Mortgage structure, household saving, and the wealth distribution*

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16th November 2025

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Abstract

Mortgage repayments make up 30% of household saving flows in the Euro area. Yet much of this saving is not voluntary: mandatory amortization schedules in mortgage contracts induce wealth accumulation through debt repayment, but limit consumption smoothing. I develop a life-cycle model with uninsurable income risk and illiquid housing wealth, where deviating from the mortgage repayment schedule is costly. This leads most homeowners to cut consumption and save more out of their income, but this saving is channeled into home equity, crowding out liquid savings. Consistent with the model, younger and lower-income homeowners in Euro-area data save more than renters but accumulate less liquid wealth, except in the Netherlands, where repayment is more flexible. I calibrate the model to Dutch HFCS data spanning a 2013 policy change that increased the cost of flexibility for new homebuyers, matching observed patterns of debt repayment and liquid wealth accumulation. Imposing the new rules on pre-2013 homebuyers increases the share of hand-to-mouth households by 15 percentage points, raising consumption volatility and marginal propensities to consume. Welfare losses, equivalent to 2-3% of lifetime consumption, are concentrated among lower-wealth households, who value payment flexibility most. Mandatory amortization reduces homeowners' ability to smooth consumption, amplifying financial wealth inequality.

*For their guidance and support throughout this project, I am especially thankful to João B. Duarte and Francesco Franco, as well as to Virginia Gianinazzi and Daniel L. Greenwald. For helpful conversations and suggestions I thank Ertunc Aydogdu, Alberto Bisin, Max Bondatti, Diana Bonfim, João Cocco, Marta Cota, Irem Demirci, Frincasco Di Biase, Ricardo Duque Gabriel, Miguel Ferreira, Nick Flamang, Anastasia Girshina, Luigi Guiso, Attila Gyetvai, Nick Hirschey, Sasha Indarte, Camille Landais, Clara Martínez-Toledano, Giorgia Menta, Virgiliu Midrigan, Gonzalo Paz-Pardo, Alessandra Peter, Juhana Siljander, Jirka Slacalek, João B. Sousa, Yasmine van der Straten, Inês Xavier, discussants Aditya Khemka, Randy Filer, Dubravko Mihajlek, and Swapnil Singh, as well as to participants in the Nova SBE PhD Research Group and Finance Brown Bag, at the NYU Student Macro Lunch Workshop, and at several conferences and workshops for useful comments. I gratefully acknowledge the financial support of the Portuguese Science Foundation (FCT) through PhD grant no. SFRH/BD/140788/2018, and of the 'la Caixa' Foundation's Social Research Call 2023 under the project code LCF/PR/SR23/57000006. This paper uses data from the Eurosystem Household Finance and Consumption Survey.

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1 Introduction

Mortgage repayment 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. Much of this saving is not chosen freely. In most countries, mortgage contracts include a strict repayment schedule, fixed at origination, that ensures principal is paid down regularly 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

In this paper, I show that mandatory amortization—unavoidable in most countries—forces homeowners to cut their consumption and reduce their liquid wealth buffers, especially early in the life cycle. Saving rates and total wealth increase (including debt repayments and home equity, respectively), but this comes at a cost to homeowners' welfare. Liquid wealth decreases for many households: they accumulate more wealth but hold it in illiquid home equity rather than accessible financial assets. This represents a reduced ability to self-insure against income shocks, leading to higher consumption volatility. While the distribution of total wealth is flattened, liquid wealth becomes more skewed, with the share of households living hand-to-mouth increasing substantially. While rigid amortization schedules may benefit financial stability, my results indicate they impose high costs on households, especially younger and lower-income homeowners, who are penalized by this contract structure.

Three facts explain why mandatory amortization has first-order effects on consumption, saving, and wealth accumulation. First, many homeowners are liquidity-constrained at purchase, with minimal liquid wealth relative to income. Second, mortgage payments are sizable relative to household income, so the amortization component alone typically represents 10–15% of income for young borrowers. Third, home equity, accumulated through these repayments, remains illiquid throughout the mortgage lifecycle, and deviating from the scheduled repayment is costly. This is especially the case in most European countries where, typically, home equity extraction is practically impossible or very costly. These three features combine to force substantial adjustments: homeowners must either cut consumption and liquid saving to meet mandated schedules, or bear the cost of delaying repayment.

Quantifying these effects using a model calibrated to Dutch data, I find that mandatory amortization imposes welfare costs equivalent to 2-3% of lifetime consumption, concentrated among young and lower-income homeowners. The share of hand-to-mouth households increases by 15 percentage points: homeowners save more, but they are less able to smooth consumption in the face of income shocks.

Recent empirical studies document that mandatory amortization sharply reduces consumption relative to more flexible repayment schemes (Backman and Khorunzhina, 2024; Bernstein and Koudijs, 2024; Larsen et al., 2024). This paper makes three contributions. First, I show that standard precautionary motives can rationalize the large effects found empirically, without requiring behavioral frictions. While some prior work stresses the role of bounded rationality, I demonstrate that the prevalence of binding liquidity constraints among homebuyers makes the standard channel quantitatively large. Second, for these homebuyers, mandatory amortization increases total wealth but crowds out liquid saving, impairing their ability to self-insure against income risk—an effect I show is substantial, given the low financial wealth and high expected income growth of many homebuyers. Third, I quantify the welfare costs of this contract feature and its distributional consequences: by limiting consumption smoothing, mandatory amortization penalizes younger, lower-wealth homeowners, and while it may reduce total wealth inequality through higher saving into home equity, it amplifies financial wealth inequality.

The framework is a model in which homeowners face uninsurable income risk, have illiquid housing wealth, and hold mortgage debt. Mortgages feature mandatory repayment schedules, from which deviating is costly. The mechanism operates through standard precautionary motives: fixed schedules divert cash flow into illiquid equity precisely when liquidity is most valuable. Households close to borrowing constraints 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—those for whom liquidity constraints bind most severely—and negligible for older or wealthier households. This model predicts that, relative to flexible repayment, mandatory amortization raises saving by young and lower-income mortgagors but lowers liquid wealth, increasing the share of 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 present novel evidence from the Euro-area Household Finance and Consumption Survey (HFCS) consistent with the model's predictions. Homeownership is prevalent and attained early, and recent homebuyers are tightly constrained, with low liquid wealth. Together with the observation that interest payments typically run below rent-to-income ratios, this suggests homeownership remains optimal despite binding constraints. With this in mind, I look at patterns in saving and wealth by homeowners over the life cycle and across income groups. Three stylized facts emerge from the data. First, the saving rate of mortgaged homeowners is much higher than other households' among younger and lower-income groups, while for older, richer groups, there is no difference. Second, this higher saving does not translate into higher liquid wealth, consistent with forced accumulation in illiquid home equity. Third, the burden is highly uneven: lower-income homeowners channel almost all their saving into mortgage amortization, whereas richer ones save well above required repayments.

To identify causal effects of mandatory amortization, I exploit variation in the Netherlands, the only Euro area country where more flexible mortgage repayment schemes are common.[1] The Dutch market features substantial contract heterogeneity: amortizing mortgages coexist with interest-only loans[2] and hybrid schemes. Before a policy reform in 2013, these flexible arrangements had costs similar to those of fully amortizing loans. In the data, Dutch homeowners paid down debt slowly, leaving substantial amounts to be repaid at maturity, while maintaining larger liquid buffers— resembling renters in their saving behavior. The 2013 policy reform increased the cost of delayed repayment for new homebuyers by restricting mortgage interest tax deductibility to amortizing loans. While the policy did not eliminate flexible contracts, it induced higher amortization: post-reform borrowers accelerated repayment and accumulated less liquid wealth over the first years of the loan, behaving more in line with the pattern observed in other countries.

I calibrate the model to data over a sample period that covers the 2013 policy change, exploiting heterogeneity across education groups—a proxy for permanent income—as well as the policy timing. The model matches lifecycle debt and wealth patterns separately for high- and low-education households, who differ substantially in initial conditions and income trajectories but are governed by common preference parameters. This strategy uses pre-policy cohorts (2010-2012) to identify household preferences and the baseline repayment friction, and post-policy cohorts (2014-2017) to identify the policy-induced increase in repayment costs. The sequential identification scheme exploits the policy timing while accounting for changes in initial conditions and interest rates across cohorts.

First, mandatory amortization sharply reduces liquid wealth early in the lifecycle, especially among lower-income borrowers, increasing their vulnerability to income shocks. The share of hand-to-mouth households—with liquid buffers below 1 month of income—increases by 15 percentage points. This raises consumption volatility and average MPCs among young (ages 30-40) and lower-income homeowners. The mechanism is straightforward: binding repayment schedules divert cash flow into illiquid home equity precisely when liquidity is most valuable for smoothing income shocks.

Second, despite the large drop in liquid wealth for more constrained borrowers, the average homeowner eventually accumulates more financial wealth over the lifecycle—but only after front-loading debt repayment. Over the life cycle, households under mandatory amortization eventually accumulate more of both illiquid home equity and liquid financial assets. While early-stage liquid wealth drops due to binding repayment constraints, households eventually build larger precautionary buffers to compensate. The lifecycle profile of saving changes: 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

[1] The exceptions are Germany and Austria, with lower homeownership rates and different mortgage structures, with rigid repayments that are reset at certain intervals along with interest rates. For these reasons they are excluded from the sample. A few countries outside the Euro, namely Sweden, Switzerland and the UK, also have interest-only components in their mortgage markets.

[2] An interest-only loan has a fixed maturity, at which all principal is due, and recurring payments only cover interest. See Appendix A for a more detailed explanation.

cuts in the reduced-form literature and the high saving rates observed among young, liquidity-constrained homeowners in my European data.

Third, effects are highly heterogeneous across the income and wealth distributions. Wealth-to-income ratios increase by approximately 10 percentage points for households in the bottom income quintile, while effects are negligible at the top. Lower-income households face more severe liquidity constraints and larger proportional increases in saving rates. This differential response flattens the saving rate gradient across income: mandatory amortization forces lower-income households to save substantially more, while high-income households remain largely unaffected. The model closely reproduces this flattening pattern observed in Dutch survey data, providing validation that the estimated friction correctly captures households' responses across the income distribution.

Fourth, mandatory amortization has opposing effects on wealth inequality. It compresses the distribution of total wealth through a saving rates channel, rather than the returns channel emphasized by previous literature: mandatory amortization forces lower-wealth households to save more, reducing differences in net worth. But *financial* wealth inequality increases, as constrained households hold more illiquid home equity at the expense of liquid buffers. Lower-wealth households become closer to the rich in net worth terms but are left worse off, with reduced financial resilience and consumption-smoothing capacity.

Fifth, welfare 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%). Importantly, these losses do not simply reflect the mechanical cost of the policy; they arise from distortions to consumption. The increase in the cost of underpaying leads households to: i) cut consumption early in life when marginal utility is high; ii) face higher consumption volatility from exposure to income risk due to crowding out of liquid saving. The costs are concentrated among young and lower-income homeowners, precisely those for whom liquidity constraints bind most severely and payment flexibility is most valuable.

My findings have broader implications for financial regulation and macroeconomic policy. Mandatory amortization is the norm in Europe, in part a market outcome and in part promoted by policymakers due to financial stability concerns. My findings show that potential benefits of this contract structure must be traded off against its 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 less costly. 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 help explain the large, persistent share of 'wealthy hand-to-mouth' households in many countries.

Related literature and contribution. Bernstein and Koudijs (2024) exploit the 2013 Netherlands policy reform also used in this paper, finding that the increase in amortization requirements led to a one-for-one increase in saving for the average first-time homebuyer, 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 and document strong take-up and positive effects on consumption, which are consistent with an important role for liquidity constraints. Additional evidence from Finland (Vihriala, 2023) and Sweden (Backman et al., 2024) corroborates these results. My paper shows that a standard life-cycle model with uninsurable income risk and illiquid housing wealth, disciplined by Dutch micro data, can rationalize many of these findings without invoking additional behavioral frictions. While there is evidence that behavioral biases amplify the effects of amortization, I focus on a standard precautionary-saving mechanism. I show that this mechanism plays an important role and trace out its long-run implications for wealth accumulation, its distribution, and for household welfare.

The closest study to this paper is Backman et al. (2024), who develop a lifecycle model with housing to analyze how repayment schedules affect borrowing decisions. Exploiting a Swedish reform that introduces an LTV threshold for flexible repayment, they document bunching and show that a standard model cannot replicate this pattern, in particular for unconstrained households. They augment the model with a behavioral "flow disutility" from amortization, arguing this is necessary to rationalize bunching around the threshold, and the observation that borrowers are willing to pay higher rates to avoid mandatory repayments. I take a different approach, abstracting from behavioral wedges. Instead, I ask how far a standard incomplete-markets model, augmented with illiquid housing wealth and mandatory amortization, can go once it is disciplined by rich cross-sectional moments on debt repayment, liquid wealth, and consumption. While Backman et al. (2024) calibrate their model primarily to match bunching at the LTV threshold, my model matches lifecycle and distributional patterns of debt repayment, liquid wealth, and saving across education groups in both pre- and post-2013 regimes. This strategy quantifies the precautionary mechanism they only briefly note in their analysis and maps it to hand-to-mouth shares, consumption volatility, wealth inequality, and welfare costs. The evidence suggests that mandatory amortization has first-order effects on consumption and saving through a standard precautionary-saving channel, with any behavioral biases potentially amplifying these effects.

Two recent papers follow a similar structural approach, deploying rich heterogeneous-agent life-cycle models to examine related aspects of mortgage design. Balke et al. (2024), calibrating their model to PSID/SCF data, show that tighter loan-to-value ceilings mainly shift the timing of households' saving for a downpayment, delaying the transition into homeownership.[3] Boutros et al. (2024) focus on interest-rate risk and show that a contract in which interest-rate changes affect principal repayment is welfare-improving and reduces consumption volatility. This paper isolates a different margin. I demonstrate that the amortisation schedule embedded in the mortgage is a powerful, often binding liquidity constraint for younger, lower-income homeowners, with signi-

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

ficant implications for their welfare and for consumption smoothing.

My paper also contributes to the wealth inequality literature, which identifies income inequality, return heterogeneity, and differences in saving rates as the key drivers of inequality dynamics (Benhabib et al., 2017, 2019; Hubmer et al., 2021). While prior work establishes the role of housing in return heterogeneity (Jorda et al., 2019; Kuhn et al., 2020; Martinez-Toledano, 2023), I identify a saving rate channel: amortization requirements force homeowners to save into illiquid home equity, compressing total wealth inequality. However, financial wealth inequality rises as lower-wealth households cut liquid saving. This reinforces the effects of declining long-term rates shown by Greenwald et al. (2021), which also concentrate costs on younger, lower-wealth households.

My results also relate to 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 may be influenced by this heterogeneity, given its quantitatively large role. They 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 well-established in the heterogeneous-agent macroeconomics 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., 2025). 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, highlighting the standard precautionary saving mechanism which drives the large effects of amortization requirements. Section 3 presents the data, the key facts about the 2013 policy change in the Netherlands used to identify the model, and a series of stylized facts on mortgages and saving rates, consistent with mandatory amortization pushing up saving by younger, poorer homeowners. Section 4 presents the full quantitative model, the calibration strategy, and its performance in fitting empirical moments on debt repayment and liquid wealth accumulation. In Section 5, I present the main results from the model on consumption, saving, and welfare. 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^{-}.[4] 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 heterogeneous 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.

[4] 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."

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.[5] 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.

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

[5] More precisely, 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. Because the housing stock is fixed and enters additively in utility, its marginal utility is a constant and therefore drops out of the first-order conditions for c_t, a_t, and d_t

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.[6] 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.[7]

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.

[6] 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.

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

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 Data on mortgages in the euro area and the 2013 Dutch reform

This section describes the institutional setting, data, and empirical patterns that inform my quantitative analysis. I use the European Household Finance and Consumption Survey (HFCS) to document lifecycle patterns of debt repayment and wealth accumulation among homeowners across the euro area, with particular focus on the Netherlands. The Dutch case is unique in the Euro-area context, as it exhibits substantial heterogeneity in repayment structures, ranging from pure interest-only to fully amortizing contracts. Further, a 2013 policy reform increased the costs of flexible repayment significantly, shifting the distribution of new mortgages toward mandatory amortization. I exploit this variation to discipline the structural model's calibration.

The empirical analysis here serves three purposes. First, I establish the institutional context across European mortgage markets and document how the 2013 Dutch policy change altered the prevalence of different contract types. Second, I characterize the initial conditions of Dutch first-time homebuyers and demonstrate compositional stability across the policy break—a critical requirement for interpreting the calibration as policy-driven rather than selection-driven. Third, I document lifecycle patterns of mortgage debt and wealth accumulation, revealing systematic differences between households facing varying degrees of repayment flexibility both within the Netherlands and across European mortgage markets.

3.1 Institutional setting: a policy change increasing the cost of delayed repayment

Mortgage markets across the euro area exhibit substantial institutional diversity, but share several common features relevant for household saving and consumption decisions. Homeownership rates are high, ranging from 50% to 80% depending on the country. Typically mortgage contracts have long maturities at origination, 20 to 30 years in most cases. Interest rate structures vary: some countries use long-term fixed rates, (similar to the United States), but in most cases the norm is adjustable rates or shorter fixation periods.

In terms of the repayment schedule, fully amortizing loans dominate despite rarely being legally required. Table 7 in the Appendix documents that most euro area countries do not mandate full amortization by regulation, although it is common for supervisory authorities to recommend amortization without legal enforcement. Yet as Figure 1 shows, over 80% of homeowners have mortgages that follow amortizing schedules in most euro area countries, except in the Netherlands, where only about a third does.

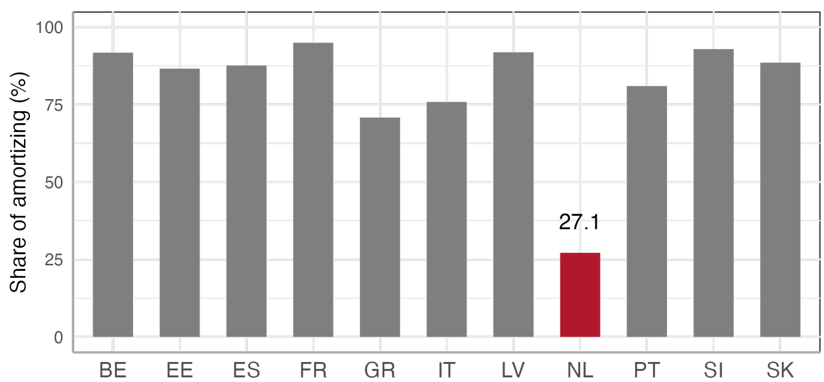


Figure 1: Share of homeowners with amortizing mortgages across euro area countries

This pattern—amortization as the norm, despite legal mandate—likely reflects a combination of factors. First, regulatory guidance and supervisory expectations create soft pressure on banks to originate amortizing loans, as these are viewed as lower-risk. Second, banks' own risk management practices favor amortization: declining loan-to-value ratios over time reduce default risk and simplify loan monitoring. Third, cultural norms and financial advice typically frame full repayment by retirement as prudent household behavior. Finally, refinancing and home equity extraction—which would allow households to undo amortization—are prohibitively costly in most euro area markets. Unlike the United States, where home equity lines of credit (HELOCs) and cash-out refinancing are common, most European countries offer limited or no such products

EMF (2019). This institutional environment makes home equity effectively illiquid once accumulated through mortgage repayment.

The result is a mortgage market where households face *de facto* mandatory amortization through contract structure and institutional frictions, even when not legally compelled. Deviating from scheduled repayment—either by refinancing to delay principal reduction or by extracting accumulated home equity—carries substantial costs.

The Netherlands: heterogeneous mortgage contracts

The Netherlands stands out as the sole euro area country where interest-only (IO) mortgages have been both legally permitted and widely used. Dutch regulation historically imposed no restrictions on mortgage contract structure. More importantly, tax policy actively encouraged IO mortgages: mortgage interest payments were fully tax-deductible with no requirement for principal repayment, making interest-only loans financially attractive for households in higher tax brackets.

However, the Dutch mortgage landscape was not a simple binary of interest-only versus fully amortizing contracts. Instead, the market exhibited substantial heterogeneity across several contract types:

- **Pure interest-only**: households pay only interest throughout the loan term, with the full principal due at maturity (typically funded through separate savings vehicles or home sale)
- **Hybrid/partial interest-only**: contracts with an initial interest-only period (e.g., 10-15 years) followed by amortization, or loans where only a fraction of the principal must be repaid
- **Linear amortization**: constant principal repayments each period, with declining interest payments and declining total payments over time
- **Annuity/fully amortizing**: standard "French loan" structure with constant total payments, rising principal component, and declining interest component

The 2013 tax reform On January 1, 2013, the Dutch government reformed the mortgage interest deduction. The key change: mortgage interest remained tax-deductible, but *only for loans with at least annuity-based (fully amortizing) repayment schedules*. Loans without scheduled principal repayment lost the tax benefit. Crucially, this was a tax policy change, not a regulatory prohibition—interest-only mortgages remained legally permissible after 2013, but lost their tax advantage.

The reform applied only to newly originated mortgages. Existing loans were grandfathered: households with interest-only mortgages originated before 2013 retained full tax deductibility. This creates a clean distinction in the data between pre-policy cohorts (2010-2012 buyers facing the old tax regime) and post-policy cohorts (2014-2017 buyers facing the new regime).

The reform did not eliminate interest-only contracts entirely—some households still chose IO despite losing the tax benefit, particularly those in lower tax brackets where the deduction was less valuable. However, the modal contract shifted decisively toward mandatory amortization.

From the perspective of the model in Section 2, the 2013 reform increased the cost parameter τ^- of deviating below scheduled repayment. Pre-2013 households choosing interest-only contracts faced low costs of flexibility (no tax penalty). Post-2013 households choosing the same contract structure would forgo substantial tax benefits, raising the effective cost. The tax change thus identifies variation in the repayment friction while holding other features of the mortgage market and broader macroeconomic environment relatively constant.

Implications for household behavior This institutional context shapes household optimization in three ways. First, the illiquidity of home equity—due to costly refinancing and limited home equity extraction products—means that mortgage repayment decisions have persistent effects on household balance sheets. Accelerated principal repayment cannot easily be reversed. Second, the heterogeneity in contract structures, particularly in the Netherlands, generates variation in the tightness of repayment constraints across households within the same housing market and time period. Third, the 2013 policy change shifted the distribution of constraints facing new homebuyers, providing identifying variation for measuring the effects of repayment rigidity.

Importantly, the Netherlands is not a textbook natural experiment with sharp treatment and control groups. Pre-2013 buyers faced a distribution of contract types with varying degrees of flexibility, and post-2013 buyers still had some IO availability. Rather than a discrete treatment, the policy change shifted the distribution of repayment frictions facing new borrowers. This continuous variation, combined with heterogeneity in household initial conditions documented in Section 3.3, disciplines the structural model's calibration in Section 4.

3.2 Data and sample construction

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.

3.2.1 Consumption and Saving

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 (≥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 2.

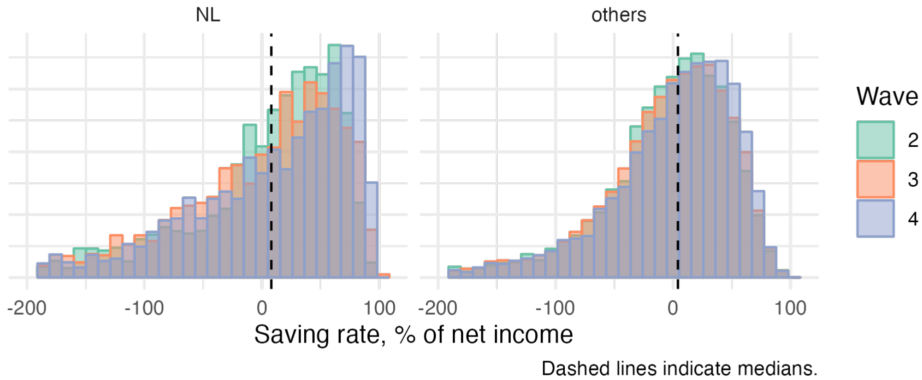


Figure 2: Distribution of saving rates, full HFCS sample, by wave

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

3.2.2 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.

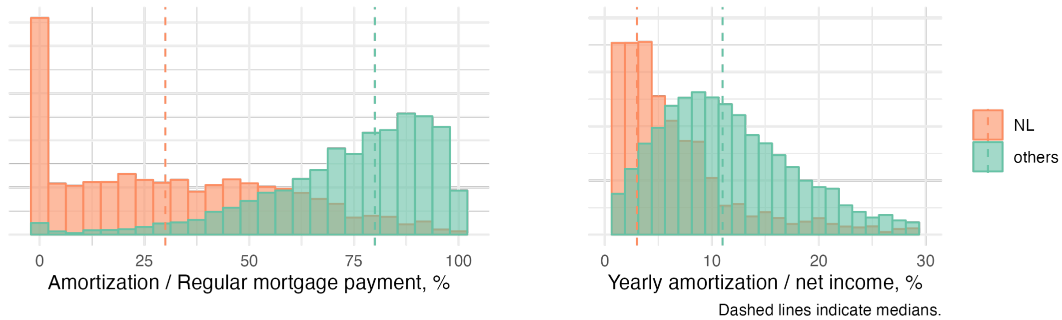
Importantly, respondents are asked to report the regular monthly payment for their current mortgage loans. Combined with other details of the loans, I can back out what is the amortization amount embedded in that monthly payment, for each surveyed household. Annual amortization for household i is given 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 20 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 3, 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 19 in Appendix).



(a) Share of regular mortgage payment going to amortization

(b) Weight of amortization on household net income

Figure 3: 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

3.3 Lifecycle Patterns: Debt Repayment and Wealth Accumulation

This section documents the central empirical patterns that motivate and discipline the structural model: how mortgage debt and wealth evolve over the homeownership lifecycle, and how these patterns differ between cohorts facing flexible versus mandatory amortization. These lifecycle profiles provide the key moments for calibration in Section 4. I focus on two dimensions of heterogeneity: cohort (pre-policy versus post-policy) and education level (a proxy for permanent income and initial wealth).

3.3.1 Debt repayment dynamics

Figure 4 shows the remaining mortgage balance as a share of the original loan amount, by years since origination. The figure displays separate profiles for pre-policy (2010-2012) and post-policy (2014-2017) cohorts, split by education level.

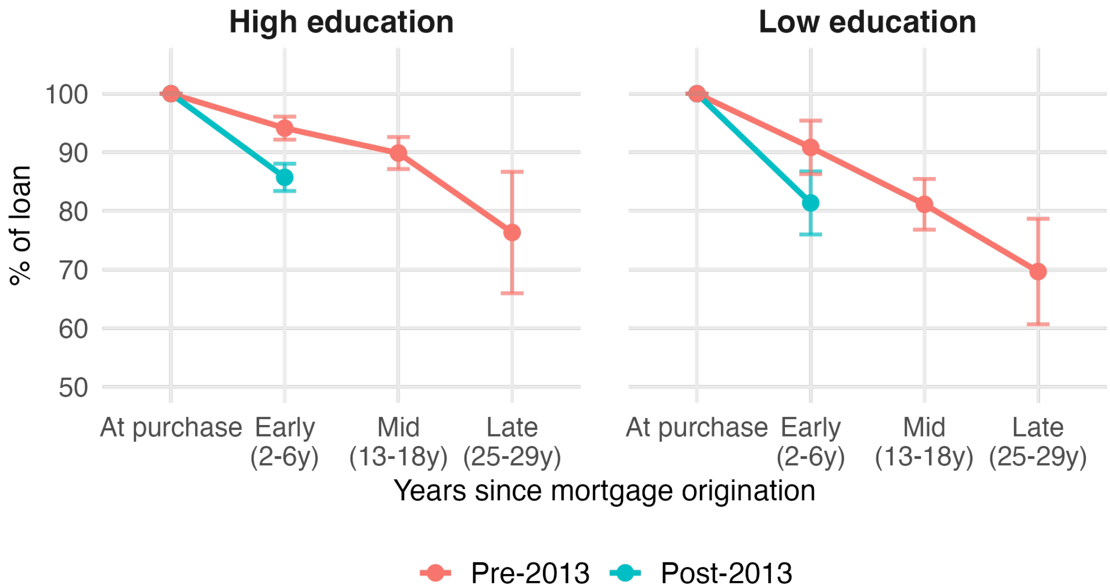


Figure 4: Outstanding mortgage balance over the lifecycle

The figure shows average remaining mortgage balance as a percentage of the original loan amount, by years since purchase. Lines show pre-policy (2010-2012 buyers) and post-policy (2014-2017 buyers) cohorts, separately for low- and high-education households. Shaded regions show 95% confidence intervals. Mortgage age is grouped into four stages: Beginning (0-2 years), Early (2-6 years), Mid (13-18 years), and Late (25-29 years).

Several patterns emerge. First, the post-policy cohort repays substantially faster in the early years of the mortgage. Within 2-6 years of origination, post-policy buyers have reduced their loan balance by approximately 10-15 percentage points more than pre-policy buyers at the same stage. This accelerated early repayment directly reflects the 2013 policy change: losing tax deductibility for interest-only contracts made flexible repayment schedules costly, pushing households toward mandatory amortization.

Second, this gap narrows later in the lifecycle. By the mid-stage (13-18 years), differences between cohorts become smaller, and by the late stage (25-29 years), remaining balances are similar. This convergence suggests that the policy primarily affects the *timing* of repayment rather than total lifetime repayment. Pre-policy households with more flexible contracts delayed repayment early but eventually reduced debt as they approached maturity or retirement.

Third, education-level heterogeneity is modest but systematic. High-education households—who have higher permanent income and typically start with more wealth— repay slightly faster than low-education households in the early stages. However, both groups show the same qualitative response to the policy: faster repayment post-2013, with gaps narrowing over time.

These patterns provide key calibration targets. All debt moments—early-stage and late-stage, for both cohorts and both education groups—are targeted in the calibration. The early-stage debt profiles for the post-policy cohort are particularly important for identifying the policy friction parameter τ^{post}, as these households faced the tightened tax treatment from origination.

3.3.2 Liquid wealth accumulation

Figure 5 shows liquid financial wealth as a ratio of annual income, by years since mortgage origination, again comparing cohorts and education levels.

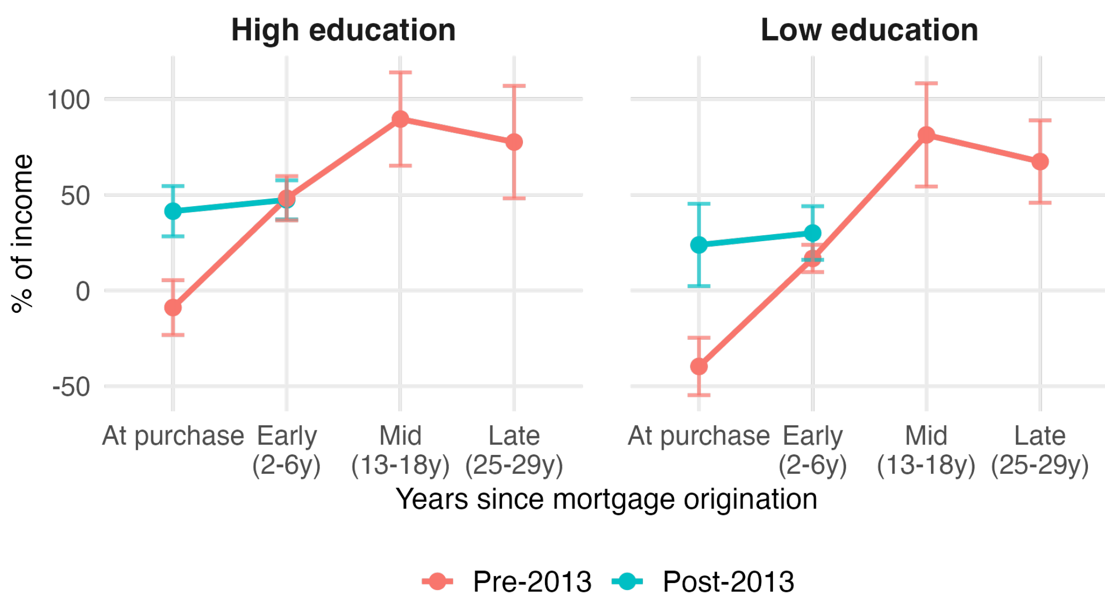


Figure 5: Liquid wealth accumulation over the lifecycle

The figure shows average liquid financial wealth (deposits, bonds, stocks) as a ratio of annual disposable income, by years since purchase. Lines and shading as in Figure 4. Liquid wealth includes all financial assets except illiquid instruments such as life insurance and pension accounts.

The liquid wealth patterns reveal the other side of the mandatory amortization trade-off. While post-policy cohorts accumulate total wealth faster (due to forced mortgage repayment), they hold *less* liquid wealth, particularly in the early and middle stages of the mortgage lifecycle. This gap is economically substantial: at the early stage, post-policy households hold approximately 0.5-1.0 fewer years of income in liquid form compared to pre-policy households.

This finding is central to the paper's mechanism. Mandatory amortization shifts household portfolios from liquid financial assets toward illiquid home equity. For households facing income risk, this compositional shift has real consequences: lower liquid buffers mean reduced capacity to smooth consumption in response to adverse shocks, even when total wealth is higher. Section 5 quantifies these effects through hand-to-mouth rates, marginal propensities to consume, and welfare costs.

Education-level heterogeneity in liquid wealth is more pronounced than for debt. High-education households accumulate substantially larger liquid buffers than low-education households at all stages, reflecting both higher income and stronger precautionary motives. Importantly, however, both groups show the same qualitative response to the policy: lower liquid wealth post-2013 despite accelerated debt repayment.

The calibration strategy targets late-stage liquid wealth for the pre-policy cohort only. Early-stage liquid wealth for the post-policy cohort is *not targeted*, allowing it to serve as a validation moment: if the model matches this untargeted pattern, it provides evidence that the estimated friction and preferences correctly capture household behavior under mandatory amortization.

Taken together, Figures 4 and 5 document the core empirical patterns that the model must explain: faster debt repayment but lower liquidity under mandatory amortization, with effects concentrated in the early lifecycle when households are most constrained. The next section verifies that the composition of homebuyers remained stable across the policy break, ensuring these patterns reflect policy effects rather than selection.

3.4 First-time homebuyers before and after the policy

A critical requirement for interpreting the calibration strategy as identifying policy effects—rather than selection effects—is that the composition of first-time homebuyers remained stable across the 2013 policy break. If households who purchased after 2013 were systematically different from those who purchased before— more patient, better planners, wealthier—then observed differences in debt and wealth accumulation could reflect selection rather than the tightening of repayment requirements. This section documents that household characteristics at purchase are remarkably stable across cohorts, while the macroeconomic environment—particularly interest rates—changed substantially.

Table 4 presents initial conditions for first-time homebuyers in the pre-policy (2010-2012) and post-policy (2014-2017) cohorts. The table pools across education types, weighting by sample composition.

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

Table 4: Initial conditions of first-time homebuyers, by cohort

Several patterns emerge. First, household demographics are essentially unchanged: the average age at purchase is 32 in both cohorts, and the share with high education rises only modestly from 69% to 74%. Second, leverage at origination remains high in both periods, with loan-to-value ratios around 100-105%, close to regulatory maximums. Third, both cohorts enter homeownership with thin liquid buffers—negative in the pre-cohort, modestly positive in the post-cohort—reflecting the fact that first-time buyers concentrate available resources into down payments.

The stability of these household characteristics contrasts sharply with the change in the macroeconomic environment. Mortgage interest rates fell from 4.6% to 2.4% between the pre- and post-policy periods, reflecting the general decline in euro area interest rates over this period. This rate decline was exogenous to individual household decisions and unrelated to the 2013 tax reform, which affected contract structure rather than pricing.

The modest increase in liquid wealth at purchase (from -0.13 to 0.31 times annual income) and the decline in house price relative to income likely reflect broader macroeconomic conditions—tighter lending standards following the financial crisis, improved labor market conditions for young workers—rather than selection into homeownership around the policy change. Importantly, both cohorts remain highly leveraged with limited liquid resources, the key initial conditions that determine exposure to binding repayment constraints.

This compositional stability is critical for the identification strategy in Section 4. The sequential calibration approach uses the pre-policy cohort to identify household preferences and the baseline repayment friction, then uses the post-policy cohort to identify the policy-induced friction, holding preferences fixed. This strategy is valid only if preferences are stable across cohorts—a maintained assumption supported by the stability in observable household characteristics documented here. The main difference between cohorts is the cost of flexible repayment (the tax treatment of interest-only mortgages), not the types of households entering homeownership.

One remaining concern is selection on unobservables: perhaps more patient or better-informed households selected into homeownership after 2013, anticipating the need to meet mandatory amortization schedules. While I cannot rule this out definitively, the stability of observable characteristics—including leverage, which would likely differ if patience varied—suggests selection on unobservables is limited. Moreover, the 2013 reform was widely anticipated and grandfathered existing contracts, reducing incentives for strategic timing of home purchase.

3.5 Heterogeneity

3.5.1 Liquidity constraints

The rich information in the HFCS on households' balance sheets and income allows us to clearly identify liquidity constrained households. I adapt the definitions of hand-to-mouth households proposed by Kaplan and Violante (2014) to the HFCS data, sorting households as follows:

- **Hand-to-mouth households** verify one of the following two conditions: i. $0 <$ Liquid wealth ≤ 1 month of net income or ii. Liquid wealth < -1 month of net income. The latter comes from assuming that, for households using short-term personal credit, their liquidity constraint (credit limit) is equal to one month of net income. These households are further sorted into:
  - **Poor hand-to-mouth**: illiquid wealth ≤ 0. Most of these households have zero illiquid assets. (However, a few households with "underwater" mortgages, i.e. the value of their mortgage liabilities exceeds that of housing assets, are also included.)
  - **Wealthy hand-to-mouth:** illiquid wealth > 0. Most of these households own real estate

and may have a mortgage loan. (However, a few households with no housing assets and some business wealth or life insurance assets are also included here.)

- **Non hand-to-mouth**

Figure 6 displays the result of this sorting, showing the estimated share of poor and wealthy hand-to-mouth in the population, respectively in the left and right-hand panels, by country group. The colours inside the bars indicate the composition of hand-to-mouth households by their membership to overall (country-level) net income quintiles.

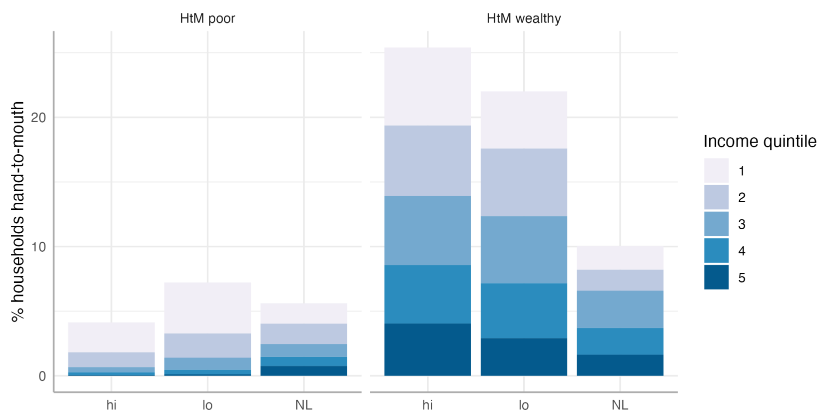


Figure 6: Share of poor and wealthy hand-to-mouth households over the income distribution, HFCS wave 3

As reported in previous studies, the share of liquidity-constrained households in euro area countries is quite high by this measure; around 30%. The Netherlands show a striking difference, with a much lower share of *wealthy* hand-to-mouth, less than half than observed in other countries, while the share of poor hand-to-mouth is on par with other countries.

3.5.2 Consumption and saving

Figure 7 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.

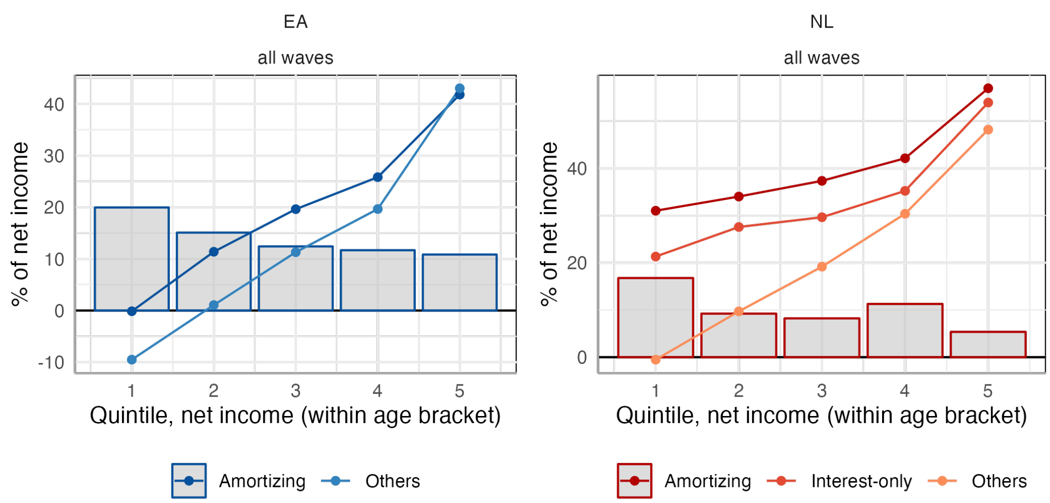


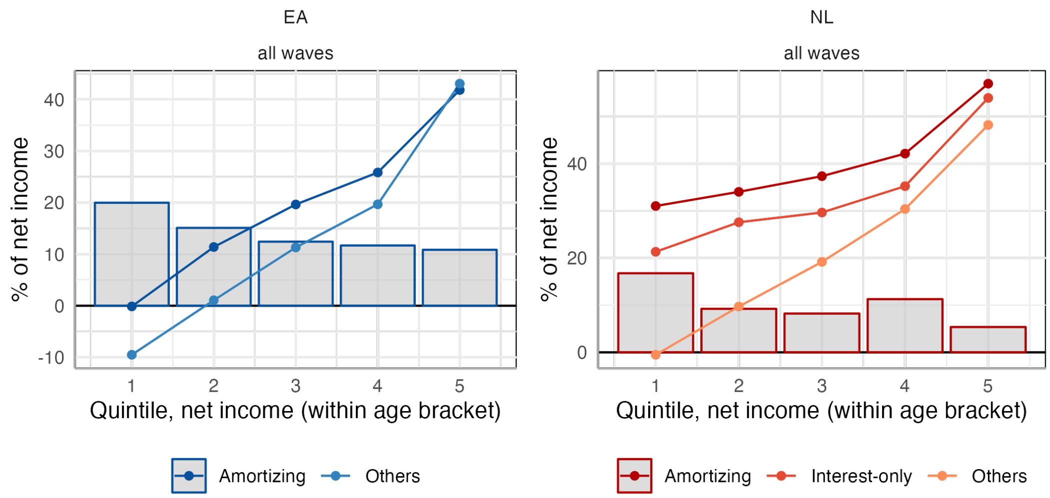
Figure 7: Saving rates over the income distribution

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.

3.5.3 Saving rates among mortgaged homeowners and other households

Over the income distribution Figure 8 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.



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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.

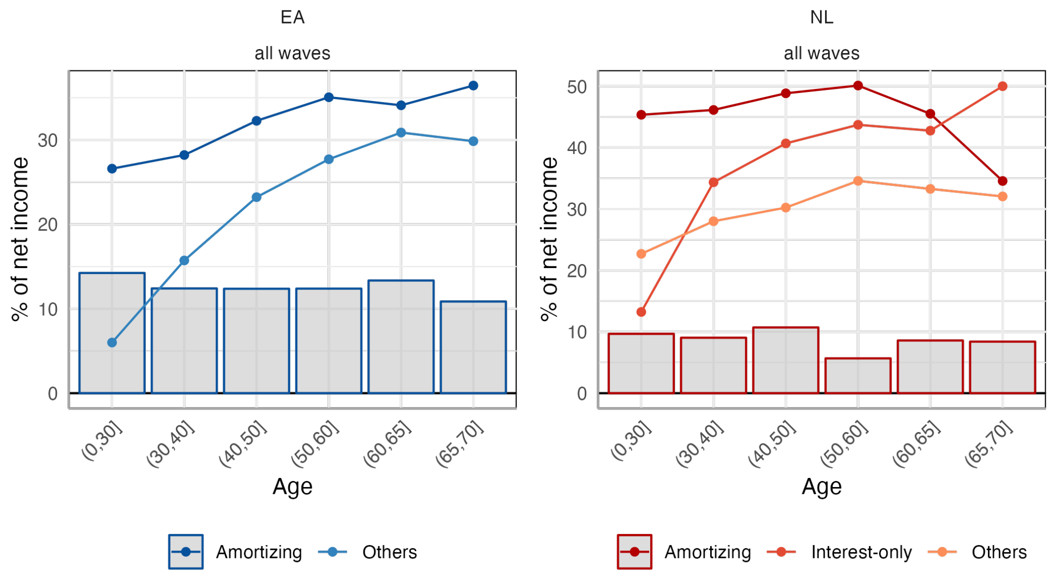

Figure 9: Saving rates over the life cycle

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.

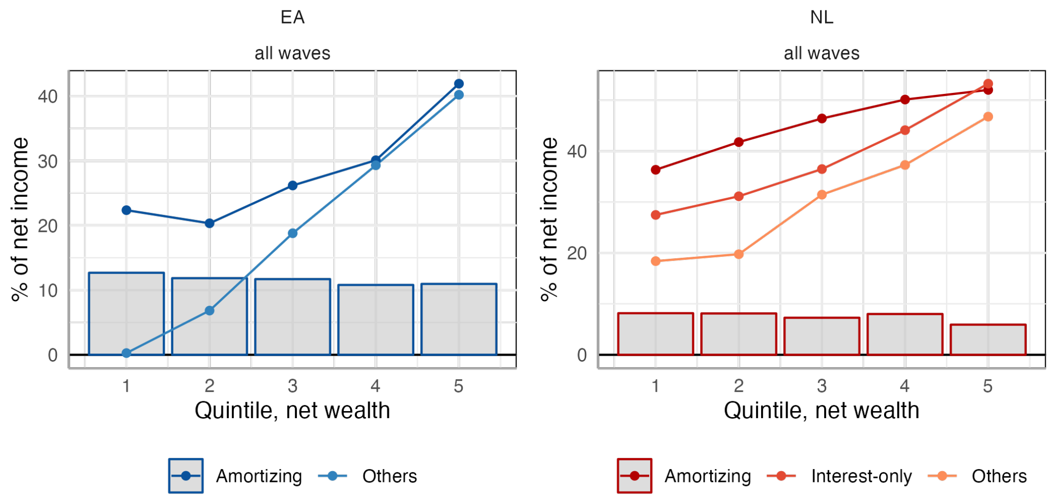

Figure 10: Saving rates over the wealth distribution

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.

3.5.4 Refinancing rates and accessibility

A key question for understanding the binding nature of amortization schedules is whether households can refinance their way out of rigid contracts. If refinancing were cheap and accessible, mandatory amortization would impose limited costs— households could simply refinance into more flexible terms when constraints bind. Figure 11 documents refinancing patterns across the income distribution, showing that refinancing is both limited in magnitude and income-dependent.

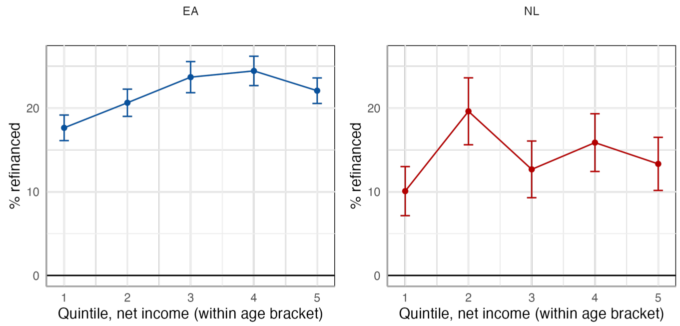

Figure 11: Share of mortgaged homeowners who have ever refinanced, by income quintile

The figure shows the percentage of mortgaged homeowners (excluding recent buyers with mortgages less than 2 years old) who report having refinanced at least once. Income quintiles are computed within age brackets. Left panel: Euro area excluding Germany and Austria. Right panel: Netherlands. Error bars show 95% confidence intervals.

In the euro area, refinancing rates exhibit a clear income gradient. Among mortgaged homeowners in the bottom income quintile, 17% have ever refinanced, compared to 20-23% in higher quintiles. While this gradient demonstrates that refinancing accessibility varies with income—consistent with liquidity and equity constraints—the more striking pattern is that refinancing remains rare in absolute terms. Even among high-income households, fewer than one in four have ever refinanced despite holding mortgages for a median of 10-15 years. This suggests that refinancing costs are substantial enough to deter most households from using it as a mechanism to escape rigid amortization schedules.

The Netherlands shows broadly similar patterns, though with greater noise likely reflecting smaller sample sizes. Refinancing rates range from 10-20% across the income distribution, with no clear monotonic relationship. The key takeaway remains: the vast majority of households—across all income levels—never refinance, even in the Netherlands where mortgage markets are relatively flexible by European standards.

These patterns validate a central assumption of the structural model: refinancing is not a costless escape valve from mandatory amortization. For constrained households—those most affected by rigid repayment schedules—refinancing is both less accessible (due to equity and income constraints) and more necessary (due to binding liquidity constraints). The fact that 80% of households never refinance despite the potential to reduce payment burdens or extract equity suggests that transaction costs are substantial. This institutional reality motivates the repayment friction parameter τ in the model and justifies the high-τ counterfactual analysis in Section 6 for countries with even more rigid mortgage markets.

4 Quantitative model and calibration strategy

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) lifecycle 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 ≤ 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 5 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	Standard maturity	HFCS and Hypostat (2019)
Risk aversion coeff., consumption (γ)	5	-	Duarte et al. (2020)
Bequest motive parameters ($\underline{b}$)	0.5	Reservation level for 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)	0.0331	Long-run real safe rate	Jorda et al (2020)
Borrowing limit, liquid (θ^A)	-1.05	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 5: Misc. externally calibrated parameter values

4.3 Model fit and parameter estimates

4.3.1 Estimated parameters

Table 6 reports the estimated parameters from the sequential calibration procedure.

Parameter	Estimate	Interpretation	Mainly identified by
β	0.987	Standard discount factor (patience)	Life-cycle wealth accumulation
b_0	3.9	Value of liquid wealth post-retirement	Terminal wealth before retirement
τ^{pre}	0.01	Pre-policy repayment friction	Baseline repayment dynamics
τ^{post}	0.665	Post-policy repayment friction	Policy effect on repayment

Table 6: Estimated parameter values

The estimated parameters are economically reasonable. The discount factor $\beta = 0.987$ corresponds to standard estimates of annual patience in lifecycle models. The bequest motive parameter $b_0 = 3.9$ implies that households value liquid wealth after mortgage retirement at roughly 3.9 times their flow consumption, consistent with precautionary saving motives extending into retirement and generating terminal wealth-to-income ratios around 1.5-2.0.

The repayment friction parameters reveal the magnitude of the policy effect. Pre-2013, the transaction cost $\tau^{\text{pre}} = 0.01$ implies nearly frictionless flexibility in repayment timing—households faced minimal penalty for delaying repayment, consistent with the widespread availability of interest-only mortgages and the observed pattern of slow amortization. The post-2013 estimate $\tau^{\text{post}} = 0.665$ indicates a dramatic tightening: delaying repayment now carries an effective penalty of 66.5% of the scheduled payment amount. This large increase $\Delta\tau \approx 0.665$ reflects both the direct tax penalty introduced by the policy and the shift in mortgage product offerings toward mandatory amortization schedules.

The policy effect is particularly striking given that mortgage interest rates fell sharply between the two periods—from 4.5% to 2.4%—moving below liquid asset returns for many households. In the absence of the policy change, this rate environment would have further incentivized slow repayment and portfolio tilting toward liquid assets. The fact that we instead observe accelerated debt repayment post-2013 allows the model to identify a substantial friction increase: the calibrated $\Delta\tau$ must be large enough to overcome the interest rate spread reversal and still generate faster debt reduction.

4.3.2 Model fit: debt repayment dynamics

Figure 12 compares model predictions to data for remaining mortgage balance over the lifecycle, separately for pre- and post-policy cohorts and by education level.

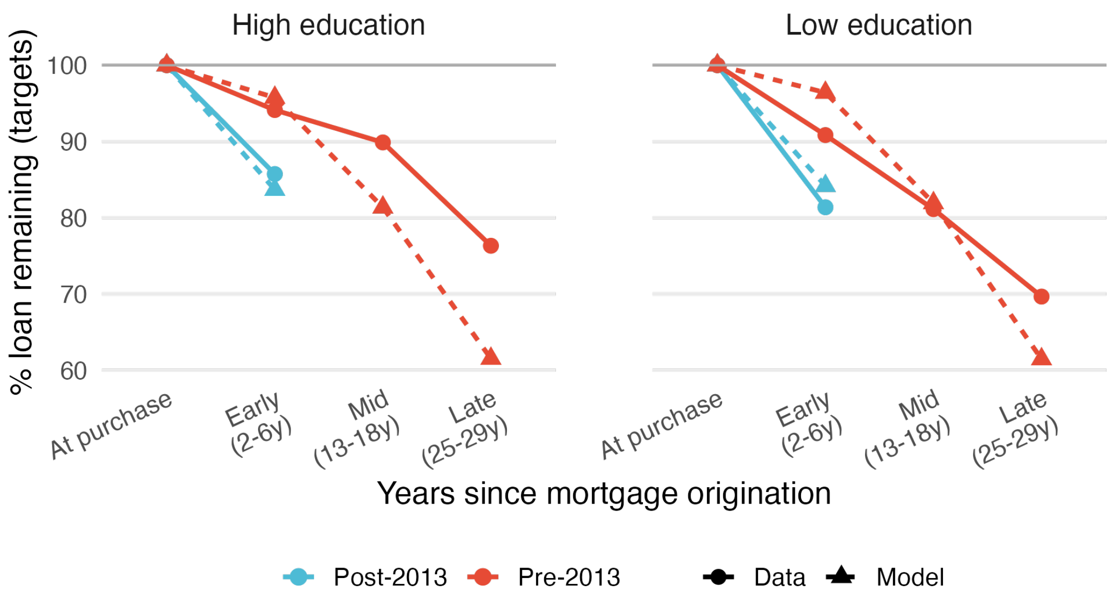

Figure 12: Model fit: debt repayment over the lifecycle

The figure shows model-predicted (lines) versus data (points with confidence intervals) for remaining mortgage balance as a percentage of the original loan amount. All debt moments shown are calibration targets.

The model successfully captures the key policy effect on debt dynamics. Pre-2013, households retained approximately 98-100% of their initial mortgage balance in the early stage (2-6 years after origination), with only modest amortization occurring later in the lifecycle. This pattern reflects the low friction environment where interest-only and flexible contracts were common. Post-2013, the model matches the sharp acceleration in early-stage repayment: outstanding debt falls to roughly 90% of the initial balance within the early stage for both education groups, despite mortgage rates falling from 4.5% to 2.4%. This represents the central identifying moment for the change in repayment frictions ($\Delta\tau = \tau^{\text{post}} - \tau^{\text{pre}}$).

The model also captures the convergence of debt profiles later in the lifecycle. By the late stage (25-29 years), both cohorts have paid down substantial portions of their mortgages, and differences between pre- and post-policy households narrow. This convergence reflects two forces: pre-policy households eventually increase repayment as they approach maturity or retirement, while post-policy households who repaid aggressively early face smaller remaining balances and lower required payments. Both education groups exhibit similar patterns, with higher-education households repaying slightly faster throughout, reflecting their higher income trajectories.

4.3.3 Model fit: liquid wealth accumulation

Figure 13 shows the model's fit to liquid wealth accumulation patterns, again comparing across cohorts and education levels.

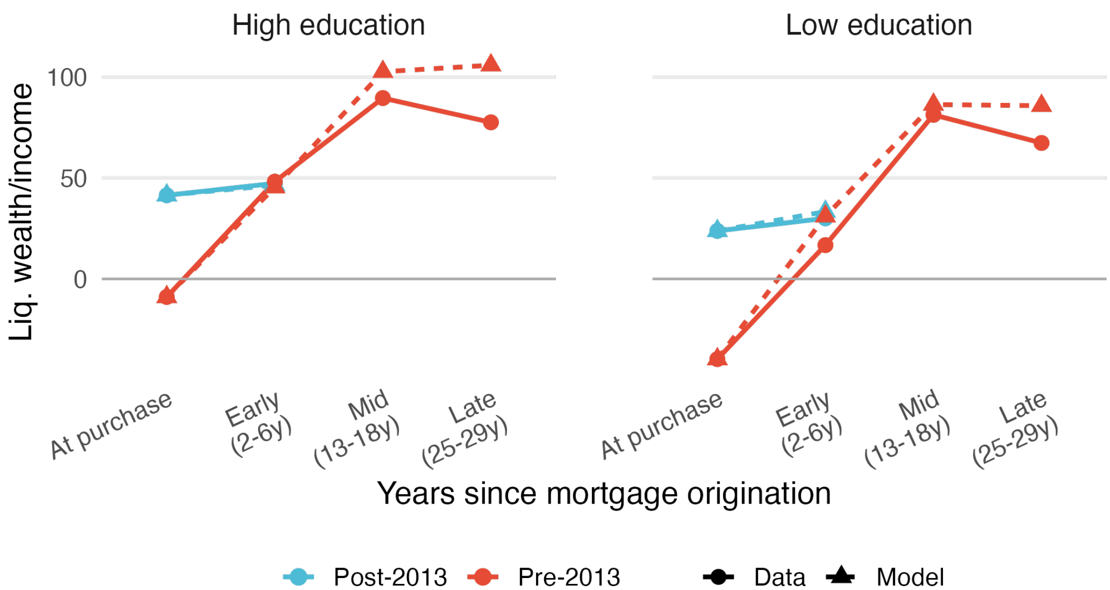

Figure 13: Model fit: liquid wealth over the lifecycle

The figure shows model-predicted (lines) versus data (points with confidence intervals) for liquid financial wealth as a ratio of annual income. Pre-2013 late-stage liquid wealth is a calibration target; post-2013 early-stage liquid wealth is NOT targeted and serves as a validation moment.

For liquid wealth, the calibration targets are late-stage wealth for the pre-policy cohort, which identify the bequest motive strength. The model matches these targets well: both data and model show households accumulating liquid wealth to approximately 0.5-1.0 times annual income by the late mortgage stage (25-30 years). Higher-education households accumulate substantially more, reflecting both higher permanent income and stronger precautionary motives, and the model captures this heterogeneity.

Critically, post-2013 early-stage liquid wealth is *not* a calibration target—it serves as a validation moment to test whether the model correctly predicts household responses to mandatory amortization. The model successfully predicts that post-2013 households hold higher liquid wealth in the early stage compared to pre-2013 households, despite facing tighter repayment requirements. This pattern emerges endogenously from two forces in the model. First, post-2013 initial conditions feature higher liquid wealth at purchase (documented in Section 3.4). Second, facing binding amortization constraints, households increase precautionary liquid saving to buffer against future states where constraints might bind even more severely. The model's ability to match this untargeted pattern—without being explicitly calibrated to it—provides strong evidence that the estimated friction and preferences correctly capture household behavior under rigid repayment schedules.

The model also captures the lifecycle trajectory of liquid wealth accumulation, though with some compression of the range. Pre-2013 households show negative or near-zero liquid wealth early in the mortgage, consistent with concentrating resources into down payments and meeting early financial obligations. Wealth accumulates gradually over the lifecycle as income rises and mortgage balances decline, reaching substantial positive levels late in the mortgage. The model replicates this trajectory for both education groups, with higher-education households maintaining consistently larger buffers throughout.

5 Consumption, saving and welfare under rigid repayment schedules

This section presents the main quantitative results. I show how mandatory amortization affects household behavior over the life cycle and across the income and wealth distributions, with particular focus on consumption, liquid wealth accumulation, and exposure to income risk. The key findings are threefold. First, constrained households cut consumption substantially, especially early in life, to meet mandatory payment schedules. Second, the effects are highly heterogeneous: lower-income households increase total saving but reduce liquid buffers, raising their exposure to income shocks. Third, these portfolio shifts generate opposing effects on wealth inequality—compressing the total wealth distribution while widening financial wealth inequality and increasing the prevalence of hand-to-mouth households.

5.1 Consumption and saving over the life cycle

Figure 14 shows average life-cycle profiles of consumption and saving rates under flexible repayment (dashed lines) versus mandatory amortization (solid lines). The left panel displays consumption normalized by initial permanent income; the right panel shows saving rates.

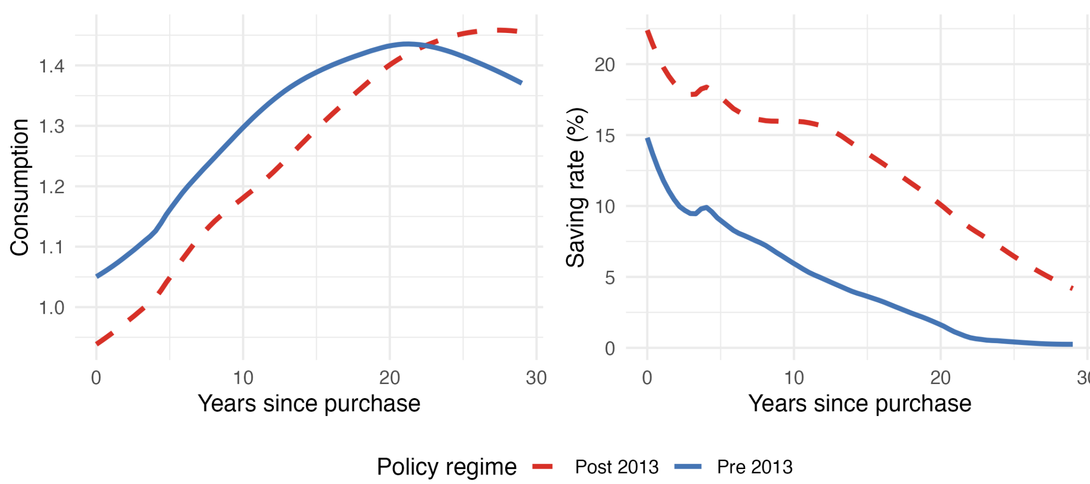

Figure 14: Consumption and saving over the life cycle

The figure shows model-predicted consumption (left panel) and saving rates (right panel) over the life cycle. Dashed lines: flexible repayment. Solid lines: mandatory amortization. Consumption is expressed as a ratio to initial permanent income.

Under flexible repayment (pre-2013, solid blue), consumption rises smoothly over the lifecycle as income grows and mortgage burdens decline. Mandatory amortization (post-2013, dashed red) disrupts this path. Households cut consumption early—by approximately 10% in the first years after purchase—to meet scheduled payments while maintaining minimal liquid buffers. Consumption remains depressed relative to the pre-policy path through the first 15 years of the mortgage. Beyond year 20, the pattern reverses: post-policy consumption exceeds pre-policy levels. This reflects the fact that households under flexible repayment must reduce consumption late in life to prepare for large balloon payments at maturity, while those under mandatory amortization have already paid down their mortgages and do not have that incentive.

The saving rate profile (right panel) mirrors these consumption dynamics. Under mandatory amortization, households save close to 20% of income in the early years—around 8 percentage points higher than under flexible contracts—driven by the combination of forced mortgage repayment and increased precautionary liquid saving. The saving rate declines more gradually under mandatory amortization than under flexible repayment, with the gap persisting throughout most of the mortgage lifecycle.

These life-cycle patterns reflect the mechanism described in Section 2. Mandatory schedules divert cash flow into illiquid home equity precisely when liquidity is most valuable—early in life when income is low, leverage is high, and income risk is substantial. Anticipating future binding constraints, even unconstrained households increase precautionary liquid buffers. The consumption cost is persistent: unlike a one-time down payment requirement, mandatory amortization binds repeatedly over decades.

5.2 Heterogeneity across the income distribution

The effects of mandatory amortization vary sharply across the income distribution. Figure 15 displays saving rates, net wealth, and liquid wealth by permanent income quintile (computed within age groups to remove life-cycle effects).

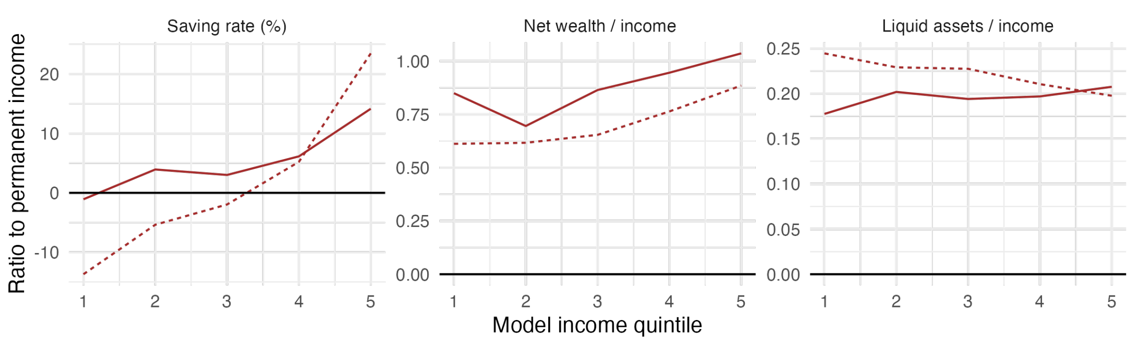

Figure 15: Saving and wealth accumulation by income quintile

The figure shows model predictions across permanent income quintiles, conditioning on age to remove life-cycle effects. Left panel: Saving rates. Center panel: Net wealth (including home equity) relative to income. Right panel: Liquid financial wealth relative to income. Dashed lines: flexible repayment. Solid lines: mandatory amortization.

The left panel shows that mandatory amortization fundamentally reshapes the income-saving gradient. Under flexible contracts, saving rates rise steeply with income—from 22% in the bottom quintile to 42% in the top—reflecting standard mechanisms: higher permanent income, stronger bequest motives, and lower marginal utility of consumption. Mandatory amortization flattens this gradient dramatically. Bottom-quintile households increase saving rates by 12 percentage points (from 22% to 34%), while top-quintile households show essentially no response or slight declines. The resulting pattern is nearly flat: saving rates range from 34-38% across quintiles under mandatory amortization, compared to 22-42% under flexible contracts.

This heterogeneity reflects differential exposure to binding constraints. Lower-income households face high payment-to-income ratios (20-25% of gross income) and thin liquid buffers, making the mandatory schedule a binding constraint in many states. Meeting scheduled payments requires cutting consumption and increasing liquid saving simultaneously—both margins of adjustment. Higher-income households can more easily accommodate scheduled payments from cash flow, treating them as a portfolio allocation rather than a binding constraint. For these households, mandatory amortization shifts wealth composition (more home equity, less liquid assets) but has limited effects on consumption or total saving.

The center and right panels examine wealth accumulation. Net wealth—including home equity net of mortgage debt—increases most for lower-income households under mandatory amortization, rising by roughly 10 percentage points of income for the bottom quintile while remaining nearly unchanged for the top quintile. This compression of the total wealth distribution reflects the forced saving through mortgage repayment, which disproportionately affects lower-income households who would otherwise repay more slowly.

However, liquid wealth tells a different story. The right panel shows that liquid financial assets increase under mandatory amortization for all income groups, reflecting heightened precautionary motives. But the increase is roughly uniform across quintiles in percentage-point terms (approximately 15-20 percentage points of income), rather than concentrated among constrained households. This pattern emerges because lower-income households face binding constraints more frequently, limiting their ability to accumulate liquid buffers even when incentives to do so strengthen. Higher-income households, facing binding constraints less often, can more fully respond to increased precautionary motives by accumulating larger liquid balances.

5.3 Hand-to-mouth households and exposure to income risk

The portfolio shifts induced by mandatory amortization—higher home equity, modestly higher liquid wealth—have important implications for household exposure to income shocks. Figure 16 shows the share of hand-to-mouth households by income quintile, defined following Kaplan and Violante (2014) as households with liquid wealth below one month of income despite positive net worth.

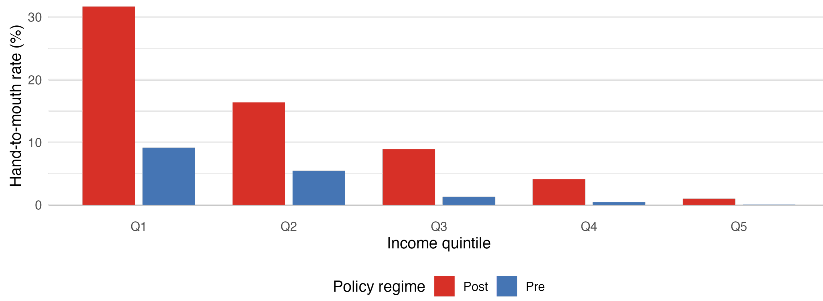

Figure 16: Hand-to-mouth rates by income quintile

The figure shows the share of wealthy hand-to-mouth households—those with substantial net worth but minimal liquid buffers—by permanent income quintile. Mandatory amortization (solid line) increases hand-to-mouth prevalence substantially, particularly among lower-income households.

Mandatory amortization increases hand-to-mouth prevalence dramatically. Under flexible contracts, 15-25% of households hold minimal liquid wealth, with slightly higher rates among lower-income groups. Under mandatory amortization, hand-to-mouth shares rise to 30-40% for the bottom three income quintiles—an increase of roughly 15 percentage points. Even in the top quintile, where the consumption and saving effects are minimal, hand-to-mouth prevalence rises from 15% to 22%.

These elevated hand-to-mouth shares reflect the fundamental trade-off mandatory amortization imposes. Households accumulate more total wealth—net worth increases by 10-15 percentage points of income for lower-income groups—but this wealth is concentrated in illiquid home equity. Despite stronger precautionary motives driving increased liquid saving, many households cannot build sufficient buffers while simultaneously meeting mandatory payment schedules. The result is a population with higher net worth but lower capacity to smooth consumption in response to transitory income shocks.

The welfare implications are substantial. Hand-to-mouth households exhibit marginal propensities to consume from transitory income shocks of 0.4-0.6 in the model, compared to 0.1-0.2 for households with adequate liquid buffers. Consumption volatility—measured as the standard deviation of consumption growth—rises by 30-40% for lower-income households under mandatory amortization. These effects operate through pure liquidity constraints: households with identical preferences, income processes, and net worth exhibit higher MPCs and consumption volatility when forced to hold wealth in illiquid form.

5.4 Welfare costs

Table 7 quantifies the welfare costs of mandatory amortization using consumption-equivalent variation: the permanent percentage increase in consumption under the policy that would restore households to their pre-policy expected utility.

Education level	Median CEV (%)	Mean CEV (%)
Low education	-2.82	-3.15
High education	-2.13	-2.47
All households	-2.41	-2.76

Table 7: Welfare costs of mandatory amortization

The table reports consumption-equivalent variation (CEV) measuring welfare losses from mandatory amortization. Negative values indicate households would require permanent consumption increases of the stated magnitude to achieve pre-policy welfare. Calculations use post-2013 initial conditions and interest rate environment, comparing flexible repayment ($\tau^{pre} = 0.01$) to mandatory amortization ($\tau^{post} = 0.665$).

The median household would require a permanent consumption increase of 2.4% to achieve pre-policy welfare levels under mandatory amortization—a substantial cost equivalent to roughly one year of consumption growth at typical rates. Welfare losses are heterogeneous: lower-education households (median CEV -2.82%) face larger costs than higher-education households (-2.13%), reflecting their higher payment-to-income ratios, thinner liquid buffers, and greater exposure to binding constraints.

These welfare costs reflect three distinct channels. First, reduced consumption: mandatory amortization forces consumption cuts averaging 10-15% early in life, particularly costly when marginal utility is high. Second, increased exposure to income risk: lower liquid buffers raise consumption volatility and reduce the capacity for self-insurance, amplifying welfare losses from uninsurable shocks. Third, distorted intertemporal allocation: mandatory schedules prevent households from optimally timing debt repayment, forcing accelerated repayment even when the mortgage-portfolio spread is small or negative.

The magnitudes are comparable to or exceed welfare costs of other financial frictions studied in the literature. Kaplan and Violante (2014) estimate welfare costs of 1-2% from eliminating all liquidity constraints in a similar environment. The larger effects here reflect that mandatory amortization creates a *persistent* constraint—binding repeatedly over 20-30 years—rather than a one-time down payment requirement.

One caveat merits emphasis. The welfare calculations hold the interest rate environment fixed at post-2013 levels, where mortgage rates (2.4%) fell below liquid asset returns for many households. In this environment, the mortgage-portfolio spread provides limited offset to the liquidity cost of forced repayment. If mortgage rates were substantially higher—as in the pre-2013 period when rates averaged 4.5%—the optimal flexible policy would involve faster repayment, reducing the welfare loss from mandatory schedules. However, observed movements in interest rate spreads between flexible and mandatory products were modest (10-20 basis points), suggesting limited equilibrium offset through pricing.

5.5 Implications for the wealth distribution

The heterogeneous saving and portfolio responses documented above have important implications for wealth inequality. Figure 17 displays saving rates, net wealth, and liquid wealth by wealth quintile.

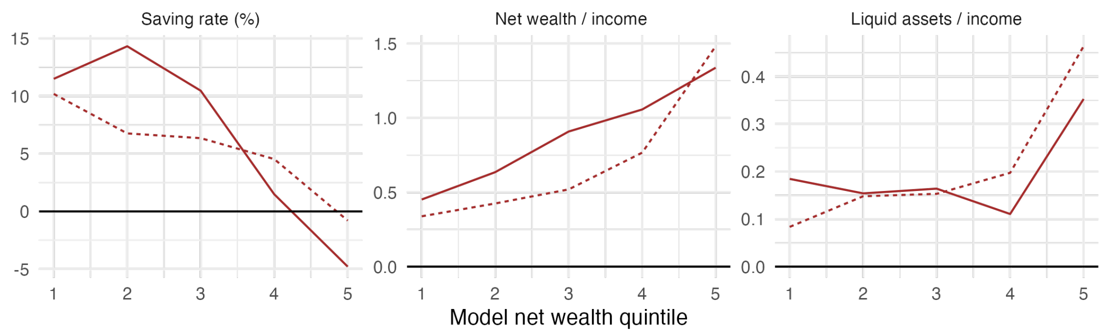

Figure 17: Saving and wealth by wealth quintile

The figure shows model predictions across wealth quintiles (computed within age groups). Left panel: Saving rates. Center panel: Net wealth relative to income. Right panel: Liquid wealth relative to income. Mandatory amortization (solid lines) versus flexible repayment (dashed lines).

Mandatory amortization has opposing effects on different dimensions of wealth inequality. The center panel shows that the net wealth distribution—including home equity—becomes more compressed. Lower-wealth households accumulate substantially more total wealth under mandatory amortization, while higher-wealth households show minimal changes. The wealth-to-income ratio for the bottom quintile rises from 0.8 to 1.1 (a 37% increase), while the top quintile ratio remains near 2.0. This compression reflects the forced saving through mortgage repayment, which disproportionately affects wealth-poor households.

However, liquid wealth inequality increases. The right panel shows that while all wealth groups accumulate more liquid assets under mandatory amortization (reflecting precautionary motives), the increase is larger in absolute terms for higher-wealth households. The liquid wealth-to-income ratio rises from 0.2 to 0.4 for the bottom quintile (a 100% increase), but from 0.6 to 1.1 for the top quintile (an 83% increase that is larger in levels). Combined with increased hand-to-mouth prevalence, this pattern implies that mandatory amortization widens financial wealth inequality even as it compresses total wealth inequality.

These distributional effects connect to broader questions about optimal financial regulation. Mandatory amortization improves household balance sheets in aggregate—net worth rises, leverage falls—outcomes typically viewed as enhancing financial stability. But these improvements come at the cost of reduced liquidity for lower-wealth households, increasing their vulnerability to income shocks and reducing consumption smoothing capacity. The welfare analysis suggests these costs are substantial, concentrated among households least able to bear them, and not fully offset by reduced borrowing costs.

6 Conclusion

This paper has shown that mandatory mortgage amortization—a pervasive feature of housing finance in most countries—acts as a powerful repayment rigidity that raises total saving while lowering liquidity and weakening consumption smoothing. In a life-cycle setting where deviating from scheduled repayment is costly and home equity is illiquid, standard precautionary motives translate repayment schedules into large, heterogeneous behavioral responses. In Euro area data, younger and lower-income mortgagors save substantially more than renters; the Netherlands, where flexible contracts are available, provides the counterexample that clarifies the mechanism.

Calibrating the model to Dutch data around the 2013 policy that increased the cost of flexibility, I match observed repayment and liquid-wealth patterns over the life cycle and across permanent-income classes, and quantify the aggregate and distributional consequences. Three conclusions follow. First, mandatory amortization increases total saving but crowds out liquid wealth, particularly among lower-income households. Applying the 2013 regime to pre-2013 borrowers would raise the share of hand-to-mouth homeowners by about 15 percentage points, amplifying consumption volatility and marginal propensities to consume. Second, repayment rigidity compresses the distribution of *total* wealth while widening inequality in *financial* wealth, generating a larger cohort of "wealthy hand-to-mouth" households with high equity and thin buffers. Third, welfare costs are sizable—equivalent to 2–3% of lifetime consumption—and concentrated among lower-wealth households who value payment flexibility the most.

These findings connect the facts in the cross-section to a structural mechanism: fixed schedules divert cash flow into illiquid equity precisely when liquidity is most valuable. They also reconcile the reduced-form evidence on consumption drops under tighter amortization with elevated saving rates among constrained owners. From a policy perspective, repayment rigidity delivers prudential benefits at the expense of household resilience: it strengthens balance sheets while increasing exposure to income risk and raising financial-wealth inequality. Where home equity is hard to access—as in much of the Euro area—amortization rules are therefore not neutral; they shape the transmission of shocks by increasing both the prevalence and MPCs of liquidity-constrained homeowners.

In sum, mandatory amortization builds wealth but at a meaningful cost in liquidity and welfare, especially for the young and the less well-off. Recognizing this trade-off is essential for housing finance policies that balance systemic stability with household consumption smoothing and financial inclusion.

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A What is an interest-only mortgage?

For clarity, this section illustrates how an interest-only mortgage differs from a standard amortizing loan. Under interest-only contracts, households pay only interest each period and repay principal in a lump sum at maturity, implying no regular amortization component.

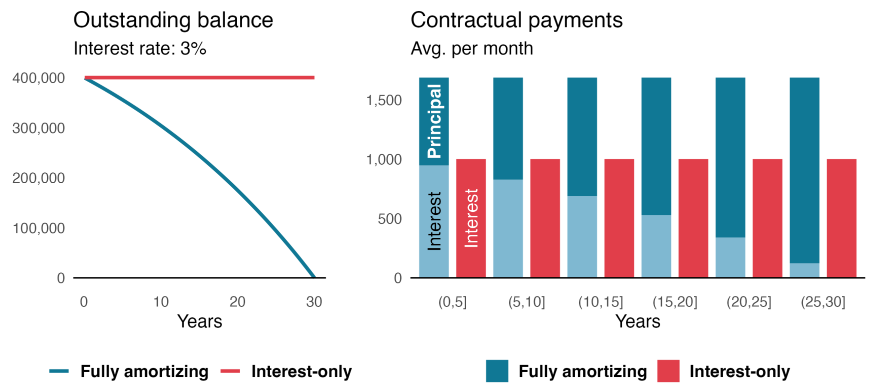


Figure 18: Illustration: Interest-only versus amortizing mortgage

B Saving and amortization checks

This appendix provides a set of robustness and validation checks related to saving behavior and mortgage amortization in the HFCS data. It also documents the calibration and numerical solution of the model described in the main text, along with several additional figures that illustrate the income process, saving rates, and mortgage characteristics.

B.1 Amortization for mortgages before and after 2013

As discussed in Section 3, the 2013 mortgage reform in the Netherlands introduced mandatory amortization for new loans. To verify that this change is reflected in the data, Figure 19 displays the distribution of amortization rates before and after 2013, and Table 8 reports the share of observations with minimal amortization.

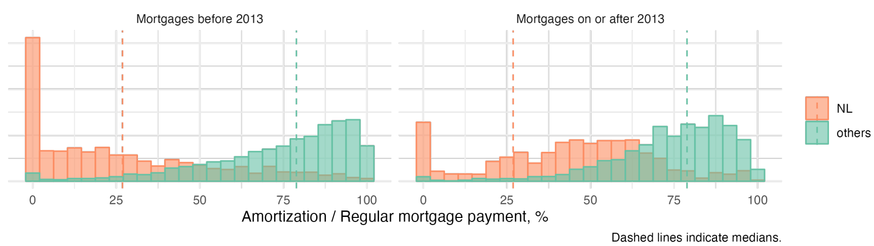


Figure 19: Distribution of amortization in the HFCS, mortgages before and after 2013

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

Table 8: Percentage of observations where amortization is less than 5% of the regular payment

B.2 Amortization calculated via annuity formula

As an additional validation, I verify that the amortization amounts reported by households are consistent with those implied by the standard annuity formula, given the loan interest rate and residual maturity. In other words, I should observe $\frac{\text{Amortization observed}}{\text{Implied repayment}} \approx 1$, where the implied repayment is given by:

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

where r is the loan interest rate and T its residual maturity.

Normally, amortization payments increase slightly over time because the total payment is fixed but the interest component declines. Therefore, I expect the ratio of observed to implied amortization to be slightly below 100% for a typical household.

The results of this exercise are shown in Figure 20.

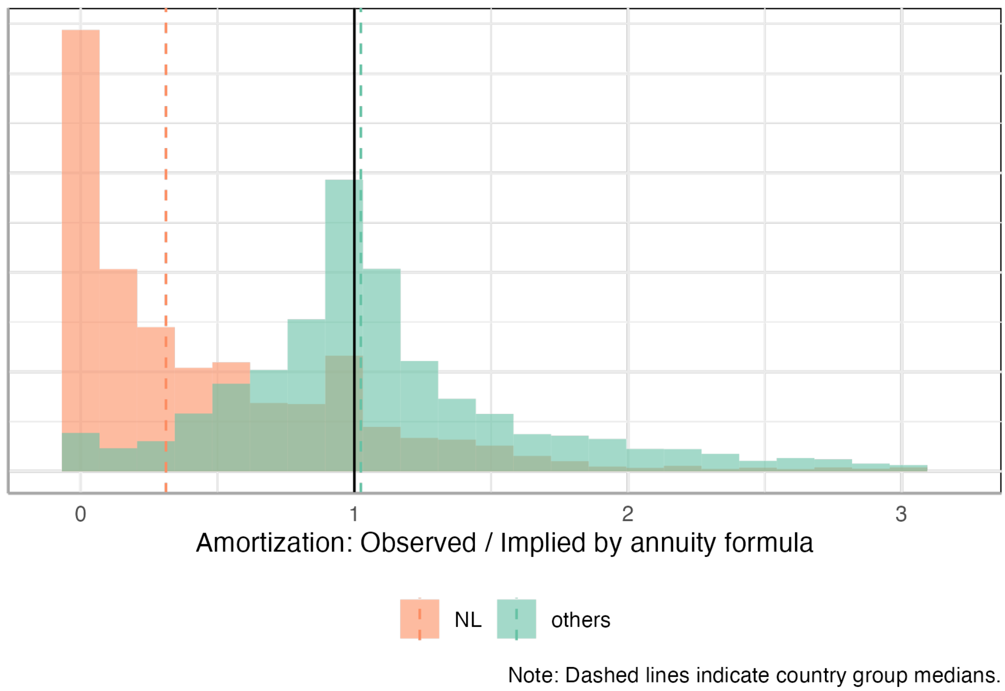
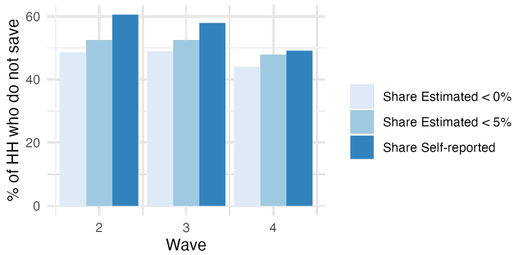


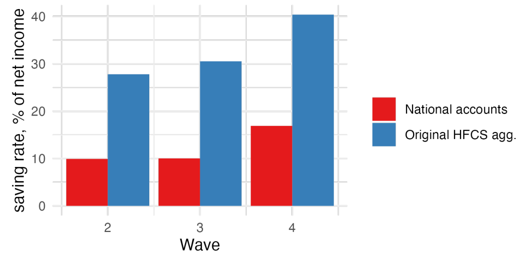
Figure 20: Histogram of the weight of amortization in regular mortgage payments, HFCS wave 3
Note: dashed lines indicate the group median. The solid line marks 100%.

B.3 Saving rates

Finally, I compare the saving rate measure constructed from HFCS data with external benchmarks. Panel (a) of Figure 21 contrasts the share of households reporting no ability to save with the share estimated to have a negative saving rate, while Panel (b) compares aggregate saving rates from National Accounts and those implied by the HFCS.



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



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

Figure 21: Statistics of saving rate measures compared with external benchmarks

C Saving rates over the life cycle

C.1 Saving by homeowners in the Netherlands and other countries

To complement the analysis in the main text, I examine how saving rates evolve over the life cycle for households with different mortgage types. The comparison highlights potential behavioral responses to the 2013 mortgage reform in the Netherlands.

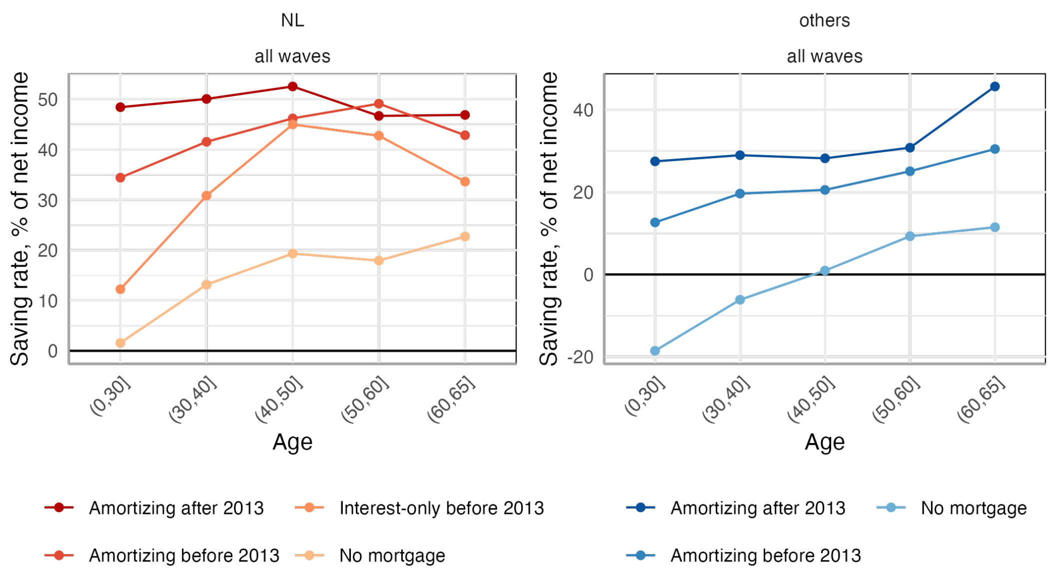


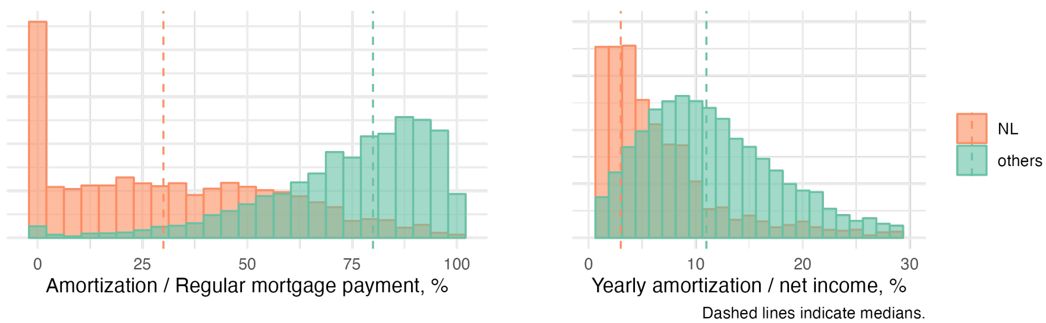
Figure 22: Saving rates by age and mortgage type, Netherlands and others

Note: There is no substantial difference in saving behavior between post-policy reform mortgages and earlier cohorts.

D Mortgage amortization in the HFCS data

D.1 Share of regular payments and income going to amortization

This section provides additional descriptive evidence on the role of amortization in mortgage payments using the HFCS micro data. It reports how much of each household's regular payment and income is devoted to principal repayment, which helps validate the empirical construction of amortization variables.



(a) % of regular payment going to amortization (b) % of household income going to amortization

Figure 23: Distribution of amortization shares in HFCS data

E Amortization by HFCS wave

Finally, Figure 24 compares the distribution of mortgage amortization across survey waves. This comparison provides a simple check that reported amortization patterns are consistent over time and across the data collection rounds.

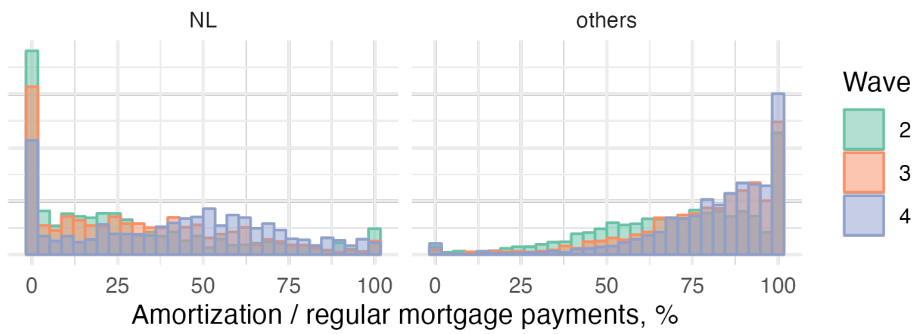


Figure 24: Distribution of mortgage amortization by HFCS wave

F Calibration

F.1 Income process

This section documents the calibration of the household income process used in the model. The specification follows the standard permanent–transitory decomposition of earnings risk, with parameters calibrated to Dutch micro data and life-cycle income profiles obtained from the HFCS.

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

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

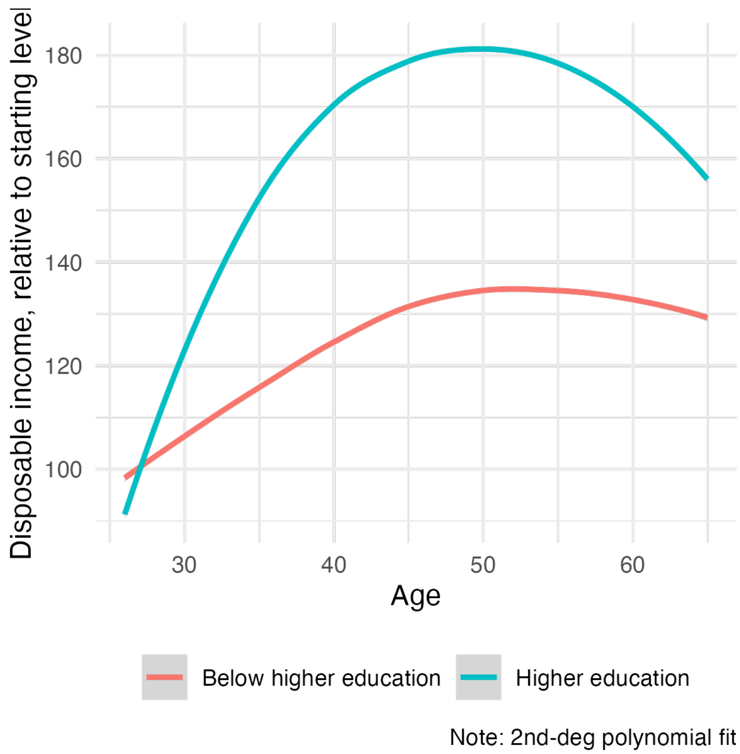


Figure 25: Model fit for the income process

G Model solution details

G.1 Household problem and numerical solution

This section briefly summarizes how the model is solved numerically. Given the high dimensionality introduced by the mortgage and saving decisions, I rely on modern computational tools from machine learning to approximate the value and policy functions efficiently.

The model solution uses stochastic gradient descent to estimate the parameters of a neural network that approximates the optimal policy function.

- Machine learning techniques allow computing the gradient $\nabla_\theta \tilde{V}(s_0, \theta; \hat{\pi})$.
- This approach is computationally feasible thanks to ML infrastructure, as neural networks are designed to handle high-dimensional problems.
- Implementation based on JAX, following Barrera and Silva (2024), *nndp*.
- Solution obtained using Google Cloud TPU resources.
- Parameters are updated according to:

$$\Delta\theta = -\alpha \nabla_\theta \tilde{V}(s_0, \theta; \hat{\pi}),$$

  i.e., moving in the direction that minimizes the loss function ($-V$), with α denoting the learning rate.