, which may exceed unity. Additionally, households begin with liquid financial assets A_{i0} held in a risk-free account yielding interest rate r.

The mortgage is a fixed-rate contract with maturity of J periods and interest rate r^m. Households service interest payments $(r^m \cdot M_{it})$ each period and choose how much principal to repay, subject to frictions described below. Home equity, the difference between house value and outstanding mortgage, is illiquid and cannot be accessed during the repayment phase. Households cannot increase mortgage debt beyond the initial balance M_{i0}; they can only repay principal or maintain the existing balance. The house price evolves deterministically at rate g (relative to the consumption price index). Since equity is illiquid before J, g affects only terminal wealth (bequest).

Liquid assets can be negative up to borrowing limit $\theta^A Y_{i0}$, where $\theta^A < 0$ represents the maximum unsecured borrowing as a share of initial income. When available, unsecured borrowing occurs at the higher rate than saving, r^-. In the mechanism exposition below, I shut down unsecured borrowing ($A_t \geq 0$) for simplicity, but in the quantitative application unsecured borrowing is allowed, to match the data from the Netherlands where many homeowners have negative net financial wealth.

In this theoretical exposition, I describe the problem for a household with given initial conditions (P_{i0}, M_{i0}, A_{i0}). The quantitative implementation in Section 4 introduces heterogeneity in these initial conditions, calibrated to match the data. Key sources of heterogeneity include the loan-to-value ratio, initial liquid wealth relative to income, and permanent income levels. This heterogeneity proves critical for understanding the distributional effects of mandatory amortization, as households beginning with thin liquid buffers face qualitatively different trade-offs than those starting with substantial precautionary savings.

Mortgage contract. The mortgage contract specifies a maturity of J periods and requires interest payments of $r^m \cdot M_{it}$ each period on the outstanding balance, where $r^m = r + s$ includes a spread s over the risk-free rate.

Each period, households choose their consumption c_{it} and mortgage principal repayment $d_{it} \geq 0$. Crucially, households cannot increase mortgage debt; they can only reduce or maintain the outstanding balance. The mortgage balance evolves as:

$$M_{it} = M_{it-1} - d_{it}.$$

The contract includes a prescribed repayment schedule $d_t^* \equiv D^*(M_{t-1}, t)$, where D^* is given by the standard annuity formula.[4] This schedule front-loads interest payments and back-loads principal reduction, with total mandatory payments $(r^m \cdot M_{t-1} + d_t^*)$ remaining constant over the loan life.

Deviating from the mandatory amortization schedule is costly. Households incur a proportional transaction cost on the deviation between chosen and mandated repayment:

$$\tau(d_t, M_{t-1}, t) = \tau^+ \cdot \max\{0, d_t - d_t^*\} + \tau^- \cdot \max\{0, d_t^* - d_t\}$$

where τ^+ governs the cost of prepayment (exceeding the schedule) and τ^- governs the cost of delayed repayment (falling short of the schedule). Taken to the data, this cost function captures refinancing fees, prepayment penalties, administrative barriers, and behavioral factors that may lead households to adhere to prescribed payment plans. Logically, τ^- must satisfy $0 \leq \tau^- < 1$, otherwise underpaying would be strictly dominated, as the marginal penalty would exceed the marginal cost of fulfilling the mandatory repayment.

When $\tau^+ = \tau^- = 0$, repayment is fully flexible and households optimally trade off mortgage reduction against liquid wealth accumulation based purely on financial returns. When $\tau^- > 0$, households face mandatory amortization: delaying payment below d_t^* is costly, effectively constraining households to meet or exceed the scheduled principal reduction. The parameter τ^- measures the strength of the amortization requirement.

Households must make a minimum payment, covering interest on the outstanding debt plus any transaction cost from underpayment, to avoid default. Default results in loss of the house and consumption constrained to a minimal subsistence level $\underline{c}$ for the remainder of the horizon, ensuring strategic default is never optimal. This specification is in line with the European institutional setting, where mortgage default carries severe and persistent consequences, given strong recourse laws. In any case, I focus on calibrations where households are able to uphold their obligations.[5]

[4] Specifically, the principal (repayment) component in period t can be written as $D^*(M_{t-1}, t) = \frac{r^m}{(1+r^m)^{J-t+1}-1} M_{t-1}$, which increases over time as the balance falls.

[5] In the quantitative implementation, I verify that default occurs very rarely for the households I study, given typical income processes and initial conditions.

2.2 The mechanism

This subsection clarifies how repayment frictions affect consumption and saving by examining a simplified version of the model. I focus on the core trade-off: when households face costs of delaying scheduled repayment, they must balance consumption smoothing through liquid wealth against adhering to the mandated amortization path.

To isolate this mechanism, assume no prepayment penalty ($\tau^+ = 0$) and that income is always sufficient to meet scheduled payments ($Y_t > D^*(M_{t-1}, t) + (r^m)M_{t-1}$), such that default is excluded. Further assume there is no unsecured borrowing ($A_t \geq 0$). The transaction cost simplifies to $\tau(d_t, M_{t-1}, t) = \tau^- \cdot \max\{0, d_t^* - d_t\}$, penalizing only underpayment.

Consider the intertemporal choice faced by a homeowner in the model over one period. The homeowner solves:

$$\max_{c_t, d_t} \; u(c_t) + \beta \, \mathbb{E}_t[V_{t+1}(Y_{t+1}, A_{t+1}, M_{t+1})],$$

where $V_{t+1}(.)$ is the continuation value, subject to the conditions:

$$\begin{aligned} A_{t+1} &= (1+r)[A_t + Y_t - r^m M_t - d_t - \tau_t - c_t] \\ M_{t+1} &= M_t - d_t \end{aligned}$$

respectively the budget constraint and the law of motion for the mortgage balance.

The first-order conditions yield the consumption Euler equation and an additional intertemporal condition, that trades off the marginal value of debt repayment against that of liquid assets:

$$u'(c_t) = \beta(1+r) \, \mathbb{E}_t[V'_A]$$

$$\mathbb{E}_t[V'_M] = \begin{cases} (1+r) \, \mathbb{E}_t[V'_A], & \text{if } d_t \geq d_t^* \\ (1+r)(1-\tau^-) \, \mathbb{E}_t[V'_A], & \text{if } d_t < d_t^* \end{cases}$$

where V'_A and V'_M denote the marginal value of liquid assets and mortgage debt reduction, respectively.

Frictionless benchmark with flexible repayment. To understand how the friction affects behavior, consider first the frictionless benchmark where $\tau^- = 0$. In this case, the second first-order condition simplifies to $\mathbb{E}_t[V'_M] = (1+r)\mathbb{E}_t[V'_A]$ for all repayment choices. With a positive mortgage-portfolio spread ($r^m > r$), delaying repayment is costly for late-life wealth. In this case, many households will desire to repay the mortgage as fast as possible, provided they have a satisfactory buffer of liquid assets to smooth out the effect of shocks on consumption and to optimally smooth consumption growth over the working life. More specifically, for households with low liquid wealth (A_t small relative to income risk), with high marginal value of liquidity V'_A due to precautionary motives, minimal repayment ($d_t \approx 0$) is optimal. As liquid wealth accumulates and V'_A declines, the mortgage spread becomes increasingly attractive, and optimal repayment rises.

Because home equity is illiquid – here, inaccessible until period J – households maintain liquid balances both to smooth consumption across time and to buffer income shocks. Once they have enough liquid wealth to cover both precautionary needs and lifecycle consumption smoothing, a 'corner solution' emerges where it becomes optimal to prepay the mortgage quickly, exploiting the spread. Optimal repayment under flexible contracts thus involves trading off the value of liquidity against the gain to late-life wealth obtained from the return differential, with the balance depending on the household's liquid wealth position.

Mandatory amortization. When $\tau^- > 0$, the policy function for repayment exhibits a kink at the mandated schedule $d_t = d_t^*$. The transaction cost introduces a wedge in the marginal value of delayed repayment, changing optimal behavior relative to the frictionless benchmark in three ways.

First, for households already at the borrowing constraint $A_t = 0$ even without the friction, and $d_t < d_t^*$, the under-repayment penalty acts like a tax equal to $\tau^-\left(d_t^* - d_t\right)$. Relative to the flexible benchmark (where d_t could be set below d_t^* at no cost), constrained households either continue to underpay and bear the penalty, reducing consumption by $\tau^-\left(d_t^* - d_t\right)$, or cut consumption to meet d_t^* and avoid the penalty. The optimal choice is state-dependent, but generally $\tau^- > 0$ raises the marginal return to repayment relative to liquidity, shifting the policy toward higher d_t.

Second, for households with interior liquid assets in the region:

$$(1+r)(1-\tau^-)\mathbb{E}_t[V_A'] \leq \mathbb{E}_t[V_M'] \leq (1+r)\mathbb{E}_t[V_A']$$

, the kink at $d_t = d_t^*$ binds. Without the friction, these households would optimally choose $d_t < d_t^*$, valuing liquidity highly enough to delay repayment. The penalty makes $d_t = d_t^*$ optimal instead. Relative to the frictionless benchmark, these households reduce both consumption and liquid saving to meet the mandated schedule while avoiding the transaction cost. This is the *binding constraint effect* at the kink.

Third, even households with sufficient wealth that the constraint does not currently bind—those for whom $\mathbb{E}_t[V_M'] < (1+r)(1-\tau^-)\mathbb{E}_t[V_A']$ and who voluntarily meet or exceed d_t^*—adjust behavior in response to the friction. Anticipating that adverse income shocks could push them toward the kink region, these households accumulate larger liquid buffers than under flexible contracts. This is the *precautionary response*: the policy function for liquid assets shifts upward even in states where the friction does not bind, as households self-insure against future states where the mandatory schedule would constrain them. Consumption falls to finance these elevated buffers. Far from the borrowing constraint (high a_t or y_t, low m_t), the shadow value of liquidity is low and the transaction cost becomes less relevant locally.

Role of the mortgage spread. So far I have assumed that the mortgage is expensive, paying a positive spread over the risk-free rate. In this case, unconstrained households will desire to repay the mortgage as fast as possible, provided they have a satisfactory buffer of liquid assets to smooth consumption. Mandatory amortization then primarily affects liquidity-constrained households—those in Groups 1 and 2—generating substantial consumption costs concentrated among the young and income-poor.

But if the cost of carrying mortgage debt is low—if the effective mortgage rate r^m is at or below the return on the household's liquid portfolio (e.g., if interest rates fall and the loan is fixed-rate, or if there is a high-return alternative asset)—then even homeowners far from their borrowing constraints would prefer to delay repayment under a flexible contract, holding more liquid assets and amortizing less. The under-repayment penalty will then affect a larger set of states. Later in life, the amortization requirement would also have an effect, although mainly compositional: higher home equity and lower liquid/risky balances, but with little change in consumption.

Summary. This framework clarifies how mandatory amortization affects household behavior through liquidity constraints and precautionary motives. The key theoretical insight is that effects are heterogeneous: concentrated among households with low liquid wealth, high leverage, or uncertain income—precisely those for whom liquidity flexibility is most valuable. This heterogeneity is central both substantively and for identification. Alternative mechanisms—present bias, limited financial literacy, or other behavioral frictions—might also generate saving responses to mandatory amortization, but would affect households more uniformly across the wealth and income distributions. The liquidity-constraint channel, by contrast, delivers sharp predictions about who responds and why, providing identifying variation for estimation.

The repayment friction encompasses various institutional and behavioral features: refinancing costs, prepayment penalties, administrative barriers, and mental accounting or habit formation that lead households to adhere to prescribed schedules. I capture this in a single reduced-form parameter τ^-, capturing the aggregate cost of deviating from the mandated schedule. While stylized, this approach allows us to quantify the total effect of repayment rigidity—which varies across institutional settings—without requiring separate identification of each underlying source. Section 3 documents empirical patterns in European household data consistent with this mechanism: higher saving rates among homeowners with amortizing mortgages relative to those with flexible interest-only loans, with effects concentrated among younger and lower-income households. Section 4 then implements a quantitative version of the model, exploiting these cross-sectional patterns and a Dutch policy change to identify τ, measure the consumption and welfare costs of mandatory amortization, and assess how these costs are distributed.

3 Evidence on mortgage amortization, consumption and saving

The Eurosystem Household Finance and Consumption Survey (HFCS) is a representative survey of euro area households, akin to the SCF in the United States, collecting data at the household level with a common methodological framework, that allows for adequate comparison across countries. I use three waves of the survey: Wave 2 (2013-14); Wave 3 (2016-17) and Wave 4 (2020-21). The first wave, from 2010-11, does not contain the information mortgages needed for this analysis.

The main focus of the survey is on household balance sheets, which are captured in great detail, showing the disaggregated portfolio of each household, including different financial instruments, but also non-financial wealth, including housing and business assets. The different liabilities of households are observed as well, comprising both mortgages and other loans to financial institutions. The data includes a high level of detail on these loans, such as amounts, payments and interest rates for individual loans.

The survey also includes some data on consumption and income, although with some limitations. The consumption data includes regular consumption expenditures but also consumption of non-durables, purchases of vehicles and housing rents. The income data includes labor income, various social transfers including public pensions, and capital income (e.g. interests and dividends from financial investments).

In the remainder of this section, I first discuss mortgage institutions in the euro area, focusing in particular on the unique case of the Netherlands; then, I explain how I measure saving rates in this data, and finally, describe how regular amortization can be computed from the variables available in the HFCS.

3.1 Homeownership and mortgage institutions in the euro area

Mortgage markets are relatively diverse across euro area countries, with quite different legislations, commercial practices and macroprudential policy rules in place. An important example is the dominant type of interest rate: in some countries, most mortgages are long-term fixed-rate, similar to the US, while in others, the dominant contract is adjustable rate or fixed with a short reset period. The markets do share some features, however. With few exceptions, loan maturities at origination are typically between 20 and 30 years, both for first-time and second home buyers.

Most relevant for our purposes is the amortization schedule. Generally, amortization schedules are fixed at the beginning of the loan, in a "French loan" system where the monthly payment is constant (other than interest rate changes) such that the debt repayment component grows over time. With very few exceptions, all mortgages are fully amortizing, i.e. the repayment schedule is set such that the loan will be fully repaid at maturity. The Netherlands is the only euro area country where *interest only* mortgages have traditionally been both allowed by regulation and remain highly popular. In a few other countries, they are allowed in some cases but play a marginal role (EMF, 2019) .

Until 2013, where a reform to the mortgage interest tax deduction changed the incentives for new homeowners, almost all mortgage issuance was of this kind in the Netherlands. As of 2017, around 40% of new mortgages, and about three quarters of the outstanding mortgage debt stock, were still interest-only, or a hybrid form (Romano, 2017).

Finally, note that in contrast to the US, refinancing and home-equity extraction are highly costly in most euro area markets over this period. In fact, many countries do not have any financial products allowing for home equity extraction available to common borrowers (EMF, 2019). This market setting, contrasting to the US, is central to the mechanism I study here.

3.2 Measuring consumption and saving in the HFCS

The HFCS does not directly record information on household saving flows nor on mortgage amortization. The approach taken here is to, using some simplifying assumptions, calculate these variables based on other quantities reported by households in the survey. Although the resulting estimates suffer from measurement issues and can hardly be taken as precise in terms of levels, the hope is they can provide a sufficiently reliable picture of their distributions.

I restrict the sample to households with heads aged 25–69, excluding retirees and elderly ($\geq$70) and dropping the top and bottom 1% of the saving-rate distribution (robustness uses 5%). All statistics use household weights and, where applicable, multiply imputed values combined with Rubin's rules, as appropriate for the structure of this representative survey data.

Household saving is calculated as the residual from income and consumption. Both are not measured easily in the HFCS. I mostly take from the approaches of Slacalek et al. (2020) and Tzamourani (2021) in adjusting the data to obtain a (rough) estimate of household net income and saving flows. The income before taxes data available in the HFCS is adjusted using information on tax wedges by income decile from EUROMOD (2020). Consumption includes nondurables consumption, as reported directly by households, and housing rent paid by non-homeowners. I also deduct interest paid on outstanding debt, to finally obtain a measure of saving flows for each household:

$$S = Y_{net} - C - \text{rent } - i \times \text{debt}$$

where C is nondurable expenditure, and rent represents yearly rent payments on the main residence for renters, for owner-occupiers imputed rent is excluded. The saving rate is simply the ratio of saving flows to net income, $s \equiv \frac{S}{Y_{net}}$. The distributions of saving rates obtained from this procedure, for each wave of the HFCS, are shown in Figure 1.

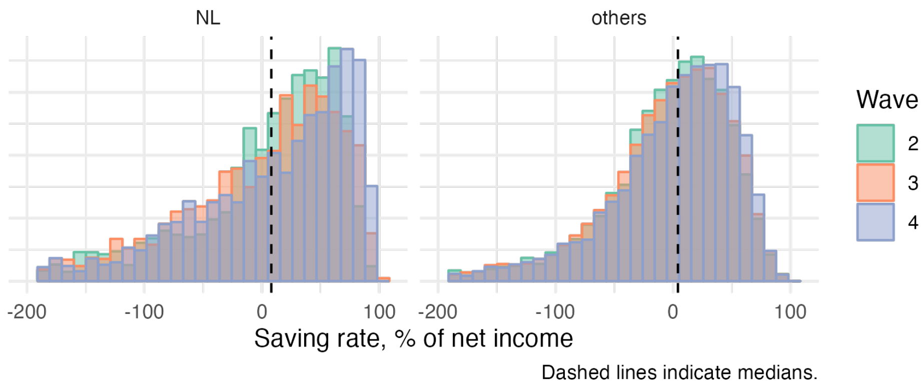


Figure 1: Distribution of saving rates, full HFCS sample, by wave

This figure shows kernel density estimates of household saving rates (as percentage of net income) across different HFCS survey waves, shown in different colors. Left panel: Netherlands. Right panel: Other Euro area countries. Dashed vertical lines indicate median values. Note that in all cases the distributions feature a substantial mass of dissavers (negative saving rates).

The median household saves about 4% of income in the full cross-country sample, and 8% in the Netherlands. There is a long left tail of dissavers, as 46.7% (45.3% in Netherlands) of households do not save or are dissaving. This number is in line with the figures for other regions, and corroborated by the saving rates observed for the Netherlands in the Euro area in their national accounts and the self-reported "ability to save" in the same data (see Appendix A.3).

Descriptive statistics

Table 2 presents summary statistics for the full HFCS sample, detailing financial variables for households across the Euro Area and the Netherlands. The data show the number of observations, and number of households represented (sum of household survey weights), net wealth, yearly net income, and saving rates, computed according to the preceding method, across the three survey waves considered. Dutch households exhibit lower median net wealth and yearly net income compared to their Euro Area counterparts but have far higher saving rates (among those who save). The table also highlights the proportion of the population that saves, i.e. has a positive saving rate, and the percentage of households with a mortgage.

	Netherlands			Other countries		
	Wave 2	Wave 3	Wave 4	Wave 2	Wave 3	Wave 4
# Households (weighted obs.)	7392012	6104344	5996156	129677418	136763861	139091778
# Obs.	1256	2038	2056	65389	69629	64318
Net wealth, average	148214.0	202509.3	243336.8	223489.4	229857.5	292542.6
Net wealth, median	80052.2	84995.8	131608.0	98841.7	100988.2	123621.0
Yearly net income, average	44331.7	59204.7	73290.6	44684.9	45678.3	49017.4
Yearly net income, median	39581.9	49760.9	60989.9	35632.6	36261.1	38119.7
Average saving rate (among those who save)	43.1	46.1	52.5	33.1	34.4	35.6
Median saving rate (among those who save)	12.2	5.1	12.9	1.6	1.7	8.0
% of pop. who save (saving rate > 0)	57.1	52.4	55.4	51.2	51.3	56.2
% of pop. with a mortgage	40.7	50.7	50.2	19.3	19.5	19.7
% of pop. owners	57.6	61.5	61.6	61.6	61.1	62.5

Table 2: Descriptive statistics, full HFCS sample

3.3 Mortgages and amortization in the HFCS

The HFCS contains a great deal of information on households' mortgage loans. For up to 3 different loans, there are details including the purpose of the loan, any previous refinancing, the original and remaining loan amount and maturity, the type (adjustable or fixed) and current level of interest rate.

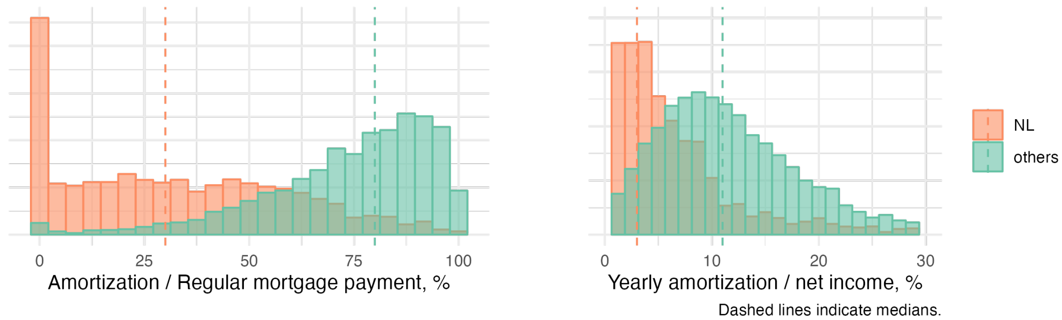
Importantly, respondents are asked to report the regular monthly payment for their current mortgage loans. Combined with other details of the loans, I can back out what is the amortization amount embedded in that monthly payment, for each surveyed household. Annual amortization for household i is given by:

$$\text{amortization}_i = \sum_l \left(12 \times \text{mtp}_{i,l} - r_{i,l} \times D_{i,l}\right),\ l = 1,2,3$$

where mtp is the reported regular monthly payment, r the reported annual interest rate and D the outstanding debt amount, for up to 3 different mortgage loans l. Figure 15 reports the sample distributions of these amortization payments, the left panel showing amortization as a share of the regular payment, and the right as a percentage of household income.

Focusing on the full cross country sample, pictured in green, I observe that most loans devote a large part of the monthly payment to amortization. The median is about 80%. This is reasonable considering that the overwhelming majority of loans has a standard annuity loan structure, which means that for the last several years of the loan the share of payment going to amortization is very high. Furthermore, this sample focuses on years with relatively low interest rates. Also, the weight of amortization payments on household income seems reasonable, in line with other sources and with mortgage market regulations. The obtained values concentrate around 10%-20% of yearly net income, as shown in Figure 2, across all countries.

The case of the Netherlands, shown in orange in the charts, is starkly different. The high prevalence of interest-only mortgages shows up in this data: there is a large bunching at zero, and many households amortize only a small amount in a regular month. The effects of a 2013 policy change that made interest-only mortgages more costly are also visible, as homeowners with mortgages originated after 2013 amortize more (see 14 in Appendix).



(a) Share of regular mortgage payment going to amortization

(b) Weight of amortization on household net income

Figure 2: Distribution of amortization in the HFCS

Panel A shows the distribution of the share of regular mortgage payments going to amortization. The Netherlands (orange) exhibits a distinct pattern with a substantial mass at zero, reflecting the prevalence of interest-only mortgages, as opposed to other euro area countries (green). Panel B displays amortization as a percentage of household net income, with the median household in standard mortgage countries dedicating approximately 15% of income to mortgage principal repayment.

Descriptive statistics

Table 3 provides summary statistics for the subset of mortgaged homeowners in the HFCS sample. Mortgaged homeowners, as a group, are younger but are otherwise not very different in terms of income or wealth to the rest of the population. The focus then is on mortgage-related variables. The table details the average housing assets, portfolio share of housing, and characteristics of the primary mortgage, including the outstanding debt as a percentage of housing assets, average remaining maturity, initial maturity, prevalence of variable rate mortgages, current interest rates, and refinancing rates.

	Netherlands			Other countries		
	Wave 2	Wave 3	Wave 4	Wave 2	Wave 3	Wave 4
# Households (weighted obs.)	3011506	3094329	3011440	25063853	26664636	27436748
# Obs.	633	1116	1103	15844	16370	15731
Net wealth, average	185325.2	222784.7	314642.1	254507.1	289997.1	341855.0
Net wealth, median	141981.8	144822.7	227365.2	131948.4	155729.4	184163.4
Yearly net income, average	52900.2	69271.8	89074.0	56670.6	58516.0	62210.6
Yearly net income, median	51869.3	61757.0	80542.5	48168.3	49526.1	52207.4
Average saving rate (among those who save)	45.1	49.6	56.9	35.1	36.2	38.3
Median saving rate (among those who save)	25.8	31.0	46.8	17.5	19.8	27.3
% of pop. who save (saving rate > 0)	65.1	66.4	73.8	65.1	66.5	73.0
Average housing assets	283418.6	290829.9	394957.9	267535.0	293834.2	340644.7
% Portfolio share of housing	78.9	77.7	83.7	82.6	82.5	81.6
Mortgage on main residence						
– Outstanding debt, % of housing assets	62.1	77.5	51.1	50.0	45.1	51.1
– Average remaining maturity, years	–	14.3	15.8	–	14.0	13.9
– Average initial maturity, years	25.5	22.3	24.0	20.1	20.5	21.5
– % of HHs with variable rate mortgages	76.0	92.3	94.4	42.2	40.0	34.8
– Average current interest rate	4.5	3.7	2.8	3.3	2.5	2.0
– % of HHs who refinanced at least once	18.8	17.1	23.0	15.2	22.7	19.3

Table 3: Descriptive statistics, mortgaged homeowners, HFCS

3.4 Stylized facts on consumption and saving rates

This section analyzes the saving rates and amortization patterns across different household types in Europe, focusing on regular mortgaged homeowners, interest-only (IO) homeowners, and other households. I continue to single out the case of the Netherlands, vis-à-vis other countries. To provide a more clear picture, the analysis excludes elderly or retired individuals, representing 22% of observations and 21% of the population, as well as extreme dissavers, 10% of the sample. By examining group means across income quintiles, wealth/income ratio quintiles, and age brackets, I provide a comprehensive view of saving behavior. The primary variable of interest is the active saving rate, defined as saving as a percentage of income. This approach enables a detailed comparison of how different mortgage structures are related to household saving patterns across the wealth distribution.

3.4.1 Saving rates among mortgaged homeowners and other households

Over the income distribution Figure 3 illustrates saving rates (lines) across income quintiles for households in the Euro Area (EA) and the Netherlands (NL). In the EA, saving rates increase with income, with the highest quintile saving approximately 40% of net income, while the lower quintiles save considerably less. In the NL, amortizing mortgage holders consistently save a higher percentage of their net income across all quintiles compared to interest-only (IO) mortgage holders and other households. Notably, the saving rate gradient is less steep for those with amortizing mortgages, indicating smaller differences in saving rates across income quintiles for this group. The highest quintile in the NL saves nearly 60% of net income among amortizing mortgage holders, whereas IO mortgage holders save about 50%, placing them between amortizing mortgage holders and other households.

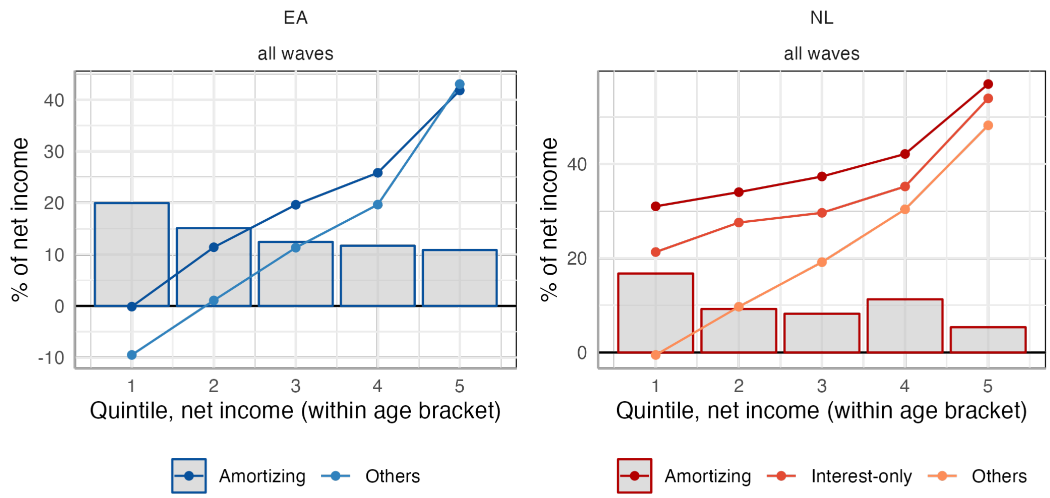


Figure 3: Saving rates over the income distribution

This figure compares saving rates (lines) and amortization payments (bars) across income quintiles. In the Euro Area (left panel), saving rates increase steeply with income among non-mortgaged households, while the gradient is flatter for mortgaged homeowners. In the Netherlands (right panel), households with amortizing mortgages show consistently higher saving rates across income quintiles, with a much flatter gradient, compared to interest-only mortgage holders and non-mortgaged households.

The figure also presents amortization payments as a percentage of net income (columns), which allows for a comparison with saving rates. In both the EA and NL, the share of income dedicated to mortgage debt repayment declines with income. Strikingly, in the EA, amortization consumes a substantial portion of saving flows for all households except those in the top income bracket. On average, mortgaged homeowners in the bottom two quintiles dissave from other assets to save into home equity through debt repayment. While the baseline level of saving rates is higher in the NL, it is evident that households in the top income quintile concentrate much less of their saving in amortization.

Over the life cycle I observe that in the EA, saving rates generally increase with age, peaking around the 50-60 age bracket, with amortizing mortgage holders saving a higher percentage of their net income compared to other households. Notably, the differences across age groups in saving rates are much wider among households who do not have a mortgage. Young mortgaged homeowners save much more than their peers without a mortgage, while for older people having a mortgage does not make much difference in their saving rate. While in part this may be due to selection, as young mortgaged homeowners may have a higher propensity to save ex ante, it can also suggest an effect of the mortgage on their saving behavior.

In the NL, a similar pattern is observed, with small differences in saving across ages, among amortizing mortgage holders. Interest-only (IO) mortgage holders exhibit a saving pattern more similar to non-mortgaged households, showing greater variation in saving rates across age groups. The highest saving rates for IO mortgage holders are observed in the 50-60 age bracket, while younger and older age groups save less.

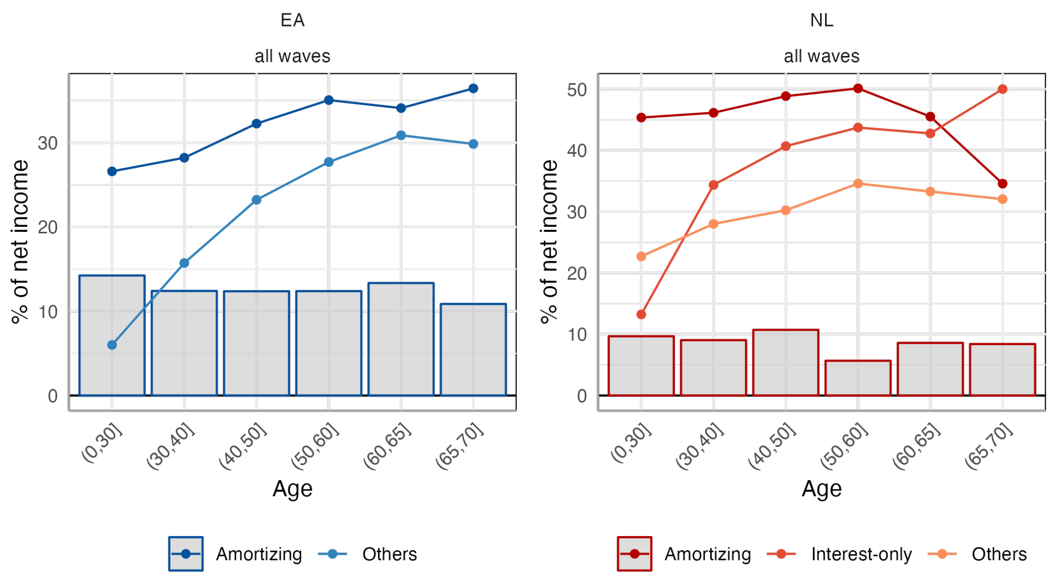


Figure 4: Saving rates over the life cycle

The figure compares saving rates (lines) and amortization payments (bars) over the life cycle. In both the Euro Area (left panel) and Netherlands (right panel), households with amortizing mortgages exhibit more stable saving rates across age groups, while other households show substantial variation. Notably, households with interest-only mortgages in the Netherlands save at much lower rates at the beginning of the life cycle, similar to non-mortgaged households, mostly composed of renters.

Amortization payments as a percentage of net income (columns) decline over the life cycle, but differences are much less steep than between different income groups. Note that as households grow older, they move closer to maturity of the mortgage loan, with the amortization component of their regular payment increasing steeply.

Over the wealth distribution In the EA, saving rates rise with wealth, peaking at around 35% of net income in the highest quintile, while lower quintiles save significantly less. The differences in saving rates across wealth quintiles are more pronounced among non-mortgaged households compared to those with amortizing mortgages, indicating more consistent saving behavior for the latter. In the NL, amortizing mortgage holders exhibit stable saving rates across wealth quintiles. Conversely, interest-only (IO) mortgage holders show a saving pattern similar to non-mortgaged households, with greater variation across wealth quintiles. The highest saving rates for IO mortgage holders occur in the top wealth quintile.

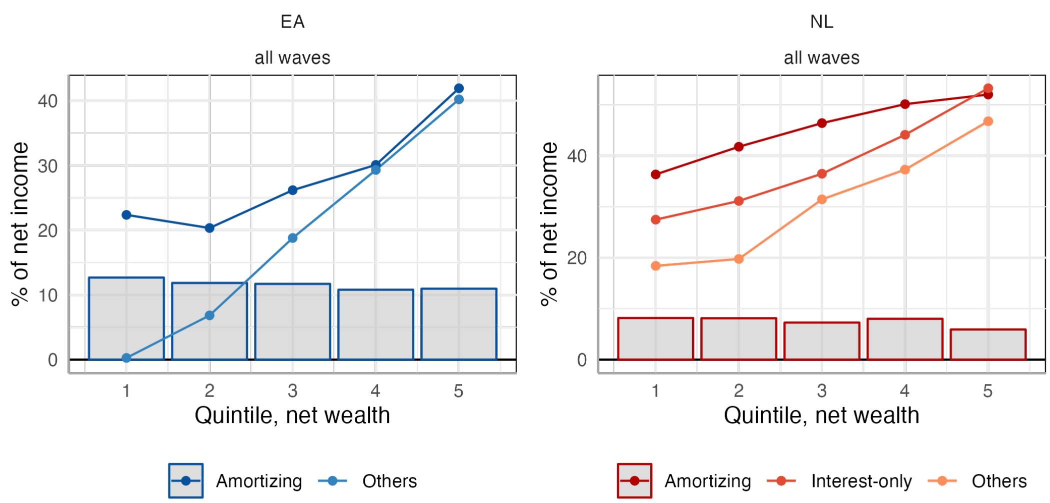


Figure 5: Saving rates over the wealth distribution

This figure compares saving rates (lines) and amortization payments (bars) by wealth quintile. The gradient of saving rates across wealth quintiles is substantially flatter for households with amortizing mortgages in both regions. In the Netherlands (right panel), the difference between households with interest-only mortgages and those with amortizing mortgages is striking, with the former being closer to the saving rates of non-mortgaged households.

The figure also shows amortization payments as a percentage of net income (columns). In both the EA and NL, the share of income dedicated to mortgage repayment decreases with wealth. Younger households, typically lower in the wealth distribution, allocate a substantial portion of their income to amortization.

3.5 Stylized facts on mortgage and wealth stocks

Figure 6 shows the average remaining balance of the main-residence mortgage (as a share of the initial value of the loan) against time to maturity. In the general Euro area sample, it basically reflects standard mandatory amortization schedules, with balances declining steadily toward zero. In the Netherlands, I observe that households with an interest-only or partially interest-only loan (most households) leave a substantial part of the loan unpaid until very close to maturity, while fully amortizing loans decline along the usual path. This matches the institutional facts and the model's flexible-repayment benchmark.

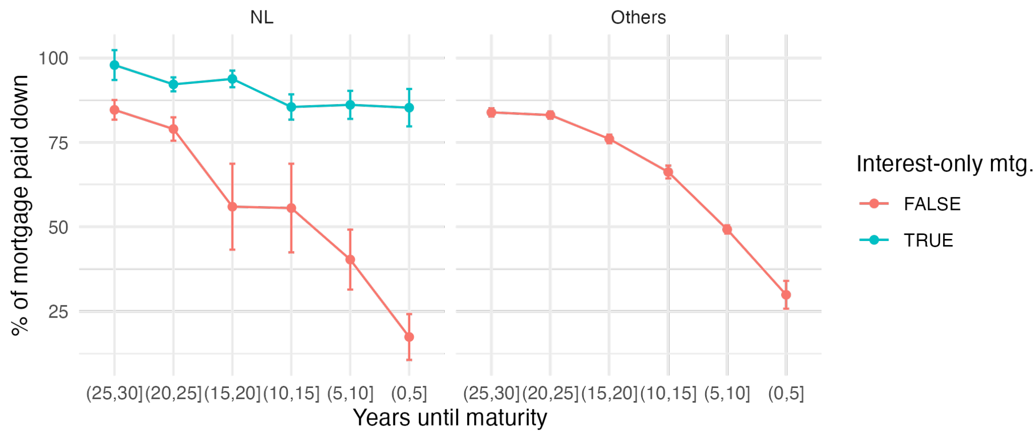


Figure 6: Outstanding mortgage balance and maturity in the data

This figure shows the average remaining mortgage balance, as percentage of original loan amount, and time to maturity of the main residence mortgage in the HFCS data. In the Netherlands (left panel), interest-only mortgages (red) maintain high balances until near maturity, while amortizing mortgages (blue) gradually decline to zero. In other Euro area countries (right panel), interest-only mortgages are very rare and not shown. Whiskers show 95% confidence intervals.

Figure 7 then shows liquid assets relative to net income by time to maturity. In the Netherlands, IO borrowers accumulate substantially larger liquid buffers as maturity approaches, compared to fully amortizing borrowers. In other euro-area countries (right panel), where IO contracts are rare, liquid assets rise much less steeply. This pattern is consistent with the mechanism's composition margin: when repayment is flexible and the after-tax mortgage carry is low relative to households' portfolio returns, unconstrained (older/richer) homeowners optimally under-repay and hold more liquid assets, whereas under rigid amortization they are tilted into illiquid home equity, leaving smaller liquid balances at similar horizons to maturity. The gap in late-life liquidity between IO and amortizing Dutch borrowers, alongside small consumption differences at these ages, is exactly what the model predicts for the low-spread case. This makes sense considering that the tax treatment of interest-only mortgaged made them very cheap to hold in the Netherlands.

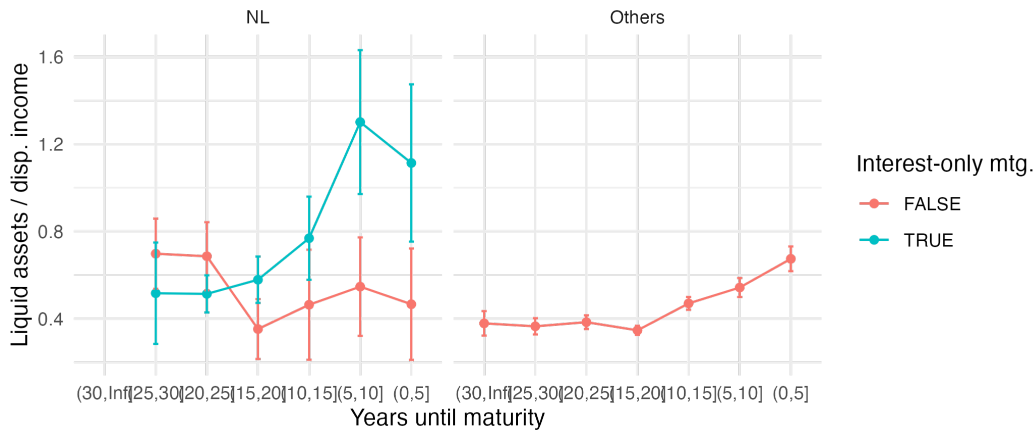


Figure 7: Liquid wealth and outstanding mortgage maturity in the data

The figure shows liquid asset holdings (as a ratio of disposable income) by time to maturity of the main residence mortgage in the HFCS data. Netherlands households with interest-only mortgages (blue line, left panel) accumulate substantially higher liquid assets as they approach maturity, compared to households with amortizing mortgages (red line). This pattern is consistent with higher saving in liquid assets. In other Euro area countries (right panel), interest-only mortgages are very rare and not shown.

The comparison underscores the model's capacity to rationalize observed patterns in debt repayment and wealth accumulation. This gives greater confidence in the model's predictions for distributional outcomes, which I analyse in the next subsection.

Taken together, Figures 6 and 7 anchor two sides of the mechanism in the data: the repayment path (IO keeps balances high; amortization reduces them) and the portfolio response (IO borrowers carry larger late-life liquid buffers; amortizers hold more housing equity). This supports the view that our earlier flow results for young/low-income owners (liquidity tightening, higher MPCs) coexist with a later-life composition effect under flexible contracts. I quantify these forces in the model next.

4 Identifying the effects of mandatory amortization: quantitative model

This section implements a quantitative version of the life-cycle model in Section 2, calibrated to Dutch data, to quantify how repayment rigidity shapes consumption, liquid buffers, and wealth accumulation. The environment mirrors Section 2 but is parameterized to HFCS moments for the Netherlands. I discipline the model with (i) the aggregate private-wealth-to-income ratio, (ii) life-cycle profiles of income and saving, (iii) mortgage institutions (initial LTVs, maturities, spreads), and (iv) the empirical weight of amortization in household cash flows. I then conduct a simple counterfactual comparing the repayment regimes before and after the 2013 policy: a flexible benchmark (no cost to delaying principal; interest-only feasible) versus a rigid regime that enforces the scheduled annuity amortization. Initial conditions reflect first-time buyers—high leverage and thin liquid buffers. I report lifecycle profiles and heterogeneity across income groups, and I read results through the sufficient statistics highlighted by the mechanism: the cash-flow burden (PTI), current LTV, liquid wealth, and the mortgage–portfolio spread. Finally, I relate the model's predictions to the cross-sectional facts in Section 3, including the composition differences between amortizing and interest-only borrowers later in life.

4.1 Implementation of full model

4.1.1 Environment and recursive problem

The basic structure of the model was presented in Section 2. I summarize the dynamic problem faced by the household here. Each period, each household i solves (i subscripts dropped for clarity):

$$V_t(s_t) = \max_{c_t, d_t} \mathbb{E}_t \left[\sum_{k=t}^{T-1} \beta^{k-t} u(c_k) + \beta^{T-t} B\big(a_T - m_T\big) \right],$$

subject to:

$$\begin{aligned} a_{t+1} &= (1+r)\Big[a_t + y_t - (r+s)m_t - d_t - \tau_t - c_t\Big], \\ m_{t+1} &= m_t - d_t, \qquad d_t \geq 0,\ c_t \geq 0, \\ a_t &\geq 0, \quad m_t \geq 0. \end{aligned}$$

States are $s_t = (t, a_t, m_t, Z_t, \theta_t)$ and income is

$$Y_t = \Gamma_t\, Z_t\, \theta_t,$$

with Γ_t the deterministic lifecycle profile, Z_t the permanent component, and θ_t the transitory shock. The income process follows the standard specification:

$$\begin{aligned} &\log Z_{t+1} = \log Z_t + \log \psi_{t+1}, \quad \log \psi_{t+1} \sim \mathcal{N}\left(-\tfrac{1}{2}\sigma_\psi^2, \sigma_\psi^2\right), \\ &\log \theta_{t+1} \sim \mathcal{N}\left(-\tfrac{1}{2}\sigma_\theta^2, \sigma_\theta^2\right), \end{aligned}$$

so that Γ_{t+1} multiplies $Z_{t+1}\theta_{t+1}$ when forming Y_{t+1}. Initial conditions (A_0, M_0) are drawn from the empirical joint distribution at origination. Permanent income and the house price are normalised at $Z_0 = P_0 = 1$.

The mortgage carries rate $r^m = r + s$ and an annuity schedule d_t^* given by the standard formula (see footnote below). The chosen principal repayment d_t can deviate from d_t^* but incurs a transaction cost

$$\tau_t = \tau^+ \max\{0, d_t - d_t^*\} + \tau^- \max\{0, d_t^* - d_t\}.$$

In what follows, the policy shift in 2013 is modelled as an increase in τ^- (cost of under-repayment) from τ^{pre} to τ^{post}.

4.1.2 Solution method: dynamic programming with neural networks

Solving this model consists of finding the policy function $\pi(s_t) \equiv \pi(t, y_t, a_t) = \tilde{\pi}(t, y_t, a_t, \theta)$ that will provide the optimal consumption and mortgage repayment (controls) conditional on current period income and assets (states).

I employ a deep neural network approach, based on work by de la Barrera and de Silva (2024), following methods proposed by Duarte et al. (2021, 2024). Traditional dynamic programming techniques face challenges in high-dimensional state spaces due to the curse of dimensionality, especially when incorporating rich income processes. The neural network approach overcomes these limitations by approximating the policy function directly. Even though the current version of the model could be solved with more traditional numerical methods techniques, I apply the neural networks approach from the outset as it can more easily scale to future extensions of the model with house-price and interest-rate risk.

The method finds the optimal policy function $\pi\left(X_t, M_{t-1}, Z_{t-1}\right)$, given initial conditions $\{A_{i0}, M_{i0}\}$, that ensures the above value function holds, in expectation, every period up to T. This policy function is parameterized as a fully connected feedforward neural network $\tilde{\pi}(X_t, M_{t-1}, Z_{t-1}, \Theta)$, where Θ is a vector of network parameters. Then, the loss function

$$L(\Theta) = -V^{\pi^{\Theta}}(\Phi_0) = -E\left[\sum_{t=0}^{T} \beta^t \, u\Big(C(\Phi;\Theta)\Big) \mid \Xi_0\right]$$

is minimized with respect to Θ to find the optimal lifetime policy function, using stochastic gradient descent with the Adam optimizer. The neural network architecture consists of five hidden layers with 500 nodes each, using tanh activation functions for the hidden layers and a sigmoid activation function for the output layer. This architecture results in approximately 1.25 million parameters to be optimized.

4.2 Calibration Strategy

I calibrate the model in two steps. First, I estimate structural preference parameters and the baseline repayment friction, i.e. in the pre-policy data where interest-only mortgages were cheaply available. In the data before the policy change I can observe both early and late lifecycle stages. Second, I identify the friction induced by the policy from post-policy data (2014-2017 homebuyers), holding preferences fixed. This sequential approach exploits the different information available across policy regimes while addressing compositional differences between cohorts.

4.2.1 Initial conditions

Initial conditions at origination—purchase age, P_0/Y_0, M_0/P_0, and A_0/Y_0—are sampled from the empirical joint distribution for Dutch mortgage holders with $\leq$ 2 years since purchase (HFCS), separately by education group. This preserves observed correlations (e.g., older buyers hold more liquid wealth; higher-income buyers select lower LTVs).

4.2.2 Step 1: Preferences and baseline friction (pre-policy)

I estimate $\Theta_1 = \{\beta,\ b_0,\ \tau^{pre}\}$ by Simulated Method of Moments, matching six moments for pre-2013 homebuyers (HFCS 2013–2021): (i) early-stage (2–5 years) debt outstanding as a share of origination by education (2 moments); (ii) late-stage (25–30 years) debt outstanding and liquid wealth/income by education (4 moments). The discount factor β governs overall wealth accumulation; b_0 pins down terminal liquid wealth; τ^{pre} captures baseline deviations from frictionless repayment (refinancing/admin costs and reduced-form adherence to schedules), identified primarily from early-stage debt conditional on the lifecycle path implied by β. Targeting moments by education helps separate preference parameters from composition.

4.2.3 Step 2: Policy friction (post-policy)

Given $\{\beta,\ b_0,\ \tau^{pre}\}$ from Step 1, I estimate τ^{post} using early-stage (2–5 years) debt outstanding for 2014–2017 buyers, separately by education (2 moments). The policy wedge is $\Delta\tau = \tau^{post} - \tau^{pre}$.

Counterfactual design. In estimation and model fit I use *cohort-specific* initial conditions and interest-rate environments: pre-2013 buyers are simulated with the pre-policy joint distribution of (A_0, M_0, P_0, Y_0) and rates; post-2013 buyers with the post-policy distribution and rates. To isolate the policy wedge, I then run a within-cohort counterfactual for the post-2013 cohort, holding their initial conditions and rates fixed and switching only the under-repayment cost from τ^{pre} to τ^{post}. This delivers the causal effect of mandatory amortization separately from concurrent changes in rates and borrower composition.

4.2.4 Estimation

I simulate lifecycle paths for samples of households drawn from the relevant initial conditions distribution (pre-2013 buyers for Step 1, post-2013 buyers for Step 2). I compute model-implied moments and minimize the weighted sum of squared distances to data targets:

$$\Theta^* = \arg\min_{\Theta} \sum_{j=1}^{J} w_j \left(\frac{m_j(\Theta) - m_j^{data}}{m_j^{data}} \right)^2 \tag{4.1}$$

where j indexes moments, w_j are weights, and $m_j(\cdot)$ are moment functions. I weight all targeted moments equally within each calibration step.

The search employs a combination of random sampling and adaptive grid refinement. For Step 1, I search over a three-dimensional parameter space; for Step 2, a one-dimensional search. I cache policy functions for each parameter combination to enable rapid re-simulation when evaluating nearby parameter values. This computational approach allows us to explore the parameter space thoroughly while maintaining consistency in the random shocks used across simulations (I use common random numbers for each household across different parameter values).

4.2.5 Externally calibrated parameters

Table 4 reports parameter values used in the model. The model considers only the working life, agents begin their lives at 30 and retire at 70. The discount factor $\beta = 0.96$ allows to attain a simulated aggregate private-wealth-to-income ratio in line with the value of 3.1 observed in the 2017 wave of the HFCS for the Netherlands. A coefficient of relative risk aversion $\gamma = 5$ is taken from Duarte et al. (2020). Earnings risk represents that observed in the Netherlands for male after-tax earnings, estimated from high-quality micro data on Dutch salaries by Paz-Pardo et al. (2020). Bequest preferences are set such that the median household holds net financial wealth equal to 1.5 times yearly income by retirement. The safe return is fixed at r = 3 %, the euro-area long-run average documented by Jordà et al. (2019). Finally, a 50-basis-point mortgage spread anchors borrowing costs at the euro-area median reported in EMF Hypostat (2019). The borrowing limit in the liquid account is set at zero, as a simplification allowed by the observation that credit card and other unsecured debt (excluding auto loans) is small in the Dutch data, as observed in the HFCS (and unlike the US setting). The initial LTV of mortgage loans is set at 100% in the model, matching the typical loan in the Netherlands.

Description	Value	Notes	Source
Life time in the model (T)	30	Most common maturity	HFCS and Hypostat (2019)
Risk aversion coeff., consumption (γ)	5	-	Duarte et al. (2020)
Bequest motive parameters ($\underline{b}$)	0.25	Wealth at retirement	HFCS 2017 micro data
Risk aversion coeff., bequest (γ^b)	2	-	–
Permanent income life cycle path	-	Age-varying, by education level	HFCS
Persistence of permanent shocks	-	Age-varying	Paz-Pardo et al (2020)
Variance of transitory shocks (σ_y^2)	0.015	Earnings shocks (transitory)	Paz-Pardo et al (2020)
Variance of permanent shocks (σ_z^2)	0.01	Earnings shocks (permanent)	Paz-Pardo et al (2020)
Riskless rate (r)	0.02	Long-run real safe rate	ECB macro data
Borrowing limit, liquid (θ^A)	-1	Share of income	-
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

Table 4: Misc. externally calibrated parameter values

4.3 Model fit

4.3.1 Estimated parameters

Table 5 reports the estimated parameters.

Parameter	Estimate	Interpretation	Mainly identified by
β	0.975	Standard discount factor (patience)	Life-cycle wealth accumulation
b_0	3.4	Value of liquid wealth post-retirement (bequest)	Terminal wealth before retirement
τ^{pre}	0.17	Pre-policy repayment friction	Baseline repayment dynamics
τ^{post}	0.74	Post-policy repayment friction	Policy effect on repayment

Table 5: Estimated parameter values

The discount factor is $\beta = 0.975$, within the range commonly used in lifecycle models. The bequest strength $b_0 = 3.000$ (with $b_1 = 0.25$) generates terminal wealth-to-income ratios around 1.5, consistent with late-stage holdings. The baseline under-repayment cost is small, $\tau^{pre} = 0.01$, reflecting flexible pre-2013 contracts. The post-policy cost rises to $\tau^{post} = 0.80$, capturing the binding nature of mandatory amortization introduced in 2013. The implied policy wedge $\Delta\tau \approx 0.79$ is identified by the sharp acceleration in early-stage principal repayment despite a lower mortgage-rate environment.

The structural model successfully replicates the key empirical patterns in both debt repayment and liquid wealth accumulation. We estimate four parameters (β, b_0, τ^{pre}, τ^{post}) to match ten targeted moments spanning early and late lifecycle stages, both before and after the 2013 policy reform, separately for each education group.

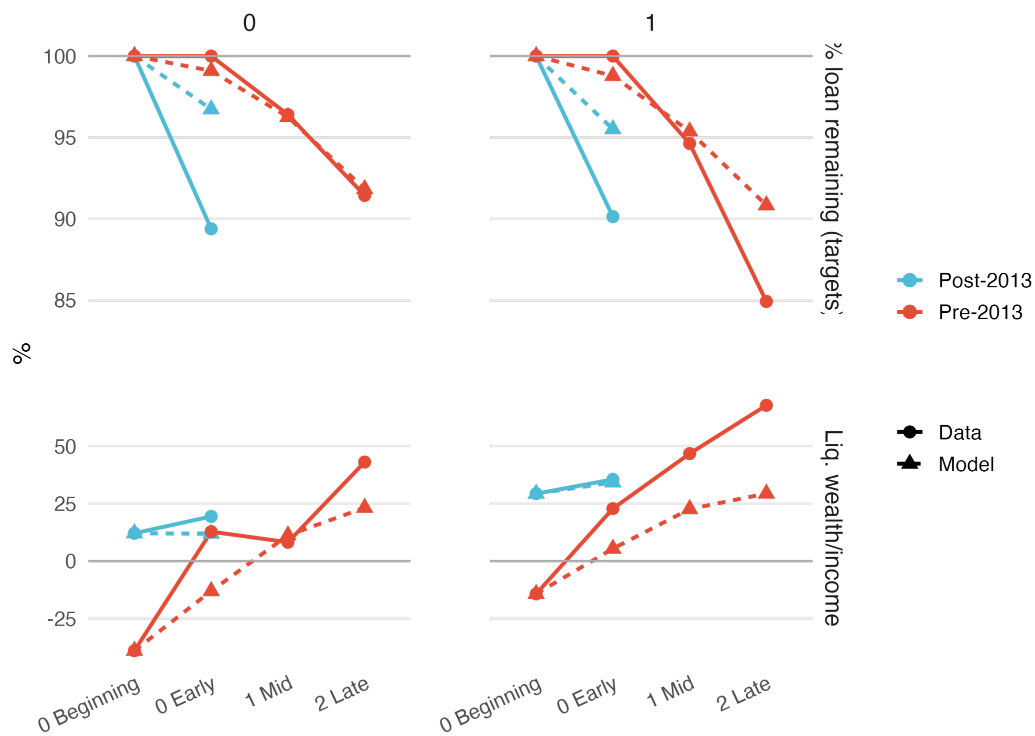


Figure 8: Targeted and non-targeted moments in model

Overall fit quality. Figure 8 demonstrates that the model closely matches the targeted moments across both dimensions. The model captures three critical empirical features: (i) substantially faster debt paydown in the early mortgage stage post-2013 compared to the pre-reform regime, (ii) the lifecycle profile of liquid wealth accumulation, with negative early-stage wealth pre-2013 transitioning to substantial positive wealth by the late mortgage stage, and (iii) systematic differences between education groups in both debt repayment speed and wealth accumulation.

Policy effect on debt dynamics. The model successfully replicates the sharp policy-induced acceleration in early-stage debt repayment. In the pre-2013 regime, households retain approximately 98–100% of their initial mortgage balance during the early stage (2–5 years), with only modest amortization occurring later in the lifecycle. Post-2013, the model matches the observed shift to accelerated repayment: outstanding debt falls to roughly 90% of the initial balance within the early stage for both education groups. This represents the central identifying moment for the change in repayment frictions ($\Delta\tau = \tau^{post} - \tau^{pre}$).

Liquid wealth patterns. The model captures the lifecycle wealth accumulation trajectory, though with some deviations. Pre-2013, both data and model show negative liquid wealth positions early in the mortgage (approximately -25% to -15% of income), rising to positive levels of 25–55% of income by the late stage (25–30 years). The model slightly understates early-stage dissaving for lower-education households. Post-2013, the model reproduces higher early-stage liquid wealth (15–35% of income), though it somewhat overpredicts wealth levels relative to the data, suggesting households may be even more liquidity-constrained by mandatory amortization than the model implies.

Education heterogeneity. The model successfully matches the distinct behavior of the two education groups. Higher-education households (type 1) exhibit both faster debt repayment and greater liquid wealth accumulation throughout the lifecycle, patterns that emerge endogenously from their steeper income profiles and potentially different preferences. The model captures these differences across all lifecycle stages and policy regimes.

Parameter estimates and economic interpretation. The calibrated parameters in Table 5 are economically reasonable. The discount factor $\beta = 0.975$ corresponds to standard estimates of annual patience. The bequest motive $b_0 = 3.4$ implies that households value liquid wealth after mortgage retirement at roughly 3.4 times their flow consumption, consistent with precautionary saving motives extending into retirement.

The repayment friction parameters reveal the magnitude of the policy effect. Pre-2013, the transaction cost parameter $\tau^{pre} = 0.17$ implies modest flexibility in repayment timing—households face only a 17% penalty on the consumption value of delaying repayment, which aligns with the observed pattern of slow amortization when interest-only mortgages dominated. The post-2013 estimate $\tau^{post} = 0.74$ indicates a dramatic tightening: the effective penalty for delayed repayment rises to 74% of its consumption value. This large increase in $\Delta\tau = 0.57$ reflects both the direct tax penalty introduced by the policy and the shift in mortgage product offerings by banks toward mandatory amortization schedules.

Policy identification through interest rate counterfactual. The large estimated change in repayment frictions is particularly notable given that post-2013 mortgage interest rates fell below liquid asset returns. In the absence of the policy change (holding τ fixed at pre-2013 levels), falling mortgage rates would have further incentivized slow repayment. The fact that we instead observe accelerated paydown despite this countervailing force allows the model to identify a substantial policy effect. The calibrated $\Delta\tau$ must be large enough to overcome the interest rate spread reversal and still generate faster post-2013 debt reduction.

Non-targeted validation. Beyond the calibration targets, the model reproduces an important non-targeted pattern: the flattening of saving rate differences across income groups observed in the Dutch cross-section (Figure 3). This provides external validation that the model's implications for consumption-income co-movement are consistent with broader empirical regularities.

5 The effects of mandatory amortization on consumption, saving and wealth

5.1 Debt repayment, wealth accumulation and self-insurance over the life cycle

Baseline consumption and saving profile

I first discuss the average profiles of consumption and saving over the life cycle predicted by the model. Permanent income follows a simple age profile of steady growth until age 50 and stagnation there after. Figure 9 shows the average age profiles of consumption, and of the saving rate. This represents the mean across simulated agents, conditional on age, for a population of 10,000 simulated agents. The dashed line represents the scenario with unrestricted repayment, where households optimize their repayment schedules without constraints, while the solid line reflects the constrained scenario of fixed, mandatory amortization schedules.

In the unrestricted model, consumption, plotted as a ratio to initial permanent income, follows a smooth pattern with a constant rate of growth over the life cycle. The average household in the model is able to smooth consumption well. Instead, when they are restricted by a mandated amortization schedule, agents consume less – up until the moment that the mortgage is paid off, and home equity is 'unlocked' after 30 years, the maturity of the loan. Consumption then jumps up as agents are finally able to use up the accumulated wealth in home equity. [6]

[6] Note that in this model, the housing services consumed correspond exactly to the implicit rent made from the housing asset, so they have a net zero effect on the saving rate.

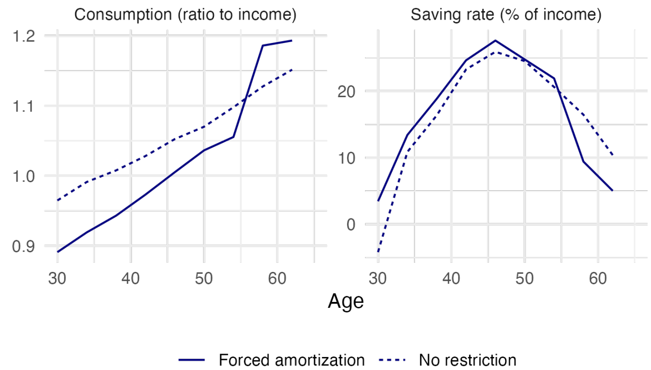


Figure 9: Life cycle income and consumption patterns in the model

This figure compares model-predicted consumption and saving rates under flexible repayment (dashed lines) versus mandatory amortization (solid lines). Left panel: Consumption-to-income ratio over the life cycle shows lower consumption under mandatory amortization until mortgage maturity. Right panel: Saving rates are higher under mandatory amortization throughout most of the life cycle, with the gap largest for younger households.

Figure 9 also shows, in the second panel, what the preceding consumption pattern means for the average saving rate over the life cycle. In the model households have low saving rates in the beginning of life, and then these grow steadily over the working life, as income also grows. The saving rate then begins to decline once income stagnates.

The impact of mandatory amortization

If forced to amortize, households save much more in the first few years. The saving rate is even negative in the first 2 years – households on average risk being very close to the liquid borrowing constraint. Although the gap narrows after the first few years, constrained households continue to save more than in the unrestricted case until mortgage maturity, after which they save substantially less.

The higher saving rates occur because young homeowners must (i) offset the portion of income locked in home equity, and (ii) maintain additional liquid buffers as the mandatory payment tightens their liquidity constraint. Later in life, households in the model draw down on the savings built via home equity. All of this can be observed in Figure 10, which shows, from left to right, the average life cycle patterns of the mortgage balance, of net wealth as a percentage of income, and of liquid wealth-to-income, respectively.

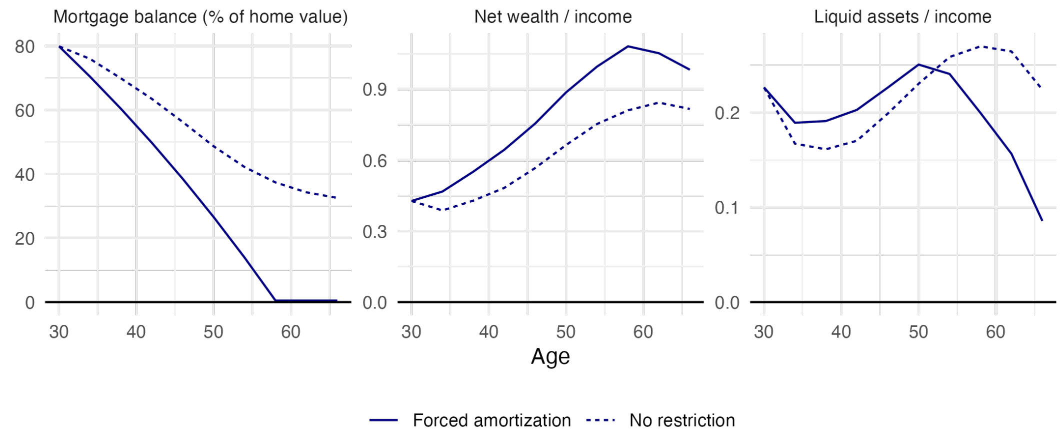


Figure 10: Life cycle saving patterns in the model

Comparison of model-predicted mortgage balances, net wealth, and liquid assets under flexible repayment (dashed lines) versus mandatory amortization (solid lines). Under mandatory amortization, households repay mortgages faster (left panel), accumulate substantially more wealth relative to income (center panel), and maintain higher liquid asset buffers (right panel), reflecting increased precautionary saving motives.

The effects of mandatory amortization on consumption translate into patterns of wealth accumulation over the life cycle. The left panel of Figure 10 shows that the optimal repayment pattern for the average household is slower than mandated, and involves leaving a substantial portion of the loan, just over 30%, still to be paid at the time of retirement. With mandatory amortization, on average repayment is faster and is concluded before the 30 years of the loan maturity – as the households who are better off i.e. have high income windfalls, make some prepayments.

The higher saving of households in the mandatory amortization case naturally leads to more wealth accumulation over the life cycle. The average household under mandatory amortization accumulates wealth equivalent to roughly 100% of income by age 60, compared to 85% under the unrestricted scenario. The tighter constraints faced by households lead to higher saving for precautionary reasons during the working life. After that, although constrained households show lower saving rates, they still reach retirement with a markedly higher wealth-income ratio.

In environments with a low after-tax mortgage carry (as in the Netherlands for many cohorts), the model predicts that interest-only borrowers carry larger late-life liquid balances and lower home equity than amortizing borrowers with similar PTI/LTV, with small consumption differences—the exact pattern documented in Section 3.5.

5.2 Differences across income groups

Effects over the income distribution

The effects of mandatory amortization vary over the income distribution. Figure 8 plots the saving rate, the share of wealth invested in housing, and the liquid assets-to wealth ratio across model permanent-income quintiles (i.e. persistent over the life cycle). Amortization affects mainly the saving rate of lower-income homeowners: in the bottom income quintile, mandatory amortization increases saving rates by approximately 12 percentage points compared to the flexible repayment regime. This heterogeneous response reflects the differential burden that fixed mortgage payments impose across income levels. Lower-income households, closer to their liquidity constraints, if required to make mandatory payments they reduce consumption and increase saving in liquid assets. Higher-income households can more easily accommodate mandatory payments by shifting the composition of saving, without substantially altering their consumption-saving decisions. While income-richer households keep their desired liquid savings buffers and make their mortgage repayments, poorer households save comparatively more, increase their net wealth, i.e. including housing assets and deducted from mortgage debt, but end up with smaller liquid savings.

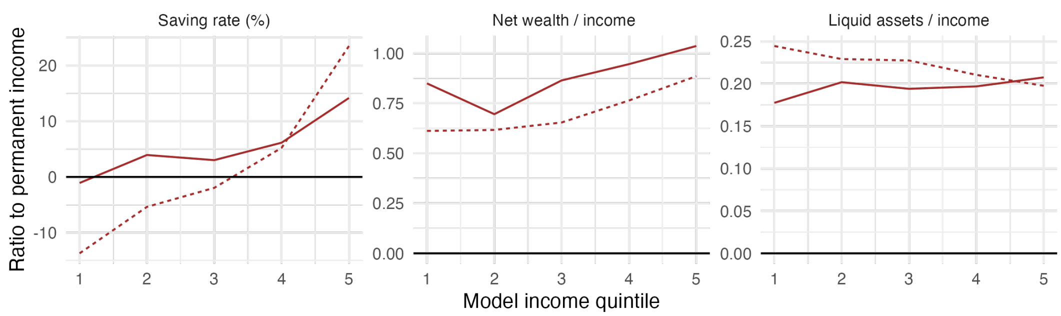


Figure 11: Saving patterns over the income distribution in the model

Model predictions for households across income quintiles show that mandatory amortization (solid lines) induces higher saving rates for lower-income households (left panel) compared to the flexible repayment regime (dashed lines), while for higher income groups the effect abates, even reversing at the top. The portfolio share of assets invested in housing is higher with mortgage amortization, for households across the income distribution (center panel). Liquid asset holdings (right panel) are higher across the income distribution, but more so for richer households.

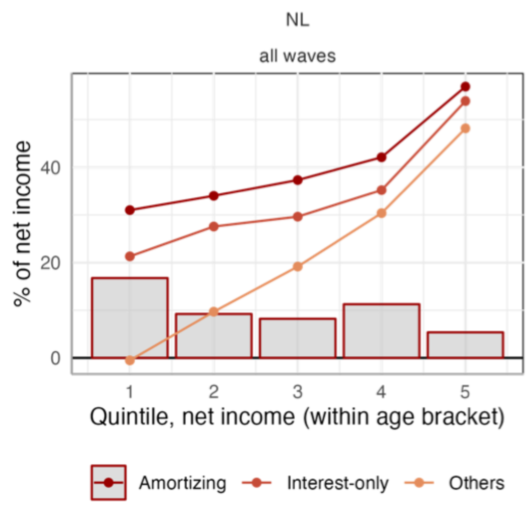
The resulting pattern shows a flattening of the saving rate gradient across income quintiles under mandatory amortization—lower-income households are "forced" to save at rates closer to those of higher-income households, reducing the typical positive correlation between income and saving rates observed in the unconstrained scenario.

Here, I look at the implications of the amortization regime for the wealth distribution, comparing outcomes across different household income and wealth groups.

Finally, Figure 12 depicts differences across income groups both in the model and in the data. In the model (left panel), I rank agents by permanent-income quintile conditioning on age, so that any variation in saving rates across quintiles is not driven by life-cycle income profiles. Again, I compare the two scenarios of mandatory amortization vs. full flexibility. Under the former scenario, households in the bottom income quintile increase their saving rates by roughly 12 percentage points relative to the flexible regime, while those in the top quintile slightly decrease their saving rate. The curve of saving rates is markedly flatter under amortization, due to the previously discussed stronger effects of mortgage-induced saving for lower income homeowners.

In the right panel, I recall a comparable picture from the HFCS data for the Netherlands, which shows a similar pattern: among households in each income quintile, amortizing mortgage holders save substantially more than those homeowners who accessed an interest-only mortgage contract (and that households without a mortgage). In the lowest quintile, for example, amortizing borrowers in the Netherlands saved 30 percent of their income on average, well above the 20% saving rate for interest-only homeowners. By contrast, in the top quintile, all three groups have high saving rates (40–50 percent). Homeowners with an amortizing mortgage still show the highest saving rates, but the difference to interest-only borrowers becomes insignificant. This mirrors the model's prediction that mandatory amortization raises saving rates more for poorer homeowners. The comparison suggests that this mechanism can, to some extent, rationalize the clear difference observed in the data.

(a) Saving rates across income quintiles in the model



(b) Weight of amortization on household net income

Figure 12: Saving rates over the income distribution – model and data

The left panel refers to the model-predicted saving rate (percentage) under mandatory (solid) vs. flexible (dashed) amortization, by income quintile (age = 50), while the right panel shows the corresponding comparison recalling the HFCS data for the Netherlands in Section 3, comparing the saving rate (percentage) across income quintiles (conditional on age), for mortgaged households with interest-only and amortizing loans, and non-mortgaged households.

5.3 Impact on the wealth distribution

Wealth distribution

The baseline model produces differences in wealth accumulation across households, depending on their initial permanent income draw and following histories over the life cycle. While this is not enough to generate a full realistic wealth distribution in the model, I can use this to measure how the different patterns in wealth accumulation over the life cycle, depending on the mortgage regime, would generate differences across households with income levels. It should be kept in mind that, at this stage, differences in wealth are more correlated with age than in the data.

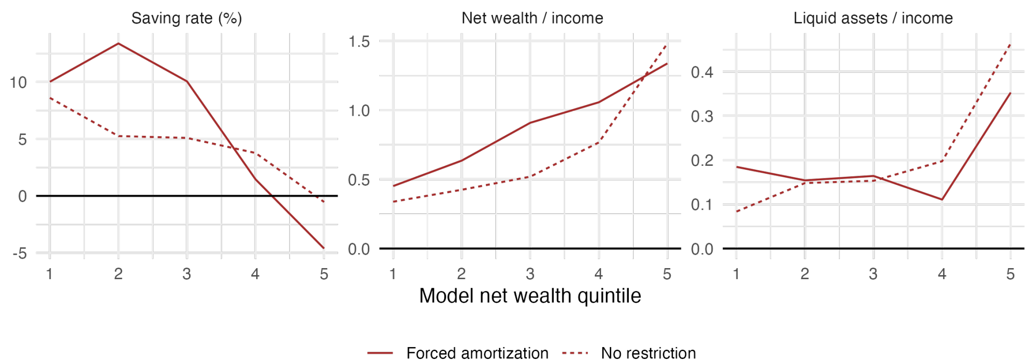


Figure 13: Saving patterns over the wealth distribution in the model

Model-predicted differences in saving and wealth accumulation across wealth quintiles under mandatory amortization (solid lines) versus flexible repayment (dashed lines). Left panel: Saving rates are higher for lower wealth quintiles under mandatory amortization but converge or reverse for higher quintiles. Center panel: Net wealth-to-income ratios show more equal distribution under mandatory amortization. Right panel: Liquid asset holdings relative to income follow a similar pattern, with mandatory amortization leading to more precautionary saving among lower wealth households.

Figure 13 examines the effects of mandatory amortization on wealth accumulation patterns for different wealth quintiles in the model. The model predicts that under mandatory amortization, wealth accumulation is more evenly distributed across wealth groups. This result is driven by the disproportionate increase in precautionary saving among lower-wealth households, who face tighter liquidity constraints and are compelled to save a significant share of their income into home equity.

Differences in overall wealth are subdued with mandatory amortization, as shown in the central panel of the Figure. These results suggest that mandatory amortization flattens wealth inequality, in the classic sense of net worth inequality, by disproportionately increasing saving rates among lower-income households. The implications for liquid wealth accumulation, and therefore for the distribution of financial wealth, are more nuanced.

Households at the bottom of the wealth distribution, who are predominantly younger, possess more financial wealth under mandatory amortization. The additional precautionary motive leads them to save more. At the other end of the wealth distribution, the situation is reversed; richer households accumulate less financial savings under mandatory amortization than they do in the unrestricted model. This suggests that the gains from the higher financial saving later in life under the unconstrained scenario are concentrated among the richest households. Overall the results suggest that, also in terms of financial wealth inequality, mandatory amortization leads to a more equal distribution.

6 Conclusion

This paper shows that the mandatory fixed amortisation schedule embedded in standard mortgages has quantitatively important implications for saving behavior, in particular for younger homeowners with lower income and wealth, and for the wealth distribution.

I first brought forth evidence suggesting that the effects of mandatory amortization on saving are stronger for poorer and younger homeowners. Using data from the HFCS, I documented previously unexplored patterns in mortgages and saving rates across Euro Area countries. Saving rates increase substantially over the income and wealth distributions, and over the life cycle. In the Euro Area, saving rates increase with income, with a less steep gradient for mortgaged homeowners, particularly those with amortizing mortgages. Across age groups, saving rates rise with age, peaking in the 50-60 age bracket, and show greater variability among non-mortgaged households. Tightly connected to the life cycle, saving rates also increase with wealth, with differences being much flatter among mortgaged homeowners.

This paper argues that fixed amortization schedules, the norm in mortgage contracts in most countries, may be an important factor driving these patterns. To explore this, I single out the case of the Netherlands, where interest-only (IO) mortgages are prevalent, in the empirical analysis. Notably, IO mortgage holders exhibit saving patterns more akin to non-mortgaged households, with lower saving rates and greater variation across groups. I take those findings as suggestive of a potential role of the amortization schedule in shaping differences in household saving behavior.

Subsequently, I use a quantitative model of consumption, saving and mortgage debt repayment to illustrate how these patterns in saving rates are consistent with a role of the amortization schedule. The key mechanism is the large precautionary saving motives faced by young households at the beginning of their life, who face mandatory amortization but also have low liquid savings. Young households, facing a restriction forcing them to save a fraction of their income into an illiquid asset (home equity), optimally save more to compensate for that restriction, building up liquid saving buffers closer to what would be optimal in their case.

The model presented in this paper demonstrates that saving rates for less affluent and younger homeowners would be markedly lower if it were less costly to deviate from the standard mortgage contract. Importantly, these results emerge from fully rational optimization under constraints and do not require any behavioral biases or information limitations, distinguishing this work from much of the recent literature on this topic. This approach allows the implications of this mechanism to be more easily integrated with state-of-the-art models of the aggregate economy.

My results have wide-ranging policy implications. Decision makers considering relaxation or tightening of mortgage lending standards must take into account that down payment requirements and amortization schedules (as well as, implicitly, maturities) have significant effects on the saving rates of homeowners. This has relevant aggregate and distributional implications – for aggregate saving, macroeconomic stability, and wealth inequality. More broadly, my results lend support to policies promoting first-time homebuyers, popular in many countries (notably in the US). The notion of the 'mortgage piggy bank' – the idea that homeownership is a powerful wealth-building device – is widely disseminated among financial advisors and the general population. However, the impact of such policies on an aggregate scale has lacked, until now, theoretical and empirical backing. This paper provides both – through indirect evidence and a clear mechanism that supports a strong effect of mortgage contract design on saving by poorer, younger homeowners.

References

Aguiar, M., M. Bils, and C. Boar (2024). Who are the hand-to-mouth? *.

Attanasio, O., A. Kovacs, P. Moran, A. Ferrero, G. Kaplan, M. Keane, H. Low, C. Meghir, B. Moll, P. Neary, C. O'dea, C. Pizinelli, A. Valentinyi, and G. Violante (2023). Temptation and commitment: A model of hand-to-mouth behavior *.

Backman, C. and N. Khorunzhina (2024, 5). Interestâonly mortgages and consumption growth: evidence from a mortgage market reform. *International Economic Review 65*, 1049–1079.

Backman, C., P. Moran, and P. van Santen (2024). Mortgage design, repayment schedules, and household borrowing. *SAFE Working Paper Series*.

Balke, K. K., M. Karlman, and K. Kinnerud (2024). Down-payment requirements: Implications for portfolio choice and consumption. Technical report.

Benhabib, J., A. Bisin, and M. Luo (2017). Earnings inequality and other determinants of wealth inequality. *American Economic Review 107*, 593–597.

Benhabib, J., A. Bisin, and M. Luo (2019). Wealth distribution and social mobility in the us: A quantitative approach. *American Economic Review 109*, 1623–1647.

Bernstein, A. and P. Koudijs (2024, 7). The mortgage piggy bank: building wealth through amortization. *The Quarterly Journal of Economics 139*, 1767–1825.

Boutros, M., N. Clara, and K. Kartashova (2024, August). The value of mortgage choice: Payment structure and contract length. SSRN Working Paper No. 5018311.

Campbell, J. Y., N. Clara, and J. F. Cocco (2021). Structuring mortgages for macroeconomic stability. *Journal of Finance*.

Campbell, J. Y. and J. F. Cocco (2015). A model of mortgage default. *The Journal of Finance 70*, 1495–1554.

Carroll, C. D. (1997). Buffer-stock saving and the life cycle/permanent income hypothesis. *The Quarterly journal of economics 112*(1), 1–55.

Carroll, C. D. and A. A. Samwick (1997, 9). The nature of precautionary wealth. *Journal of Monetary Economics 40*, 41–71.

de la Barrera, M. and T. de Silva (2024). Model-agnostic dynamic programming. *Mimeo, MIT*.

De Nardi, M. (2004). Wealth inequality and intergenerational links. *The Review of Economic Studies 71*(3), 743–768.

Duarte, V., D. Duarte, and D. Silva (2024). Machine learning for continuous-time finance. *CESifo Working Paper 10909*.

Duarte, V., J. Fonseca, A. Goodman, and J. Parker (2021). Simple allocation rules and optimal portfolio choice over the lifecycle. *NBER Working Papers 29559*.

EMF (2019). Hypostat 2019 report. *European Mortgage Federation*.

Engelhardt, G. V. and C. J. Mayer (1998, 7). Intergenerational transfers, borrowing constraints, and saving behavior: Evidence from the housing market. *Journal of Urban Economics 44*, 135–157.

EUROMOD (2020). Euromod statistics on distribution and decomposition of disposable income version no. i3.0+.

Gourinchas, P.-O. and J. A. Parker (2002). Consumption over the life cycle. *Econometrica 70*(1), 47–89.

Greenwald, D. L. (2018). The mortgage credit channel of macroeconomic transmission. *SSRN Electronic Journal*.

Guren, A. M., A. Krishnamurthy, and T. J. Mcquade (2021). Mortgage design in an equilibrium model of the housing market. *Journal of Finance 76*, 113–168.

Hubmer, J., P. Krusell, and A. A. Smith (2021). Sources of us wealth inequality: Past, present, and future. *NBER Macroeconomics Annual 35*, 391–455.

Jorda, O., K. Knoll, D. Kuvshinov, M. Schularick, and A. M. Taylor (2019). The rate of return on everything, 1870-2015. *The Quarterly Journal of Economics*, 1225–1298.

Kaplan, G. and G. L. Violante (2014). A model of the consumption response to fiscal stimulus payments. *Econometrica 82*, 1199–1239.

Kuhn, M., M. Schularick, and U. I. Steins (2020). Income and wealth inequality in america, 1949-2016. *Journal of Political Economy*.

Larsen, L. S., C. Munk, R. S. Nielsen, and J. Rangvid (2024, 3). How do interest-only mortgages affect consumption and saving over the life cycle? *Management Science 70*, 1970–1991.

Martinez-Toledano, C. (2023). House price cycles, wealth inequality and portfolio reshuffling. *Mimeo*.

Romano, C. (2017). Dutch residential mortgages: Despite recent measures vulnerabilities persist dutch residential mortgages. *Scope Ratings - Financial Institutions*, 1–7.

Slacalek, J., O. Tristani, and G. L. Violante (2020). Household balance sheet channels of monetary policy: A back of the envelope calculation for the euro area. *Journal of Economic Dynamics and Control 115*.

Tzamourani, P. (2021). The interest rate exposure of euro area households. *European Economic Review 132*.

van Horen, N. and B. Tracey (2022). Help to spend? the housing market and consumption response to relaxing the down payment constraint. *CEPR Discussion Papers*.

Vihriala, E. (2023, 11). Self-imposed liquidity constraints via voluntary debt repayment. *Journal of Financial Economics 150*.

A Saving and amortization checks

A.1 Amortization for mortgages before and after 2013

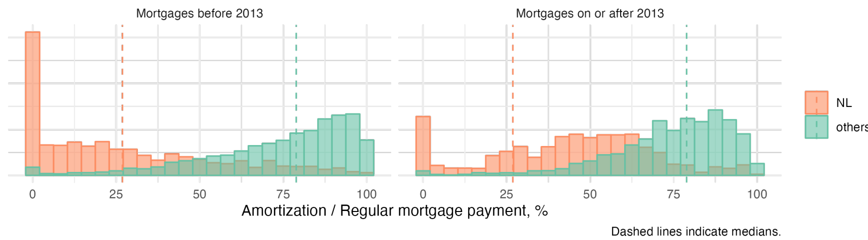


Figure 14: Distribution of amortization in the HFCS, mortgages before and after 2013

	Netherlands	Other
Mortgages before 2013	30.1	1.7
Mortgages on or after 2013	11.8	1.0

Table 6: Percentage of obs. where amortization is less than 5% of the regular payment

A.2 Amortization calculated via annuity formula

An additional check I performed is to verify that, at the household level, the amortization amounts are consistent with those implied by the standard annuity formula, given the interest rate and residual maturity of the corresponding loans. In other words, I should observe $\frac{\text{Amortization observed}}{\text{Implied repayment}} \approx 1$, where the implied repayment is given by the standard annuity formula as follows:

$$\text{Implied repayment at } t = \text{Outstanding debt} \times r \times \left(\frac{1}{1 - \frac{1}{(1+r)^{T-t}}} - 1 \right),$$

where r is the loan interest rate and T its residual maturity. This is illustrated in Figure 15 below, where I compute the ratio between the observed amortization and the amount implied by the annuity formula as above. Normally, in most countries, amortization payments increase slightly over time: monthly overall payments, rather than amortization amounts, are fixed in the terms of the loan. Therefore, other things equal, I would expect this measure to be slightly below 100% for the typical household.

The results of this exercise are shown in the histograms of Figure 16.

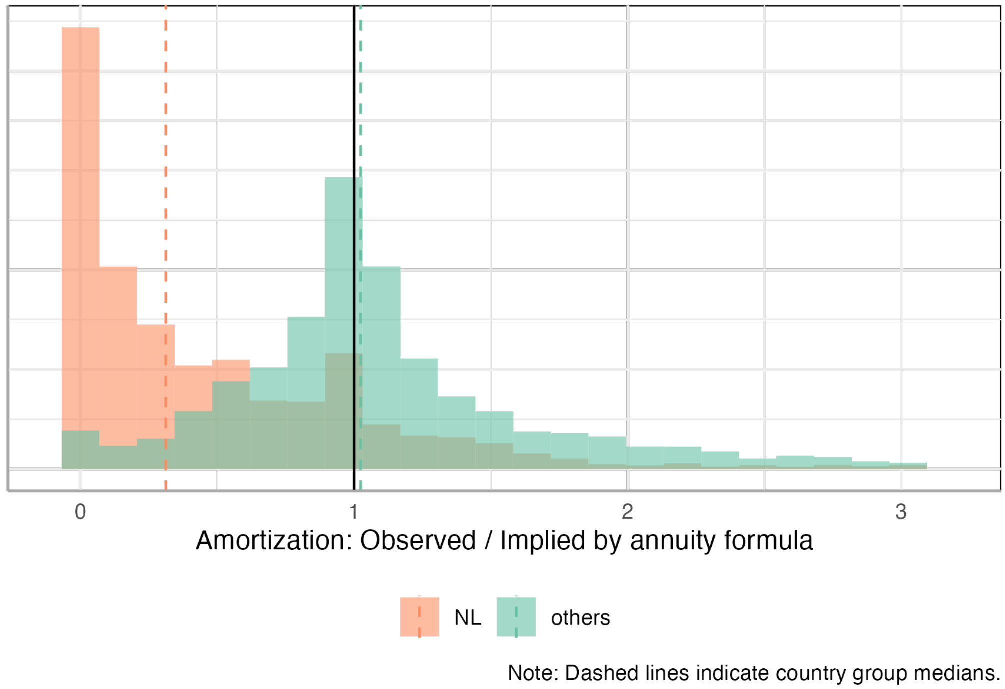
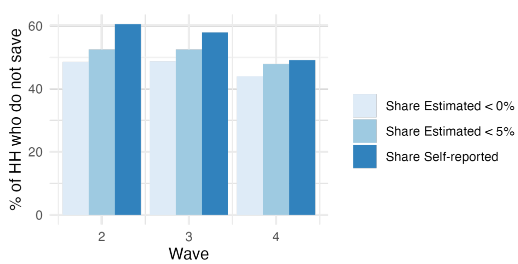
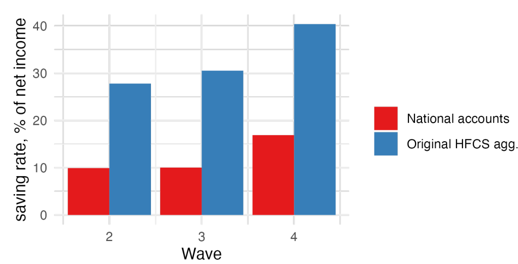


Figure 15: Histogram of the weight of amortization in regular mortgage payments, HFCS wave 3
Note: dashed lines indicate the group median. The solid line marks 100%.

A.3 Saving rates



(a) Percentage of HH who do not save under estimated saving rates and according to responses to a question on ability to save



(b) Aggregate saving rates in National Accounts and as implied by the HFCS

Figure 16: Statistics of saving rate measure compared with external benchmarks