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Mortgage structure, household saving and the wealth distribution

Draft version

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Mortgage structure, household saving and the wealth distribution*

Luís Teles Morais†

April 2025 - **work in progress**

Abstract

In this paper, I show that fixed amortization schedules, a common feature of mortgage contracts, have powerful and heterogeneous effects on household saving, with implications for the wealth distribution. Using data from the Eurosystem Household Finance and Consumption Survey, I document that younger, poorer homeowners allocate a large share of their income to mortgage repayment, unlike those with higher income and wealth. This pattern is observed everywhere except in the Netherlands, where interest-only mortgages are common. I then estimate a life-cycle model, with rich income risk and realistic long-term mortgage contracts, in order to rationalize these findings and examine their implications for saving over the life cycle and across the distribution of wealth. The model shows that mandatory amortization increases saving rates, boosting both home equity and financial wealth, particularly up to age 40. Wealth-to-income ratios increase by close to a quarter for lower-income homeowners at age 40, while the impact for the highest-income households is minimal. The effects of mandatory amortization build up over time and have a substantial effect on the distribution of total wealth, which becomes more equal, and of financial wealth, which becomes more skewed.

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1 Introduction

Housing is the largest asset in most households' wealth portfolios, making up roughly two-thirds of total wealth for the median household in both the United States and the Euro area. While this is well known, the flow of saving into housing through mortgage debt repayment has received comparatively little attention. This flow is substantial: mortgage debt repayment accounts for a quarter of gross household saving in the US, or a third in the Euro area (Table 1). Since only about 40% of the population has an outstanding mortgage, for these households, the fraction of their saving dedicated to building home equity is even more significant.

	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

These large repayments are not strictly voluntary. In most mortgage contracts, households must follow a fixed payment schedule that dictates a predetermined path of debt reduction. A growing empirical literature using administrative microdata has documented that this feature of mortgage contracts significantly impacts household saving behavior. Recent studies, namely Bernstein and Koudijs (2024), exploiting policy changes in the Netherlands – where interest-only mortgages are common – and others in Nordic countries (Backman and Khorunzhina, 2024; Larsen et al., 2024; Vihriala, 2023) find that mandatory amortization substantially increases household saving compared to more flexible repayment schemes.

The exact transmission mechanism from mortgage design to household saving behavior, however, remains underexplored. Are households substituting between assets, merely reallocating their saving from liquid to illiquid forms? Or does mortgage design increase overall wealth accumulation? Most importantly, how do these effects vary across households at different points in the income and wealth distributions, and what are the implications for the shape of the wealth distribution?

In this paper, I address these questions by first documenting new stylized facts about mortgage repayment patterns and saving rates across the income and wealth distributions, and then developing a life-cycle model with rich income risk and realistic mortgage constraints to rationalize these patterns and explore their long-run implications.

My findings reveal that fixed amortization schedules in mortgage contracts act as a powerful liquidity constraint that disproportionately affects younger and less affluent homeowners. Using data from the Eurosystem Household Finance and Consumption Survey (HFCS), I document that younger, poorer homeowners allocate a much larger share of their income to mortgage repayment than their older, wealthier counterparts. By exploiting the unique institutional environment in the Netherlands, where interest-only mortgages are common, I demonstrate that these patterns are directly linked to the constraints imposed by standard repayment schedules.

The empirical analysis yields three key findings. First, mortgaged homeowners in the Euro area exhibit significantly flatter saving rate gradients across income and wealth distributions compared to non-mortgaged households. Second, the burden of amortization is highly uneven: households in the bottom income quintile dedicate up to three times more of their income to mortgage repayment than those in the top quintile. Third, in the Netherlands, I find that homeowners with interest-only mortgages exhibit saving patterns similar to non-mortgaged households – with steeper saving rate increases across income groups and over the life cycle – suggesting that mandated amortization rather than homeownership itself drives the flattening of saving rate gradients.

I then develop a life-cycle model featuring uninsurable income risk and realistic mortgage contracts to quantify the effects of mandatory amortization on household saving and wealth accumulation. The model, solved using neural networks and calibrated to the Euro area, produces several novel insights.

First, for the average household, mandatory amortization increases total wealth accumulation to 100% of income by age 60, compared to just 85% under flexible repayment. This 15 percentage point difference represents a substantial increase in lifetime wealth accumulation driven purely by mortgage design. Second, and contrary to conventional wisdom, households under mandatory amortization regimes accumulate more of both types of assets – not only illiquid home equity but also liquid financial savings increase, as households build larger precautionary buffers to compensate for tighter liquidity constraints. Third, these effects are highly heterogeneous: the wealth-to-income ratio for households in the bottom income quintile increases by approximately 25 percentage points under mandatory amortization, while the effect for the top quintile is just 5 percentage points.

The model also provides insights into the mechanism driving these results. When households face income uncertainty and high transaction costs for adjusting mortgage payments, they respond rationally by reducing consumption and increasing precautionary saving in liquid assets. This response is not driven by behavioral biases or commitment devices, but rather by optimal behavior under tight liquidity constraints and uninsurable income risk. The effect is strongest for younger, less wealthy households who face both higher income volatility and steeper mandated saving through amortization. The resulting pattern resembles what Bernstein and Koudijs (2024) term the "mortgage piggy bank" effect, but emerges from fully rational optimization rather than from behavioral factors.

The heterogeneous impact of mortgage design on saving rates has important implications for the evolution of the wealth distribution. My results suggest that mandatory amortization compresses saving rate differentials across income and wealth groups, potentially counteracting forces that would otherwise lead to greater wealth concentration over time. While younger and less affluent homeowners save substantially more under fixed amortization schedules, the effect on wealthier households is modest. While this paper presents substantial advances in both empirical analysis and modeling of mortgage design's effects on saving behavior and wealth distribution, several important extensions remain under development. The current model demonstrates the mechanism's operation in partial equilibrium; ongoing work extends the analysis to a general equilibrium setting where interest rates adjust endogenously. This expanded framework incorporates additional dimensions of heterogeneity, including in discount factors and housing consumption preferences, to capture the full dynamics of wealth accumulation across the distribution.

Related literature and contribution

This paper sits at the intersection of several strands of literature.

First, it extends the household finance literature on mortgage design, specifically, recent papers focusing on mandatory amortization.[1] Using quasi-experimental settings, recent studies have demonstrated that mandatory amortization requirements substantially increase household saving compared to more flexible repayment schemes. Bernstein and Koudijs (2024) provide compelling evidence in the context of the Netherlands, where interest-only mortgages are unusually prevalent. Exploiting a 2013 policy reform that required amortization for new mortgages to qualify for mortgage interest deductibility, they find that this policy lead to one-for-one increases in saving among first-time homebuyers, mostly financed by cuts in consumption. Similar findings emerge from Nordic countries, where rich administrative data allows for precise identification. Backman and Khorunzhina (2024) examine the introduction of interest-only mortgages in Denmark in 2003, documenting strong take-up and corresponding reductions in saving. Larsen et al. (2024), also with Danish data, show interest-only mortgages allow both young and old households to overcome liquidity constraints and increase consumption. Additional evidence from Finland (Vihriala, 2023) and Sweden (Backman et al., 2024) consistently demonstrates the impact of repayment schedules on saving behavior.

My paper contributes to this literature in three directions. First, I provide a theoretical framework that explains these empirical patterns through fully rational optimization under constraints, connecting the empirical findings to standard macroeconomic models of household behavior, leaving a smaller role for potential behavioral biases. Second, my quantitative approach allows me to trace out the long-run implications of this effect for wealth accumulation by different households, which the empirical literature so far, based on short time windows of data around policy changes, has not been able to do. This approach also allows me to show the implications of this effect for the distribution of financial and housing wealth.

Second, it connects to the wealth inequality literature e.g. Benhabib et al. (2017, 2019); Hubmer et al. (2021), which shows that wealth inequality dynamics are driven by a combination of income inequality, heterogeneity in returns on wealth, and heterogeneity in saving rates. While previous work has established housing's role in the distribution of returns (Jorda et al., 2019; Kuhn et al., 2020; Martinez-Toledano, 2023), I introduce a new channel: saving rate heterogeneity induced by mortgage contract design.

Third, my paper follows up on a theoretical literature that has been considering the optimal

[1] There is also a smaller literature looking at the effects of down payment requirements (Engelhardt and Mayer, 1998; van Horen and Tracey, 2022) on young homeowners' saving behavior.

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 in saving is both large and highly heterogeneous, and complex, in the sense that it increases wealth accumulation but at the cost of decreasing liquid saving buffers for many households. My results suggest that optimal mortgage design must take into account this heterogeneity.

Mandatory amortization flattens the wealth distribution by disproportionately increasing saving rates among less affluent homeowners, effectively serving as a "forced saving" mechanism. This provides theoretical foundation for the longstanding intuition that homeownership, through what Bernstein and Koudijs (2024) call the "mortgage piggy bank," promotes wealth building and reduces overall wealth inequality. However, my analysis reveals a more nuanced picture: while total wealth inequality decreases, financial wealth inequality may increase as households adjust their liquid saving to compensate for illiquid home equity accumulation, potentially reducing self-insurance against income shocks.

These findings have important policy implications for macroprudential regulation of mortgage lending, particularly regarding down payment requirements, amortization mandates, and mortgage interest deductibility. My results suggest that while mandatory amortization promotes wealth building, especially among younger and less affluent homeowners, the constraints it imposes on liquidity may carry welfare costs through reduced consumption smoothing. Understanding this tradeoff is essential for designing optimal mortgage regulations.

Structure of the paper Section 2 presents the HFCS data, describing the significant detail on housing and mortgages it contains, allowing for a detailed analysis of the role of amortization in saving. Section 2.4 presents a series of stylized facts on mortgages and saving rates, that suggest constraints related to mortgage contracts push up saving of younger, poorer homeowners. In Section 3, I present the quantitative model I use to rationalize these results and explore their implications for the saving and wealth distributions. Section 5 concludes.

2 Evidence on mortgage amortization and saving from the HFCS

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.

2.1 Homeownership and mortgage institutions in the euro area

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

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

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

2.2 Measuring saving in the HFCS

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

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:

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

The saving rate is simply the ratio of saving flows to net income, $s \equiv \frac{S}{Y_{net}}$. The distributions of saving rates obtained from this procedure, for each wave of the HFCS, are shown in Figure 1.

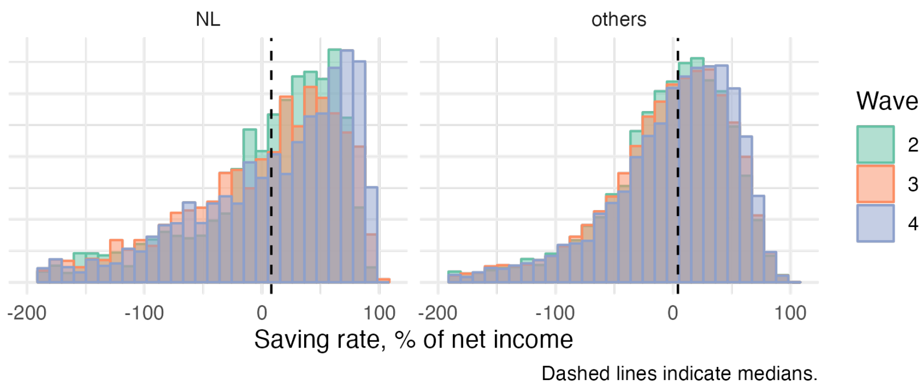


Figure 1: Distribution of saving rates, full HFCS sample, by wave

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

The median household saves about 4% of income in the full cross-country sample, and 8% in the Netherlands. There is a long left tail of dissavers, as 46.7% (45.3% in Netherlands) of households do not save or are dissaving. This number is in line with the figures for other regions.

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

2.3 Mortgages and amortization in the HFCS

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

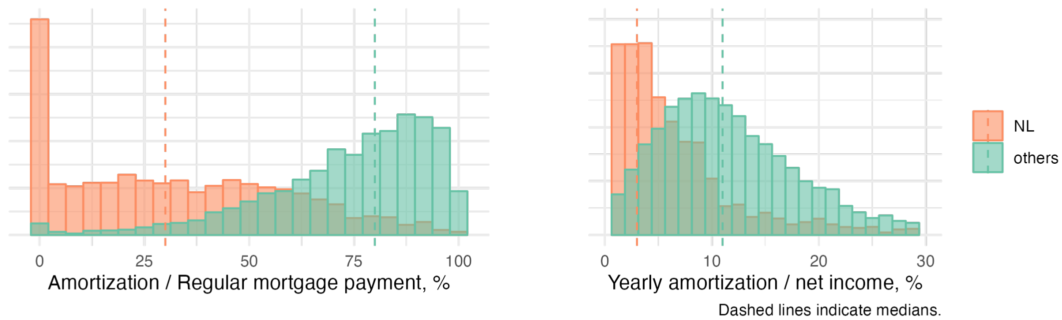
Importantly, respondents are asked to report the regular monthly payment for their current mortgage loans. Combined with other details of the loans, we can back out what is the amortization amount embedded in that monthly payment, for each surveyed household. Annual amortization for household i is given 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 14 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, we observe that most loans devote a large part of the monthly payment to amortization. The median is about 80%. This is reasonable considering that the overwhelming majority of loans has a standard annuity loan structure, which means that for the last several years of the loan the share of payment going to amortization is very high. Furthermore, this sample focuses on years with relatively low interest rates. Also, the weight of amortization payments on household income seems reasonable, in line with other sources and with mortgage market regulations. The obtained values concentrate around 10%-20% of yearly net income, as shown in Figure 2, across all countries.

The case of the Netherlands, shown in orange in the charts, is starkly different. The high prevalence of interest-only mortgages shows up in this data: there is a large bunching at zero, and many households amortize only a small amount in a regular month. The effects of a 2013 policy change that made interest-only mortgages more costly are also visible, as homeowners with mortgages originated after 2013 amortize more (see 13 in Appendix).



(a) Share of regular mortgage payment going to amortization

(b) Weight of amortization on household net income

Figure 2: Distribution of amortization in the HFCS

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

Descriptive statistics

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

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

Table 3: Descriptive statistics, mortgaged homeowners, HFCS

2.4 Stylized facts on saving and mortgages in Europe

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

2.4.1 Saving rates among mortgaged homeowners and other households

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

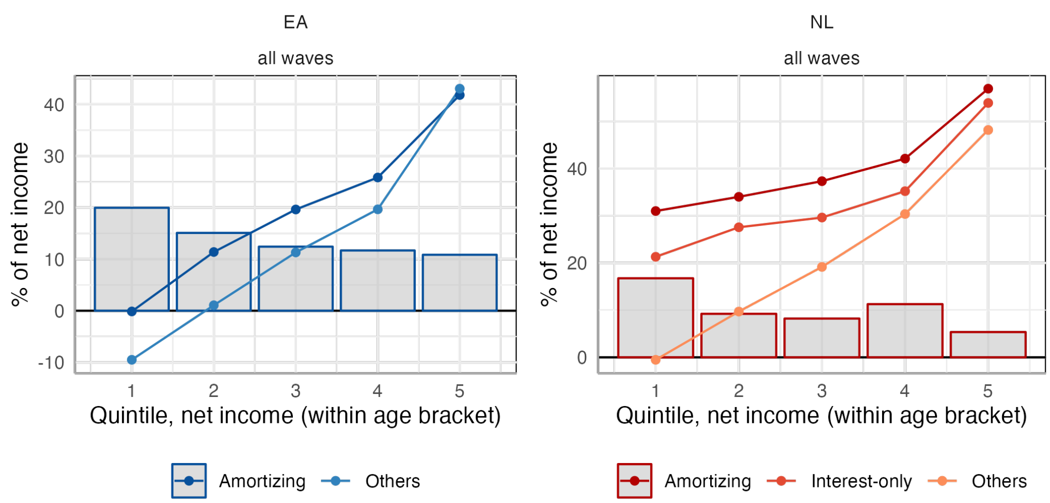


Figure 3: Saving rates over the income distribution

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

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

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

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

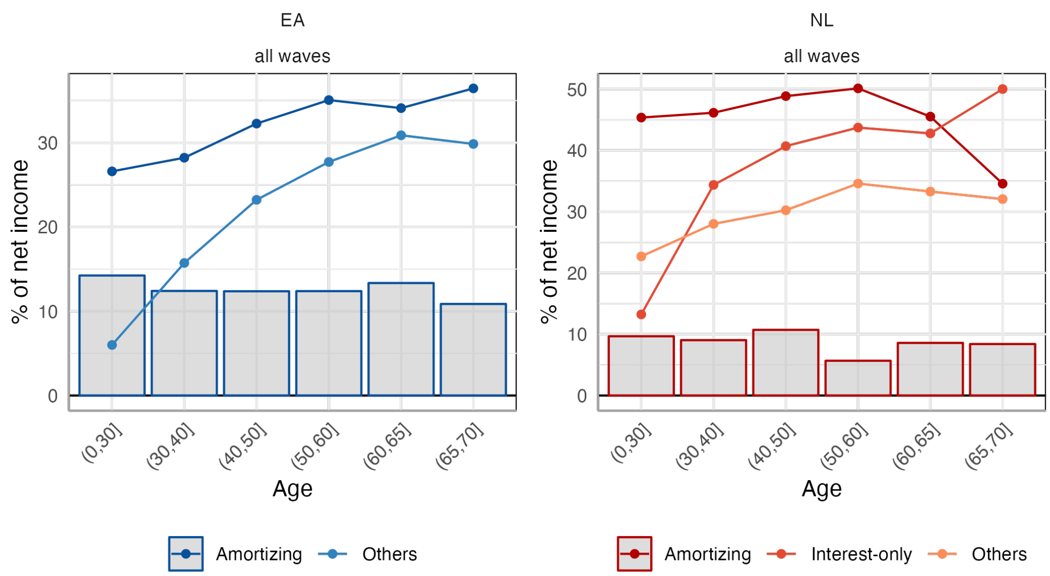


Figure 4: Saving rates over the life cycle

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

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

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

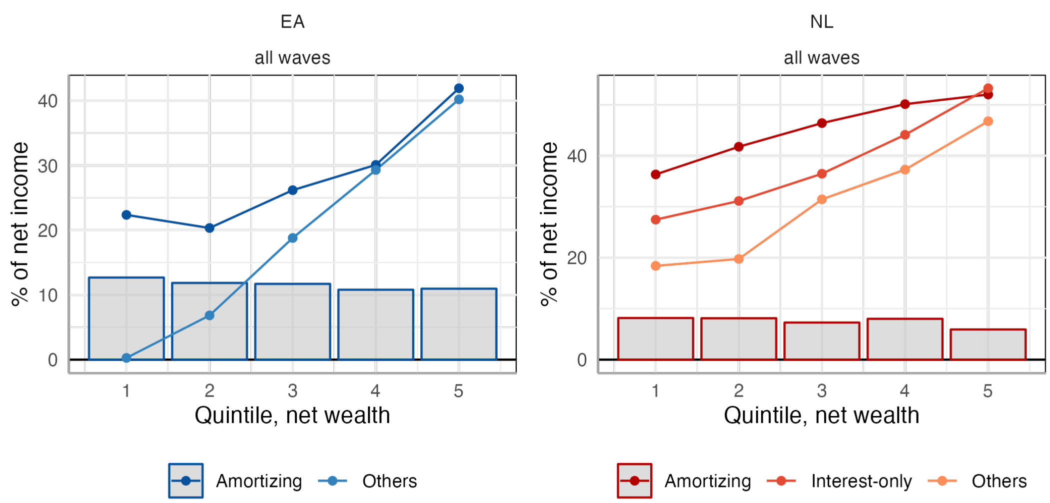


Figure 5: Saving rates over the wealth distribution

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

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

3 A model of consumption, saving and mortgage repayments

In a standard life cycle model of household saving, when a household is hit with a negative income shock, it is optimal to reduce saving if the shock is not permanent. A mortgage payment, including debt repayment, would in this context impose a ’hard’ constraint on saving. Further, the transaction costs involved in selling a house, or refinancing the mortgage, become larger relative to income. A household can, in this situation end up "over-saving": it would better off if could save less (into its illiquid home equity) but the high costs involved prevent it from fully readjusting its saving behavior.

In this scenario, the household might compensate for this lack of flexibility by saving less into liquid assets (than it would be optimal absent frictions in mortgages). Note that a given household could end up in this situation as a result of perfectly rational decisions, or even with perfect foresight. Depending on the rental rate (or house price-to-rent ratio), and the interest rate on mortgage loans, it might be optimal for a household to buy a house and enter such a contract, regardless of the costs of ‘over-saving’.

I study the problem of a household who has just bought a house and entered a mortgage contract. They have some home equity, due to the down payment, and almost no liquid savings.

3.1 Setup

Time is discrete, and each period t represents one year. Households live for a maximum of J periods, may face each period an exogenous risk of death δ_t and discount future utility by factor β. Households maximize expected utility and have time-separable preferences.

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, they derive utility from non-housing consumption :

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

where γ governs intertemporal elasticity of substitution.

As explained in Campbell and Cocco (2015), with fixed housing consumption and preferences separable in housing and non-housing consumption, housing can be disregarded in the household's optimization problem.[2]

At the end of the model life, households leave a bequest b, deriving some utility from the wealth left over in the last period. I assume that the utility from the bequests is given by the expression, following the standard form introduced by De Nardi (2004) :

$$U(b_{it}) = B\frac{(b_{it} - \underline{b})^{1-\gamma} - 1}{1-\gamma},$$

where B measures the strength of the bequest motive, and $\underline{b}$ reflects the extent to which bequests are a luxury good. In the current stage of the model development, where the model represents only the working life, the bequest represents the accumulated savings desired to leave for the retirement phase of the life cycle. The bequest corresponds to the remaining financial assets, subtracted by any remaining mortgage debt outstanding, in other words, households must repay the mortgage debt in full by retirement.

Income Households supply labor inelastically, until they retire at 65. They receive exogenous labor earnings given by:

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

where Γ_t captures the life cycle profile of earnings, Z is the persistent component of earnings and θ_{it} is the transitory component. As in Carroll and Samwick (1997), and standard in the literature, the permanent component evolves stochastically according to $\log Z_{i,t} = \log Z_{i,t-1} + \log \psi_{i,t}$, where $\log \psi_{i,t} \sim \mathcal{N}\left(-\sigma^2_{\psi,t}/2, \sigma_{\psi,t}\right)$, and the transitory component is iid, with $\ln \theta_{i,t} \sim \mathcal{N}\left(-\sigma^2_{\theta,t}/2, \sigma_{\theta,t}\right)$.

[2] as 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.

Assets and liabilities

Life for households in the model begins just after buying a house. Inspired by Ganong and Noel (2020), at $t = 0$, agents are endowed with a home with market price P_{i0} and a 30-year fixed rate mortgage with balance M_{i0}. They are further endowed with a certain amount in a liquid risk-free account, A_{i0}. Savings in the risk-free asset yields interest at rate r, and households pay interest rate $r + s$ on their mortgage, where s is the mortgage spread. The house price may drift relative to the consumption price index at rate g.

Beyond the mortgage, households can borrow directly in cash up to θ^A at rate r. At any point, the mortgage cannot exceed a loan-to-value constraint $\theta^M P_{it}$. House prices evolve deterministically according to $g = \Delta \log P$.

Mortgage debt repayment

Each period, households decide on their consumption c_{it} and mortgage debt repayment d_{it}. They can potentially increase their debt, "extracting home equity" ($D_{it} < 0$). Households face a mandated repayment schedule which, by the standard annuity formula, can be represented as a function of outstanding debt and time to maturity, $D^* \left(M_{t-1}, t\right)$.[3] The mortgage must be repaid within 30 years or by 70 years of age, whatever comes first. Deviating from the mandatory amortization schedule is costly. Households incur a proportional transaction cost on the difference between mandated and executed repayment, at rate τ^+ if they wish to prepay their mortgage (increase repayment), and τ^- if they defer repayment or extract home equity. This is summarized by the transaction cost function:

$$\tau \left(D_t, M_{t-1}, t\right) = \left(D_t - D^* \left(M_{t-1}, t\right)\right) \times \left(\tau^+ \mathbf{1} \left\{D_t > D^* \left(M_{t-1}, t\right)\right\} + \tau^- \mathbf{1} \left\{D_t < D^* \left(M_{t-1}, t\right)\right\}\right)$$

There is no default, as $g \geq 0$ and the income process is calibrated such that homeowners always have enough disposable income to make their mortgage payment.

3.2 Timing and recursive representation

Each period, each household i solves (i subscripts dropped for clarity):

$$V_t(S_t) = \max_{C_t} E_0 \left[\sum_{t=0}^{T} u(S_t, C_t)\right]$$

$$\text{s.t.:}$$

$$S_{t+1} = m\left(S_t, C_t, Z_t\right)$$

$$C_t \in \Xi \left(S_t\right)$$

[3] $D^*(m,t) = m\left(r+s\right)\left[\left(1+r+s\right)^{\left(T^M - t\right)} - 1\right]^{-1}$, where T^M is the period at which the loan matures.

where S_t are state variables and C_t controls, and initial conditions will be given by the endowment $\{A_{i0}, M_{i0}\}$. The initial permanent income and house price levels are normalized to $Z_{i0} = P_{i0} = 1$ for all i.

The states are $s_t = (y_t, a_t, z_t, m_t)$, where y_t, z_t are exogenous and a_t, m_t endogenous. y and z are transitory and permanent income, evolving as described above. d is an exogenous mortgage debt repayment dependent on the outstanding mortgage and t. The control variables here are c_t, d_t, consumption and mortgage debt repayment.

Each period, states will evolve according to m, which contains the laws of motion for the states, which following for the above description of the model, are:

$$\begin{cases} \log y' = \log z' + \sigma_y \varepsilon_y, & \varepsilon_y \sim N(-\frac{\sigma_y^2}{2}, \sigma_y^2) \\ \log z' = \log z + \log \Gamma(t') + \sigma_z \varepsilon_z, & \varepsilon_z \sim N(-\frac{\sigma_z^2}{2}, \sigma_z^2) \\ a' = (1+r)\left(a + y - m\left(r+s\right) - d^*\left(m,t\right) - c\right) \\ m' = m - d \end{cases}$$

where, by the annuity formula, $d^*(m,t) = m_t\left(r+s\right)\left[\left(1+r+s\right)^{\left(T^M - t\right)} - 1\right]^{-1}$, and T^M is the mortgage maturity.

$\Xi\left(S_t\right)$ summarizes the state-dependent borrowing and liquidity constraints:

$$\Xi(s_t) = \begin{cases} [0, y_t + a_t] \\ [-\theta^M, m_t] \end{cases}$$

3.3 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. While in the current version of the paper, the model can still be solved with traditional computational techniques, the necessity of including further states to account for additional risks, namely house price risk and interest rate risk, and potentially stock return risk, and to then solve the model for a population of households along different dimensions, to match the distribution of financial and housing wealth, will require these methods.

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.

3.4 Exercise

The household begins their life with some home equity, due to the initial down payment. This means they begin their life at the loan-to-value constraint:

$$M_{i0} = \theta^M P_0$$

and almost no liquid asset, as an example of the situation of a homeowner who used up its savings to make the necessary down payment. The model household starts off with liquid assets worth 1 month of permanent income:

$$A_{i0} = \frac{P_{i0}}{12} = \frac{1}{12}$$

The first exercise consists of comparing two extreme scenarios for the repayment friction:

1. *No restrictions:* households can choose their optimal repayment path ($\tau^+ = \tau^- = 0$)
2. *Forced amortization:* households are forced to stick to the mandated repayment scheme ($\tau^+ = \tau^- = +\infty$, in practice the problem loses one control, D_t, and one state M_t, as it now becomes exogenous).

These scenarios are both extreme: in the first, access to home equity and the path of debt repayment are completely free; in the second, they are absolutely immutable. In reality, the situation is typically somewhere in between. A third scenario will be implementing the transaction costs present in the US and in Europe.

3.5 Calibration

Table 4 reports parameter values used in the model. The model considers only the working life, agents begin their lives at 30 and retire at 70. The discount factor $\beta = 0.96$ allows to attain a simulated aggregate private-wealth-to-income ratio in line with the value of 3.1 observed in the 2017 wave of the HFCS for the average country. A coefficient of relative risk aversion $\gamma = 5$ is taken from Duarte et al. (2020). Earnings risk follows Cagetti (2003). 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).

Description	Value	Target moment	Source
Life time in the model (T)	40	Working life 30–70	–
Discount factor (β)	0.96	Wealth–income ratio W/Y = 3.1	HFCS 2017 micro data
Risk aversion (γ)	5	Average MPC = 0.22	Duarte et al. (2020)
Bequest motive parameters ($\underline{b}$)	1.5	Wealth at retirement	HFCS 2017 micro data
Bequest motive parameters ($\underline{b}$)	0	Normalisation	–
Variance of transitory shocks (σ_y^2)	0.05	Earnings shocks (transitory)	Cagetti (2003)
Variance of permanent shocks (σ_z^2)	0.01	Earnings shocks (permanent)	Cagetti (2003)
Riskless rate (r)	0.03	Long-run real safe rate	Jordà et al. (2019)
Mortgage spread	0.005	EA median fixed-rate spread	EMF Hypostat (2019)

Table 4: Model parameter values

4 Debt repayment and wealth accumulation under different amortization regimes

This subsection examines how mandatory amortization affects household consumption and saving over the life cycle. By simulating household consumption decisions under different mortgage regimes, we explore the implications for saving and wealth accumulation over the life cycle and, as a consequence, for the distribution of wealth.

4.1 Life cycle saving patterns

Consumption and saving

We first discuss the average profiles of consumption and saving over the life cycle predicted by the model. Permanent income follows a simple age profile of steady growth until age 50 and stagnation there after. Figure 6 shows the average age profiles of consumption, and of the saving rate. This represents the mean across simulated agents, conditional on age, for a population of 10,000 simulated agents. The solid line represents the scenario with unrestricted repayment, where households optimize their repayment schedules without constraints, while the dashed line reflects the constrained scenario of fixed, mandatory amortization schedules.

In the unrestricted model, consumption, plotted as a ratio to initial permanent income, follows a smooth pattern with a constant rate of growth over the life cycle. The average household in the model is able to smooth consumption well. Instead, when they are restricted by a mandated amortization schedule, agents consume less – up until the moment that the mortgage is paid off, and home equity is 'unlocked' after 30 years. Consumption then jumps up as agents are finally able to use up the accumulated wealth in home equity. [4]

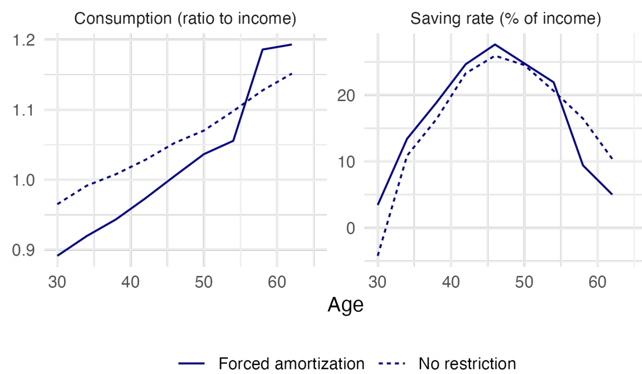


Figure 6: Life cycle income and consumption patterns in the model

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

Figure 7 shows, in the first panel, what the preceding consumption pattern means for the average saving rate over the life cycle. In the modelm households have low saving rates in the beginning of life, and then these grow steadily over the working life, as income also grows. The saving rate then begins to decline once income stagnates. The impact of mandated amortization is clear, and varies over the life cycle. If forced to amortize, households save much more in the first few years. The saving rate is even negative in the first 2 years – households on average risk being very close to the liquid borrowing constraint. While the difference abates, the average household always saves more over the life cycle, up until the point when home equity is unlocked, and then save much less on average than the unrestricted case. This is attributed to homeowners saving more to build up a liquid savings buffer, in order to compensate for the saving they have to put into inaccessible home equity. Later in life, many households draw down on this home equity.

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

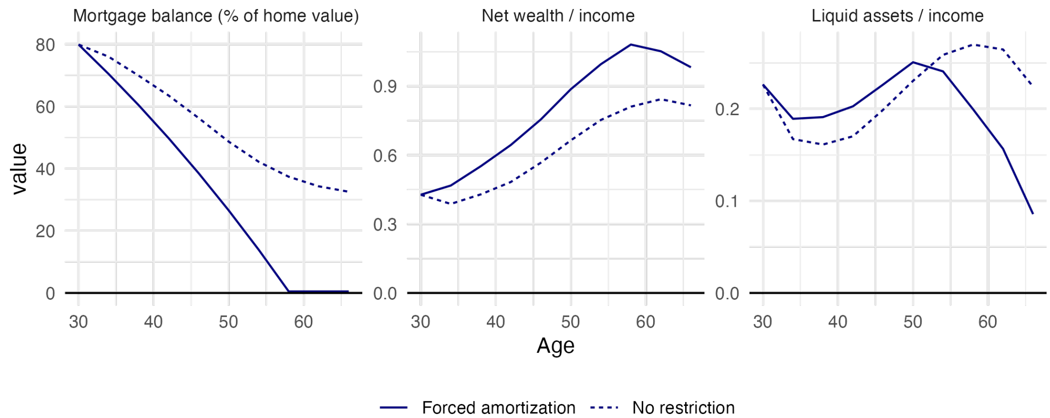


Figure 7: Life cycle saving patterns in the model

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

Mortgage repayment and wealth accumulation

The effects of mandatory amortization on consumption translate into patterns of wealth accumulation over the life cycle. The center panel of Figure 8 shows that the optimal repayment pattern for the average household is slower than mandated, and involves leaving a substantial portion of the loan, just over 30%, still to be paid at the time of retirement. With mandatory amortization, on average repayment is faster and is concluded before the 30 years of the loan maturity – as the households who are better off i.e. have high income windfalls, make some prepayments.

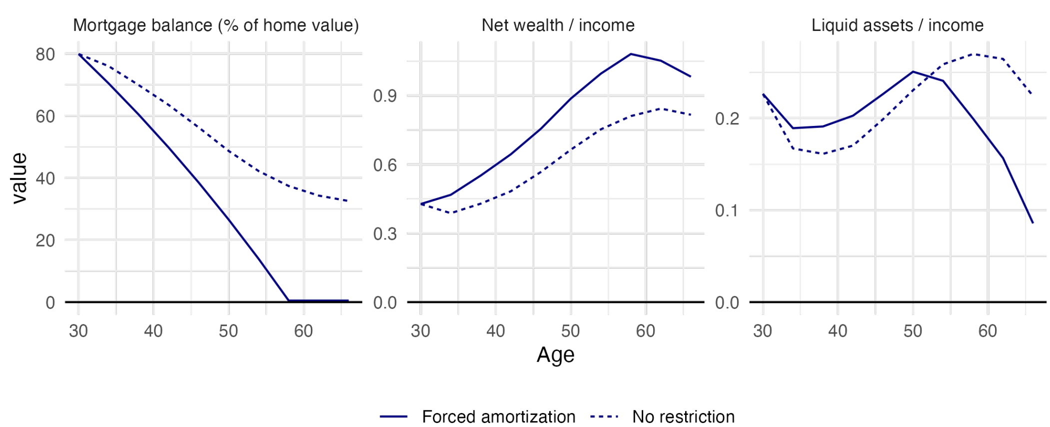


Figure 8: Saving patterns over the income distribution in the model

Model predictions for households across income quintiles show that mandatory amortization (solid lines) leads to higher saving rates, particularly for lower-income households (left panel). This translates into greater wealth accumulation (center panel) and higher liquid asset holdings (right panel) compared to the flexible repayment regime (dashed lines).

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

Constrained households in the model do not simply substitute financial savings for home equity. Higher wealth accumulation comes from both more home equity building through mortgage repayment, on the one hand, and from higher liquid savings, on the other hand. Households consume less and use the saving for both. They are forced to amortize and, on top of this, as their precautionary motives to save are stronger due to a larger mortgage payment, they save a higher amount into liquid assets (as a share of their income). In the last years before retirement, they draw down more on these liquid assets, as they have meanwhile accumulated more wealth overall.

Comparison with the data

I bring some additional facts from the HFCS data analysed in Section 3 that allow a direct comparison with the model results. Figure 9 shows how the outstanding mortgage balance (as a share of the initial value of the loan) is related to the remaining maturity. In the general European sample, it reflects standard mandatory amortization schedules. In the Netherlands, we observe that households with an interest-only or partially interest-only loan (most households) leave a substantial part of the loan unpaid until very close to maturity, as predicted in the model.

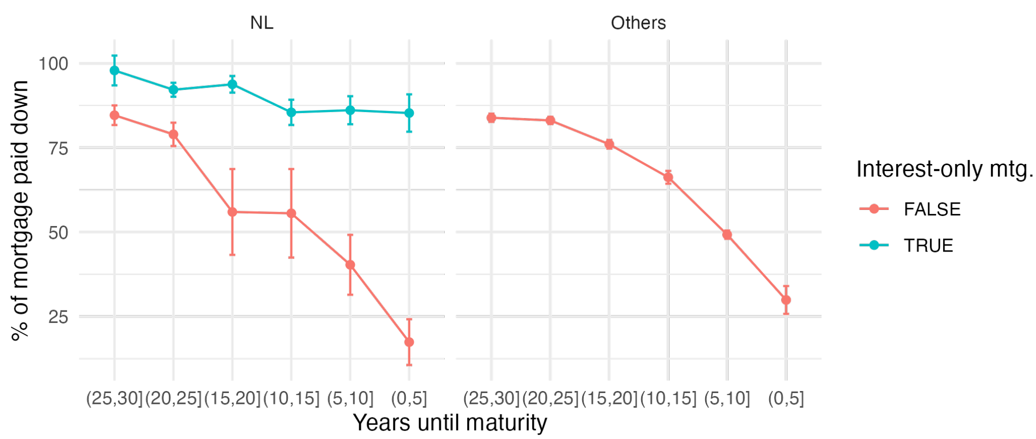


Figure 9: Outstanding mortgage balance and loan maturity in the data

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

The model prediction that households on average, when unconstrained, build larger financial saving buffers later in life, in part to pay out their mortgage loan at maturity, also bears out in the data for the Netherlands. Households whose mortgages are close to maturity (and are older) have far larger liquid savings than their counterparts in other countries, as well as Dutch households who opted to have a fully amortizing mortgage.

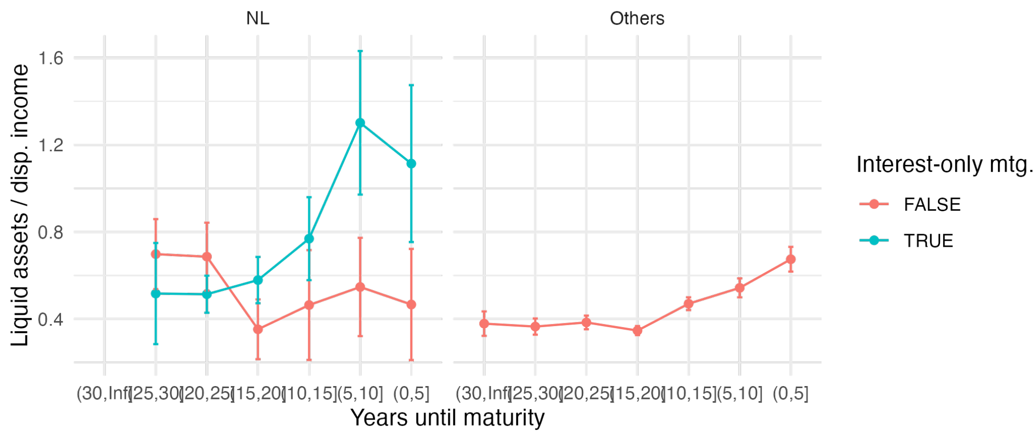


Figure 10: Outstanding mortgage balance and loan maturity in the data

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

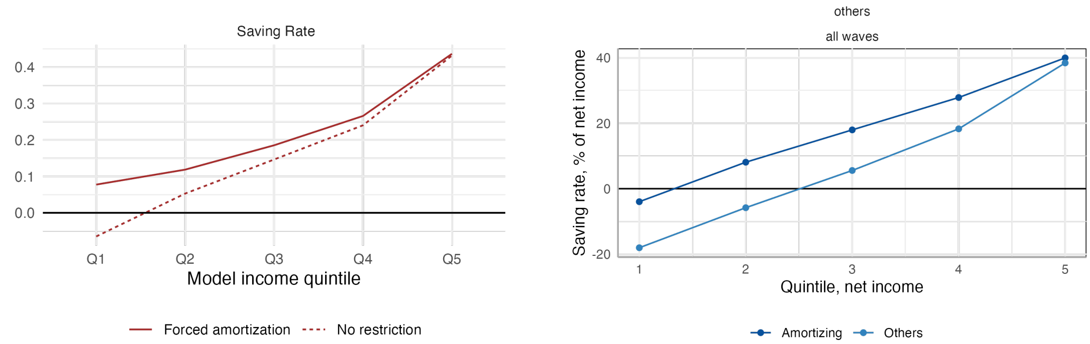
The comparison underscores the model's capacity to rationalize observed patterns in debt repayment and wealth accumulation. This gives greater confidence in the model's predictions for distributional outcomes, which we analyse in the next subsection.

4.2 Implications of amortization for the wealth distribution

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

Heterogeneity over the income distribution

Finally, Figure 11 depicts differences across income groups in the model and in the data. The left panel looks at saving rates across income groups in the two scenarios previously discussed. As in the data, I look at income quintiles conditional on age, so differences do not come from the life cycle profile of income. For households in the bottom income quintile, saving rates under mandatory amortization are approximately 12% higher than in the flexible regime, whereas top quintile households exhibit only a 3% increase. Importantly, the gradient becomes flatter in the 'forced amortization' scenario: the effect of mortgage-induced 'forced' saving is stronger for lower income homeowners. The right panel recalls the same patterns in the data for the euro area. The comparison suggests that this mechanism can, to some extent, rationalize the clear difference observed in the data.



(a) Share of regular mortgage payment going to amortization

(b) Weight of amortization on household net income

Figure 11: Saving rates over the income distribution – model and data

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

Wealth distribution

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

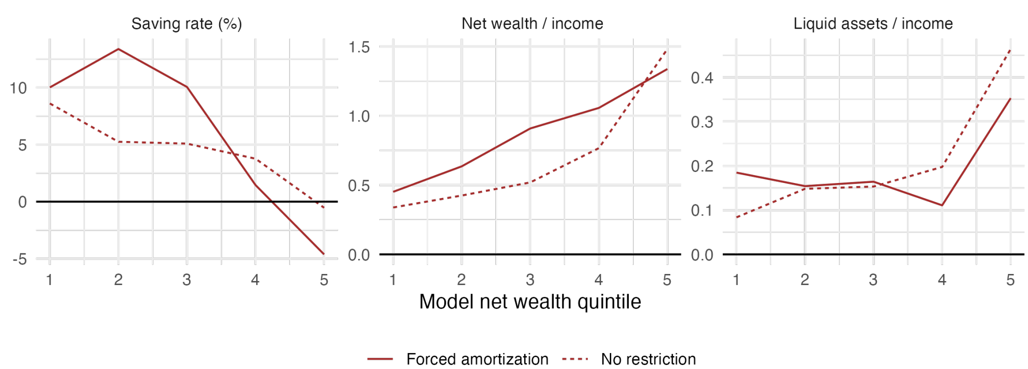


Figure 12: Saving patterns over the wealth distribution in the model

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

Figure 12 examines the effects of mandatory amortization on wealth accumulation patterns for different wealth quintiles in the model. The model predicts that under mandatory amortization, wealth accumulation is more evenly distributed across wealth groups. This result is driven by the disproportionate increase in precautionary saving among lower-wealth households, who face tighter liquidity constraints and are compelled to save a significant share of their income into home equity.

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

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

Future research Work is in progress to improve the model and tighten its fit to the data, in order to confirm and expand on these results. Crucially, the next step is to add heterogeneity in discount factors, following Krusell and Smith (1997), as a simple way of generating a more realistic distribution of saving and wealth and matching it to the data. The model will be extended to include housing consumption explicitly in household preferences and allow for different levels, i.e. different sized houses, as well as the option to rent. Afterward, a third risky asset will be introduced, to take into account the trade-off between repaying costly mortgage debt or investing in risky equities with potentially higher return.

Finally, rather than the simple knife-edge cases examined here, with fully mandatory amortization pitched against fully flexible repayment, alternative mortgage structures will be explored, namely simulating the effects of flexible repayment schemes, such as countercyclical payments (e.g., Guren et al., 2023), and comparing their distributional consequences to those of mandatory amortization.

5 Conclusion

What are the effects of a constraint imposed by typical mortgage design – the mandatory, fixed amortization schedule – on the saving rates of homeowners, in particular, younger and poorer ones? What are the implications might these effects for the shape of the wealth distribution?

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

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

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

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

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

References

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Ganong, P. and P. Noel (2020). Liquidity versus wealth in household debt obligations: Evidence from housing policy in the great recession. *American Economic Review 110*, 3100–3138.

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

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

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

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

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

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

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

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

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

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

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

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

A Saving and amortization checks

A.1 Amortization for mortgages before and after 2013

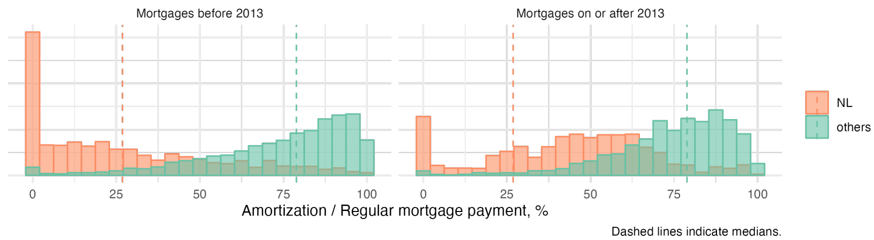


Figure 13: Distribution of amortization in the HFCS, mortgages before and after 2013

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

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

A.2 Amortization calculated via annuity formula

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

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

where r is the loan interest rate and T its residual maturity. This is illustrated in Figure 14 below, where I compute the ratio between the observed amortization and the amount implied by the annuity formula as above. Normally, in most countries, amortization payments increase slightly over time: monthly overall payments, rather than amortization amounts, are fixed in the terms of the loan. Therefore, other things equal, we would expect this measure to be slightly below 100% for the typical household.

The results of this exercise are shown in the histograms of Figure 15.

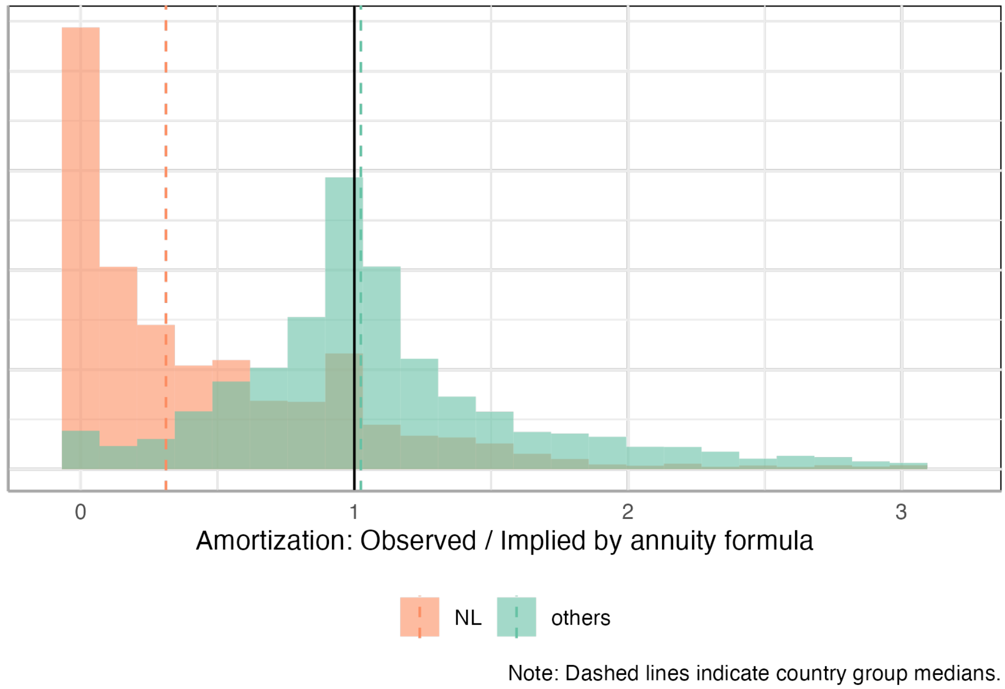
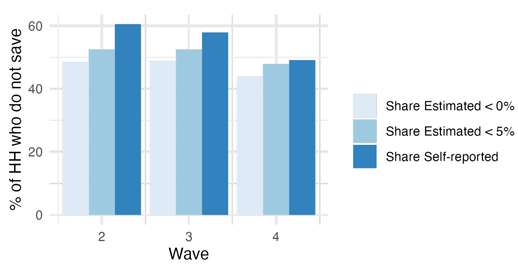
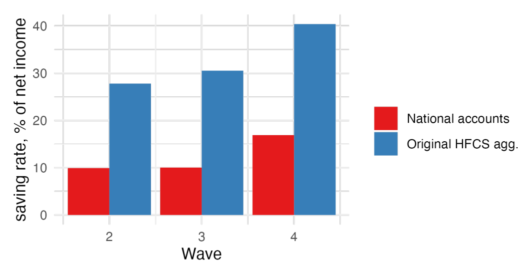


Figure 14: Histogram of the weight of amortization in regular mortgage payments, HFCS wave 3
Note: dashed lines indicate the group median. The solid line marks 100%.

A.3 Saving rates



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



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

Figure 15: Statistics of saving rate measure compared with external benchmarks