CFS Working Papers Series

No. 740

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# Tax Incentives, Portfolio Choice, and Macroprudential Risks*

Janosch Brenzel-Weiss  Winfried Koeniger†  Arnau Valladares-Esteban‡

January 28, 2026

**Abstract**

We calibrate a lifecycle portfolio-choice model of homeowners facing uninsurable income risk to show that tax deductions for mortgage interest payments and voluntary pension contributions have sizable effects on household portfolios and macroprudential risks. The deductions reduce the after-tax cost of debt and increase the after-tax return of pension savings so that the mortgage incidence increases and portfolios shift from home equity and liquid assets towards pension savings. Because the consumption responses to a house-price decline are heterogeneous, the distribution of household debt shapes the quantitative effect of the tax deductions on the homeowners' resilience after a house price bust.

***Keywords***— Mortgage amortization, Tax incentives, Household consumption, Portfolio choice, Housing busts, Economic stability, Macroprudential policy.
***JEL Codes***— D14, D15, D31, E21, G11, G21, H24.

*Janosch Brenzel-Weiss and Winfried Koeniger gratefully acknowledge support by the SNSF, Switzerland under project number 1000018-200917. We thank Jonathan Chassot for outstanding research assistance. We thank colleagues and participants at seminars and conferences for their helpful comments.

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# 1 Introduction

Home equity and pension savings play a central role in households' wealth accumulation. In practice, tax incentives for accumulating home equity and pension savings vary significantly across countries. In the US, the Netherlands, and Switzerland, for example, mortgage interest payments related to the primary residence are tax-deductible. Instead, this is not the case in Germany or France (OECD, 2020). At the same time, countries differ substantially in tax incentives towards voluntary pension savings (OECD, 2007, 2023).

We contribute to the literature by quantifying how more generous tax deductions for mortgage interest payments and voluntary pension contributions shape portfolio choices and macroprudential risks. To this end, we build a lifecycle portfolio-choice model of homeowners who earn stochastic labor income until retirement and decide between amortizing the mortgage, accumulating risk-free liquid assets, and saving in an illiquid pension account.

We calibrate the model to Germany, the largest European economy. Germany is an interesting setting for our quantitative analysis because the German tax system does not allow households to tax deduct mortgage interest payments for the primary residence, it has a relatively low cap on voluntary pension contributions that can be tax deducted, and there are discussions to change this setting.[1] In our main counterfactual, we assess the implications of changes that are inspired by existing alternative tax incentives for retirement saving in other high-income countries. We introduce a tax deduction of mortgage interest payments and raise the cap on tax-deductible voluntary pension contributions.

The more generous deductions increase mortgage incidence from 55.4% to 66.1%, while household debt increases by 8.1 percentage points (pp). The share of pension savings in the average homeowner's portfolio increases from 15.3% to 25.4%, while home equity decreases from 75.4% to 69.2%, and the share of liquid assets nearly halves. At the same time, net worth remains almost unchanged.

Portfolios shift from home equity and liquid assets to pension savings because of two main forces. First, the interest deduction reduces the after-tax cost of holding debt. In the benchmark economy, the gross interest rate agents pay to hold debt is 4%. However, once mortgagors can deduct interest payments, the after-tax cost of debt declines to an average of 3%, reducing the incentive to amortize and accumulate home equity.

Second, the more generous deduction for voluntary pension contributions increases the after-tax return of pension savings relative to home equity or liquid assets. The cap on deductible contributions limits the extent to which homeowners can benefit from this higher after-tax return. A larger cap allows homeowners to earn the higher after-tax return on a larger share of saved resources, and therefore increases their pension contributions.

The tax incentives we introduce into the calibrated German economy mimic those in Switzerland, allowing us to assess that about a quarter of the observed differences in mortgage incidence between the two countries can be accounted for by the interest deduction and the higher cap. The comparison between Germany and Switzerland is particularly suited to help us understand the role of tax incentives in shaping the differences in household portfolios observed in the data, as both countries have very similar mortgage credit supply and homeownership rates.

We ensure that the policy changes we implement in the model are revenue-neutral using two instruments. We accompany the interest deduction with the taxation of imputed rent, as implemented in Switzerland. The imputed rent taxes the housing services that homeowners derive from their own property. We show quantitatively that, in expectation, the imputed rent approximately offsets the tax savings associated with the interest deduction. Thus, the introduction of the interest deduction does not distort the expected value of owning a house. Furthermore, we increase the income tax level, while keeping tax progressivity fixed, to counteract the decline in tax revenue from a higher cap on pension

[1] See, for example, the summary of the political parties' position on tax incentives for homeowners, put in an international context in German Bundestag Research Service (2024).

contributions.

We find that the more generous tax deductions have quantitatively sizable implications for macroprudential risks. They reshape agents' consumption functions, and, thus, their marginal propensities to consume (MPCs). As Berger, Guerrieri, Lorenzoni, and Vavra (2018) have shown, changes in the MPCs imply different consumption responses to a house price bust.

In the short run, i.e., holding the benchmark portfolio distribution constant, the more generous deductions improve the consumption resilience to a house price bust of 96% of mortgagors. The median elasticity of consumption to a house price movement among mortgagors declines 15.3%, from 0.48 to 0.41. Because the interest deduction reduces the cost of holding debt, conditional on a portfolio position, mortgagors tend to have more resources available for consumption, which reduces their MPC and, therefore, the elasticity of their consumption to a house price change.

However, in the longer run, the more generous deductions also lead mortgagors to take on more debt. In our model, similarly to a broad class of incomplete-markets models with uninsurable risk, the MPC increases as debt approaches the borrowing constraint, which, in turn, tends to increase the elasticity of consumption to a change in the house price, creating a counterbalancing effect. The fraction of mortgagors who are more resilient to a house price bust due to the deductions declines from 96% to 81.2%, once we take into account the endogenous changes in the portfolio distribution.

The mortgage interest deduction primarily affects mortgagors, while the higher cap on deductible pension contributions has the largest impact on outright owners. Pension savings yield a substantially higher after-tax return than liquid assets, whose returns are taxed. Moreover, because outright owners tend to be closer to retirement, the illiquidity of pension savings is less of a concern for them. In the model, most outright owners contribute the maximum deductible amount to their pension account, both before and after the cap increase. A higher cap tends to raise their (illiquid) savings, their MPCs, and their consumption elasticity to a house price change.

In the short run, the median elasticity among outright owners increases 14.2%, from 0.18 to 0.20, with 67.4% of outright owners having a lower resilience to a house price bust. Accounting for the endogenous changes in portfolios raises the median elasticity among outright owners further to 0.28, a 57% increase with respect to the benchmark, and leaves 73.4% of outright owners more exposed to a decline in house prices.

Aggregating the effects on mortgagors and outright owners implies that, in the short run, the homeowners' average elasticity of consumption to a house price change is 9.5% lower due to the deductions, with 67.7% of homeowners being more resilient to a house price bust. However, accounting for the portfolio changes induced by the deductions, the average elasticity is 3.5% higher than the benchmark, while the share of homeowners with higher resiliency declines to 56.8%.

From a lifecycle perspective, the more generous deductions reduce the exposure of consumption to labor income risk. In the benchmark, the consumption of the median household has a coefficient of variation over the lifecycle of 18.0%. The deductions reduce it to 15.83%, with 90% of households experiencing smoother consumption in the counterfactual compared to the benchmark. We show that the lower after-tax cost of debt resulting from the interest deduction is the main driver of smoother consumption.

Overall, our findings suggest that tax deductions may serve as an additional macroprudential policy tool to reduce the impact of housing busts on homeowners' consumption. The deductions we study are likely to be most effective if implemented temporarily in the aftermath of a negative shock, i.e., before they significantly reshape portfolios over time.

Our analysis also illustrates the limits of using aggregate household debt as an indicator for the vulnerability of households to housing busts. The heterogeneous resposnes of homeowners to house-price declines imply that the distribution of debt shapes the effect of the tax deductions on the resilience of homeowners after housing busts. The tax deductions we study generate more household debt and, on average, increase the resilience of mortgagors' consumption to changes in house prices.

**Related literature.** Our analysis connects the strands of literature on (i) lifecycle portfolio choice with housing and illiquid retirement assets, (ii) tax incentives and portfolio composition, (iii) household balance sheets, MPCs, and the consumption response to housing busts, and (iv) macroprudential policies and comparative household finance. For brevity, we focus on some key contributions in each of these strands of literature.

*Lifecycle portfolio choice with housing and illiquid assets.–* Cocco (2005) and Cocco, Gomes, and Maenhout (2005) analyze how households facing uninsurable income risk allocate resources across liquid wealth, risky assets, and housing. Corradin, Fillat, and Vergara-Alert (2014), Fischer and Stamos (2013), and Longstaff (2001) emphasize that transaction costs and illiquidity shape portfolio choices and their optimal timing. We build on this literature and analyze in more depth how homeowners choose to amortize their debt and contribute to an illiquid pension account, with a focus on how tax incentives affect this portfolio choice.

*Tax incentives and portfolio composition.–* A large literature shows that tax incentives shift savings across taxable liquid assets, housing, and tax-favored mortgage debt and retirement accounts (Alan, Atalay, Crossley, and Jeon, 2010; Amromin, Huang, and Sialm, 2007; Karlman, Kinnerud, and Kragh-Sørensen, 2021; Poterba, 2001; Sommer and Sullivan, 2018). Our contribution is to *jointly* consider the tax deductibility of mortgage interest payments and voluntary pension contributions within a lifecycle model of homeowners, quantifying how a lower after-tax mortgage rate and a higher after-tax pension return reallocate portfolios from home equity toward pension savings.

*Balance sheets, MPCs, and consumption responses to shocks.–* Households with substantial illiquid wealth exhibit high marginal propensities to consume when their buffer stock of liquid assets is thin (Kaplan and Violante, 2014). Balance sheets of households thus affect the consumption response to macroeconomic shocks, as shown, for example, by Maxted, Laibson, and Moll (2025), who also focus on the portfolio choices of homeowners, as we do in this paper. Berger et al. (2018) have shown that the consumption response to house price changes can be approximated by the MPC and the exposure in terms of the house value at risk, implying a large heterogeneity in the consumption response of homeowners (Guren, McKay, Nakamura, and Steinsson, 2021; Hintermaier and Koeniger, 2024). Aastveit, Juelsrud, and Wold (2024) and van Bekkum et al. (2024) analyze empirically how tighter maximum LTV constraints affect the solvency and liquidity of households based on detailed micro data for the Netherlands and Norway, respectively. We contribute to this literature by analyzing how tax-induced portfolio shifts alter the MPCs and, consequently, the consumption response to a housing bust.

*Macroprudential policy and comparative household finance.–* The literature on borrower-based measures of macroprudential regulation analyzes the implications of financing constraints, as captured, for example, by the maximum loan-to-value ratio that restricts the size of mortgages (Bianchi and Mendoza, 2018; Jeanne and Korinek, 2019). Recent work by Balke, Karlman, and Kinnerud (2024) analyses how financing constraints shape household portfolios and the consumption response to shocks. We complement this research by showing the potential of tax deductions (for mortgage interest payments and voluntary pension contributions) as an additional macroprudential policy instrument. Furthermore, our analysis relates to the literature on comparative household finance, which highlights how institutional differences across countries shape portfolio patterns (Badarinza, Campbell, and Ramadorai, 2016).

Relative to previous research, which has investigated these issues separately – i.e., the effect of tax deductibility of mortgage interest payments on household debt, the effect of tax incentives on pension savings, and the effect of housing busts on consumption – we analyze these issues jointly. We do so within a lifecycle framework, in which tax incentives determine the amortization of mortgages as well as voluntary pension savings, with heterogeneous implications for MPCs, consumption elasticities with respect to house price changes, and macroprudential risk.

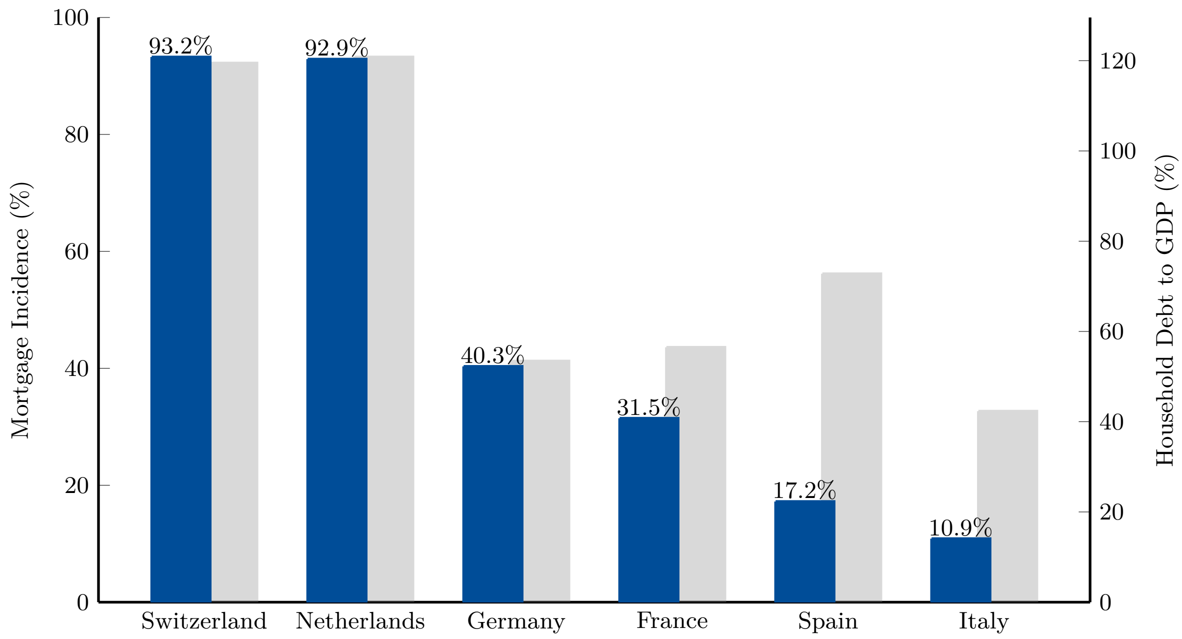
The rest of the paper is organized as follows. Section 2 presents the motivating evidence and describes the relevant institutional background. Section 3 introduces the model, and Section 4 describes its calibration. Section 5 shows how more generous tax deductions shape homeowners' portfolios quantitatively, and illustrates the main mechanisms. Section 6 provides quantitative results on the macroprudential implications of the more generous tax deductions. Section 7 concludes.

## 2 Empirical Motivation and Institutional Context

Figure 1 illustrates how mortgage incidence near retirement and household debt vary across the six largest economies in continental Europe.[2] The blue bars in Figure 1 show the fraction of near-retirement homeowners who hold mortgage debt linked to their main residence. The differences across countries are striking. In the Netherlands and Switzerland, more than 90% of homeowners still hold mortgage debt as they approach retirement, whereas mortgage incidence is much lower in the rest of the countries. In France and Germany, mortgage incidence is between 30% and 40%, and in Spain and Italy it is below 20%.

Because mortgage debt is the largest component of household debt, Figure 1 further shows that there is a strong cross-country association between near-retirement mortgage incidence and household debt-to-GDP ratios, which we plot in light gray bars.[3] Household debt-to-GDP ratios are above 120% in Switzerland and the Netherlands, and below 60% in Germany, France, and Italy.

Figure 1: Mortgage incidence near retirement and household debt across European economies




**Notes**: On the left vertical axis: SHARE 2013 (Netherlands) and 2015 (France, Germany, Italy, Spain, and Switzerland). Mortgage incidence of non-retired homeowners between ages 51 and 65. On the right vertical axis: IMF 2013-2015. Household debt, loans, and debt securities as a percentage of GDP.

Many factors may explain the differences in near-retirement mortgage incidence and household debt across countries. However, the Netherlands and Switzerland, the countries with high mortgage incidence and high household debt, share a critical feature of the tax system: mortgage interest payments associated

[2] In the US, the mortgage incidence among homeowners aged 50 or above is 57% (West et al., 2014, Table 3-8), and household debt as a percentage of GDP is 79%, as reported by the IMF Global Debt Database for 2013-2015. Due to the implicit government subsidies that imply a dominance of 30-year fixed-term mortgage contracts with full amortization in the US, which is rather unique among high-income countries (Badarinza et al., 2016), we do not include the US in Figure 1.

[3] Bover, Casado, Costa, Caju, McCarthy, Sierminska, Tzamourani, Villanueva, and Zavadil (2016) document that large differences in secured debt across euro-area countries remain after controlling for household composition.

with the main residence are tax deductible, while there is no comparable counterpart for this tax deduction in Germany, France, Italy, or Spain (Bover et al., 2016; Bourassa et al., 2010).

We argue that these differences in tax incentives play an important role in explaining the observed differences in near-retirement mortgage incidence and household debt across countries. We develop a lifecycle portfolio-choice model of homeowners who decide on mortgage amortization, liquid savings, and illiquid pension savings. We assess the quantitative importance of tax incentives by calibrating the model to Germany and then introducing the tax incentives that mimic those observed in Switzerland. This counterfactual exercise allows us to quantify how much of the difference in near-retirement mortgage incidence that we observe in Figure 1 can be accounted for by the tax incentives.

Comparing Germany to Switzerland is particularly informative, as the two countries are similar across several key dimensions but differ in the tax incentives for amortizing the mortgage (i.e., accumulating home equity) and voluntary pension savings, the two main portfolio components for most households.

In Switzerland, homeowners can deduct mortgage interest payments on their primary residence, whereas that is not the case in Germany. Switzerland also features a substantially higher cap for deducting voluntary pension contributions than Germany, which, as we show in Section 5, also contributes to explaining the difference in mortgage incidence between the two countries.[4]

At the same time, the mortgage supply side is broadly comparable across the two countries.[5] Lending criteria are similar: when buying a house, the lender typically requires the future homeowner to make a down payment of at least 20% of the house value. The remainder may be financed with a mortgage. The implicit maximum loan-to-value (LTV) ratio is not legally binding. However, lenders typically impose it because mortgages with higher LTV ratios often trigger stricter capital requirements. In both countries, the typical first-time homeowner is about 45 years old and takes on initial debt, implying a LTV ratio of about 70%.

The lending standards in Germany and Switzerland are conservative in international comparison. This implies that mortgage delinquency and negative home equity after house price corrections are negligible. Therefore, we abstract from these risks in our analysis. The homeownership rate among household heads aged 36 to 65, on which we focus in our model, is also similar and around 50% in both countries.[6] Although the homeownership rate is lower in Germany and Switzerland than in other developed countries, homeowners account for a large part of the population so that they are in the focus of macroprudential regulators.[7]

# 3 The Model

We consider a dynamic, lifecycle portfolio-choice model of homeowners who are exposed to uninsurable income risk. Our goal is to illustrate how tax deductions for mortgage interest payments and voluntary pension contributions shape the portfolio choices of homeowners, their MPCs, and the elasticity of consumption to a house price change.

For this purpose, we abstract from the possible effects of tax deductions on homeownership decisions. In a frictionless economy (e.g., without uninsurable income risk and interest rate spreads), the interest deduction does not affect the value of owning a house when accompanied by the taxation of imputed rent. In our setting, this result holds quantitatively in expectation, as we discuss further below.

[4]The cap in Germany corresponds to 6.8% of the average annual income compared to 13.5% in Switzerland. We summarize the pension systems in Germany and Switzerland in Appendix A.

[5]See Drudi et al. (2009), Basten and Koch (2015), Swiss National Bank (2018), and Koeniger, Lennartz, and Ramelet (2022).

[6]Using data from the Household Finance and Consumption Survey (HFCS), we compute a homeownership rate in Germany of 51% for household heads aged 36 to 65. We obtain 49% using the German Socio-Economic Panel (SOEP). For the same age group in Switzerland, we find rates of 51% using the Swiss Household Panel (SHP) and 44% using the Household Budget Survey (HABE).

[7]For example, Switzerland further tightened the borrowing requirements for homeowners after the financial crisis. See the analysis and references in Bolliger et al. (2025) for further details.

Homeowners face persistent labor income shocks, and their expected average lifecycle income profile has the standard hump shape. Upon retirement, agents earn returns from their net worth and obtain a pay-as-you-go pension based on their prior history of labor earnings. Before retirement, homeowners choose how to allocate their savings. They choose between contributing to illiquid pension savings and accumulating home equity if they have a mortgage or other liquid assets if they are outright owners.

Pension savings are illiquid until retirement, and homeowners can make tax-deductible, voluntary contributions up to a cap. Homeowners may or may not be able to deduct mortgage interest payments, depending on the tax deduction regime. The generosity of tax deductions will thus affect the portfolio choice of homeowners. Risk aversion and prudence lead agents to strike a balance between maintaining sufficient liquidity and achieving higher after-tax portfolio returns. Because tax rates are progressive, portfolio choices affect marginal tax rates as they change taxable income.

Homeowners with a representative house value enter the model as mortgagors obtaining a draw of home equity and pension savings. To reduce the computational burden, we model the accumulation of home equity or liquid assets using the same state variable, called *liquid equity*. Furthermore, the house value provides collateral. The house value restricts borrowing as determined by a maximum loan-to-value (LTV) ratio. We allow for an interest spread, with a higher interest rate on negative liquid equity positions.

As mentioned above, we abstract from homeownership choices following Campbell and Cocco (2003), Berger et al. (2021), and Maxted et al. (2025). On the one hand, this improves computational tractability as the model already includes four state variables (two of which are endogenous), a consumption and portfolio choice, a nonlinear tax function, and three occasionally binding constraints (two of which depend on an endogenous state variable). On the other hand, we do not expect that adding a homeownership choice would substantially alter the key insights of the analysis because the policy changes we consider do not quantitatively change the value of owning a house.

Let us explain. Although the tax deduction of mortgage interest payments potentially distorts the value of owning a house, this distortion is offset by the taxation of the imputed rent for owned housing, which we introduce at the same time (in line with observed tax regimes as explained in Section2). That is, for a given mortgage and amortization schedule, the tax deduction of mortgage interest payments reduces the user cost for a homeowner with a mortgage. It is well known, however, that the taxation of the imputed rent eliminates this distortion in a frictionless environment, in which the imputed rent equals the market value of the rental income that homeowners would earn if they rented the property.[8] As we explain in more detail in Section 5, we choose the level of the imputed rent so that it also offsets the distortion in homeownership choice in our economy with frictions. Quantitatively, the tax deduction for mortgage interest payments, combined with the imputed rent, leaves the expected value of homeownership approximately unchanged.

## 3.1 The Portfolio-choice Problem

Homeowners have model age $j = 1, \ldots, J$ until retirement. Because the model is specified in discrete time and the tax burden depends on portfolio choices, the timing of asset return accrual is important. We assume that agents observe their income shock at the beginning of the period, choose consumption and portfolio allocations, and then asset returns accrue before the period ends. This timing assumption makes the consequences of tax optimization transparent because the tax implications of portfolio choices materialize in the current period.[9] We further assume for tractability that asset returns and prices are risk-adjusted and certain.

We present the optimization problem of homeowners in recursive form and then provide a more

[8]See Gruber, Jensen, and Kleven (2021), for example, for a recent presentation of this argument in the context of an empirical application to the Danish housing market.

[9]The alternative assumption that returns accrue at the beginning of the next period would imply that the tax implications of current portfolio choices are only known in expectation, given that income is uncertain.

detailed explanation. For a given position of liquid equity $a$, pension savings $a_p$, income realization $y$, and age $j$, the value function is given by:

$$V^j(a, a_p; y) = \max_{c, a', a'_p} \left\{ u(c) + \beta \mathbb{E}_{y'} V^{j+1}(a', a'_p; y') \right\}$$

$$\text{s.t.} \quad c^{a' \geq 0} = y - T(y_\tau^{a' \geq 0}) - (q_p a'_p - a_p) - (q_a a' - a), \tag{1}$$

$$c^{a' < 0} = y - T(y_\tau^{a' < 0}) - (q_p a'_p - a_p) - (q_\ell a' - a), \tag{2}$$

$$y_\tau^{a' \geq 0} = y + \theta_\ell (\iota + \zeta_h) h - (q_p a'_p - a_p) + \iota q_a a', \tag{3}$$

$$y_\tau^{a' < 0} = y + \theta_\ell (\iota + \zeta_h) h - (q_p a'_p - a_p) + \theta_\ell (\iota + \zeta_\ell) q_\ell a', \tag{4}$$

$$q_a = 1/(1 + \iota), \; q_\ell = 1/(1 + \iota + \zeta_\ell), \; q_p = 1/(1 + \iota + \zeta_p), \tag{5}$$

$$(\bar{p} + a_p)/q_p \geq a'_p \geq a_p/q_p > 0, \tag{6}$$

$$a' \geq -\bar{\mu} h, \tag{7}$$

$$y(j) = \exp\left( \sum_{i=0}^{4} \psi_i \cdot j^i + \hat{y} \right), \text{ and} \tag{8}$$

$$\hat{y}' = \rho \hat{y} + \epsilon, \text{ where } \epsilon \sim \mathcal{N}(0, \sigma_\epsilon^2). \tag{9}$$

Given the state variables $(a, a_p, y, j)$, agents decide current consumption $c$, next-period liquid equity $a'$ and pension savings $a'_p$. We assume a standard continuous, concave, and twice differentiable utility function $u(c)$, and a discount factor $\beta > 0$.

The budget constraint in (1) and (2) differs depending on whether the homeowner chooses a positive or negative liquid equity position ($a' \geq 0$ or $a' < 0$). The distinction is required because of the interest spread and the tax deductions which (i) depend on the chosen liquid equity position, and (ii) affect the taxable income $y_\tau$ that enters the tax function $T(\cdot)$.

Taxable income is defined in (3) and (4), respectively. When the liquid equity position is chosen to be positive, the asset earns the risk-free rate $\iota$ and the interest income $\iota q_a a'$ is included in taxable income.[10] With a negative liquid equity position, the homeowner borrows and thus pays the risk-free rate plus a spread $\zeta_\ell$. The homeowner can deduct interest payments $(\iota + \zeta_\ell) q_\ell a' < 0$ from taxable income if the tax-deduction regime allows it. The value of the indicator variable $\theta_\ell = \{0, 1\}$ captures whether mortgage interest payments can be deducted.

As previously discussed, the deduction is accompanied by the taxation of the imputed rent $(\iota + \zeta_h) h$. The parameter $\zeta_h$ captures the spread, which is used for tax purposes to compute the rental return on the house value $h$. The borrowing constraint in (7) also depends on the value of the house as collateral and features a maximum LTV ratio $\bar{\mu}$.

The contributions to pension savings $q_p a'_p - a_p$ reduce taxable income regardless of the position in liquid equity. As shown in (6), the contributions are capped at $\bar{p}$, and pension savings remain illiquid until retirement, i.e., contributions cannot be reversed, implying that the stock of pension savings cannot be reduced.[11]

Finally, (8) and (9) describe the labor income process. Shocks follow an autoregressive process of order one with persistence parameter $\rho$ and variance $\sigma_\epsilon^2$. The deterministic component follows a hump-shaped profile, as described by a fourth-degree polynomial.

[10] The multiplication with the price $q_a$ results from the timing assumption, as one unit of the asset $a'$ costs $q_a a'$ at the time when the portfolio is chosen.

[11] In the last period before retirement (at age $J$), liquid equity and pension savings are equally liquid, which is at odds with the illiquidity premium $\zeta_p$ that we assume for pension savings. We therefore do not allow pension contributions in the last period so that $q_p a'_p - a_p = 0$ for all homeowners in period $J$.

### 3.2 The Retirement Period

The continuation value at retirement depends on accumulated, consolidated net worth and pre-retirement labor income:

$$\begin{aligned} V^{J+1}(a, a_p) =& \frac{1}{1-\beta} u\left(y_\tau^{J+1} - T\left(y_\tau^{J+1}\right)\right), \text{ where} \\ y_\tau^{J+1} =& \iota \cdot x + \chi \cdot y^{J+1}, \text{ and} \\ x =& h + a + a_p - \upsilon \frac{a^2}{2} \mathbb{1}_{a<0}. \end{aligned}$$

We model consumption in the retirement period as for a permanent income consumer with (approximately) infinite horizon who faces no uncertainty and discounts the future at the risk-free rate $\iota$. Thus, consumption equals the after-tax income flow $y_\tau^{J+1} - T\left(y_\tau^{J+1}\right)$.

Taxable income in retirement $y_\tau^{J+1}$ consists of the returns on net worth $\iota \cdot x$ and a public pension transfer $\chi \cdot y^{J+1}$. Net worth ($x$) is the consolidated asset position based on the portfolio at retirement, net of a cost of retiring with debt $\upsilon \frac{a^2}{2} \mathbb{1}_{a<0}$ with the indicator function $\mathbb{1}_{a<0}$ taking value one if $a < 0$ and zero otherwise. The cost is quadratic in debt size and scaled by the parameter $\upsilon$. It captures costs that indebted homeowners may face, such as those incurred when bequeathing a house with a mortgage. The parameter $\upsilon$ also provides an additional margin to match mortgage incidence and debt at retirement when calibrating the model to the data.[12]

The transfer $\chi \cdot y^{J+1}$ from the pay-as-you-go pension is determined by the replacement ratio $\chi$ applied to income $y^{J+1}$, which is estimated based on the history of pre-retirement income conditional on the last income realization at age $J$.[13] This approach allows the pension transfer to be a function of the (estimated) income history without having to add state variables to the problem.

### 3.3 Optimal Choices and After-tax Returns

The solution to the model is characterized by three policy functions: $c^j(a, a_p; y)$ for consumption, $a'^j(a, a_p; y)$ for next-period liquid equity, and $a_p'^j(a, a_p; y)$ for next-period pension savings, as well as by the distribution of agents over the state space, $\Gamma(a, a_p, j, y)$.

To better understand the shape of the policy functions, we derive the conditions that govern optimal choices. For clarity, we present these equations only for interior optima and then discuss features of the solution at corners below.

The first-order conditions, which characterize the optimal portfolio choices at interior optima, are

$$\beta \frac{\partial \mathbb{E}_{y'} V^{j+1}(a', a_p'; y')}{\partial a'} = q_a \frac{\partial u(c)}{\partial c} \left(1 + \iota \frac{\partial T(y_\tau)}{\partial y_\tau}\right) \tag{10}$$

for positive next-period liquid equity ($a \geq 0$),

$$\beta \frac{\partial \mathbb{E}_{y'} V^{j+1}(a', a_p'; y')}{\partial a'} = q_\ell \frac{\partial u(c)}{\partial c} \left(1 + (\iota + \zeta_\ell)\theta_\ell \frac{\partial T(y_\tau)}{\partial y_\tau}\right) \tag{11}$$

for negative next-period liquid equity ($a' < 0$), and

$$\beta \frac{\partial \mathbb{E}_{y'} V^{j+1}(a', a_p'; y')}{\partial a_p'} = q_p \frac{\partial u(c)}{\partial c} \left(1 - \frac{\partial T(y_\tau)}{\partial y_\tau}\right) \tag{12}$$

for next-period pension savings.

[12] An alternative option is to calibrate a parameter $\xi$ that scales the value of the retirement period, so that $V^{J+1}(a, a_p) = \xi \cdot \frac{1}{1-\beta} \dots$. The advantage of our approach is that it makes the cost explicit in monetary units, allowing for a more immediate interpretation.

[13] See, for example, Yang (2009) or Hintermaier and Koeniger (2011) for further details.

Taxable income $y_\tau(a', a'_p, a_p, y)$ is a function of state variables ($a_p$ and $y$) and control variables ($a'$ and $a'_p$). Thus, tax deductions open an additional channel through which endogenous choices affect both sides of the first-order conditions (10), (11), and (12). In what follows, we explicitly state the arguments of the taxable income function to clarify how tax incentives shape optimal decisions.

The envelope conditions at interior optima are

$$\begin{aligned}\frac{\partial V^j}{\partial a} =& \frac{\partial u(c)}{\partial c}, \text{ and}\\ \frac{\partial V^j}{\partial a_p} =& \frac{\partial u(c)}{\partial c}\left(1 - \frac{\partial T\left(y_\tau(a', a'_p, a_p, y)\right)}{\partial y_\tau}\right),\end{aligned}$$

implying that

$$\frac{\partial \mathbb{E}_{y'} V^{j+1}(a', a'_p; y')}{\partial a'} = \mathbb{E}_{y'}\left[\frac{\partial u(c')}{\partial c'}\right], \text{ and} \tag{13}$$

$$\frac{\partial \mathbb{E}_{y'} V^{j+1}(a', a'_p; y')}{\partial a'_p} = \mathbb{E}_{y'}\left[\frac{\partial u(c')}{\partial c'}\left(1 - \frac{\partial T\left(y_\tau(a'', a''_p, a'_p, y')\right)}{\partial y_\tau}\right)\right], \tag{14}$$

where $c'$ denotes consumption in the next period, and $a''$ and $a''_p$ denote the choice of liquid equity and pension savings two periods ahead.

The first-order conditions (10) to (12) together with the envelope conditions (13) and (14) imply that the expected marginal rate of intertemporal substitution equals the relative after-tax price for substituting consumption across periods. We now discuss how tax deductions shape the relative price and, thus, change accumulation decisions by triggering intertemporal substitution of consumption.

*Liquid assets.–* Combining (10) and (13), for a homeowner who accumulates positive next-period liquid equity,

$$\beta \mathbb{E}_{y'}\left[\frac{\frac{\partial u(c')}{\partial c'}}{\frac{\partial u(c)}{\partial c}}\right] = q_a\left(1 + \iota \frac{\partial T\left(y_\tau(a', a'_p, a_p, y)\right)}{\partial y_\tau}\right). \tag{15}$$

The after-tax return of accumulating liquid equity, on the right-hand side of (15), decreases with the amount of liquid equity. Each additional unit of liquid equity savings generates lower after-tax returns than the previous one because the flow of gross returns $\iota q_a a'$ increases taxable income and the marginal tax burden as taxes are progressive.

*Home equity.–* Combining (11) and (13), for a homeowner who accumulates negative next-period liquid equity (and thus home equity),

$$\beta \mathbb{E}_{y'}\left[\frac{\frac{\partial u(c')}{\partial c'}}{\frac{\partial u(c)}{\partial c}}\right] = q_\ell\left(1 + (\iota + \zeta_\ell)\theta_\ell \frac{\partial T\left(y_\tau(a', a'_p, a_p, y)\right)}{\partial y_\tau}\right). \tag{16}$$

Equation (16) shows how the tax deduction for debt interest payments affects the after-tax return of accumulating liquid equity. Without the deduction ($\theta_\ell = 0$), the right-hand side of the equation equals $q_\ell$. With the deduction ($\theta_\ell = 1$), the price increases because the factor multiplying $q_\ell$ is greater than 1, thus implying a *de*crease of the after-tax return. Ceteris paribus, this induces intertemporal substitution towards present consumption and less accumulation of home equity (i.e., less amortization of the mortgage). Whether the agent indeed finds it optimal to consume more will also depend on the size of the income effect and the attractiveness of other possible portfolio choices, such as pension savings.

Note that, with the interest deduction, accumulation of home equity increases taxable income and thus the marginal tax burden, reducing the after-tax return on the right-hand side of (16). Adding a marginal unit of home equity implies that the risk-free interest rate plus the mortgage spread ($\iota + \zeta_\ell$) can no longer be deducted for the repaid unit of debt.

The accumulation behavior for liquid equity differs at the corners, i.e., at (or close to) the borrowing constraint or close to $a' = 0$, where the interest spread makes (15) and (16) slack. The effect of the interest deduction on consumption and accumulation behavior close to the corners shows in the consumption function, its slope, and thus in the marginal propensity to consume as discussed further in Section6.

*Pension savings.*– Combining (12) and (14), for a homeowner who accumulates pension savings,

$$\beta \mathbb{E}_{y'} \left[ \frac{\frac{\partial u(c')}{\partial c'}}{\frac{\partial u(c)}{\partial c}} \right] = \frac{1}{\mathbb{E}_{y'} \left[ 1 - \frac{\partial T\left(y_\tau(a'', a_p'', a_p', y')\right)}{\partial y_\tau} \right]} \times \left[ q_p \left( 1 - \frac{\partial T\left(y_\tau(a', a_p', a_p, y)\right)}{\partial y_\tau} \right) + \frac{\mathrm{Cov}\left( \frac{\partial u(c')}{\partial c'}, \frac{\partial T\left(y_\tau(a'', a_p'', a_p', y')\right)}{\partial y_\tau} \right)}{\frac{\partial u(c)}{\partial c}} \right]. \tag{17}$$

Differently to (15) and (16), the right-hand side of (17) does not only depend on the exogenous asset price $q_p$ and the current-period marginal change in the tax burden $\left(\partial T\left(y_\tau(a', a_p', a_p, y)\right)/\partial y_\tau\right)$, but also on the expected next-period marginal change in the tax burden and its comovement with next-period marginal utility. The reason is that the tax deduction associated with pension savings is based on the contribution to pension savings (a flow) rather than the level of future pension savings (a stock). Thus, the decision to accumulate pension savings features an additional intertemporal trade-off as it offers the opportunity to shift the tax burden over time by choosing the optimal timing of voluntary contributions.[14]

The additional intertemporal trade-off strengthens the channel through which current-period after-tax returns of accumulating voluntary pension savings depend on the expected saving behavior in the future. This effect is already transparent for interior optima, as illustrated in (17). It becomes even more relevant once corner solutions are considered. Because tax-deductible voluntary pension contributions are capped, the agent may accumulate more pension savings in the current period if the contributions are expected to be constrained by the cap in some future income states. Analogously, because pension savings are illiquid, the homeowner may make less voluntary pension contributions today if the illiquidity of pension savings is expected to be binding in some future income states.

# 4 Calibration

We determine the 22 parameters of the model in three steps. First, we set 9 parameters to values commonly used in the literature or to values that reflect the German economic and institutional context. Second, we estimate the 9 parameters governing the exogenous income process and the tax function using microdata on taxable and disposable income for German homeowners. Finally, we calibrate the remaining 4 parameters using the simulated method of moments (SMM) to match the observed age profiles of mortgage incidence, pension savings, and liquid equity among German homeowners.

## 4.1 Mapping the Model to the Data

To calibrate the model, we use income data from the German Socio-Economic Panel (SOEP) and wealth data from the Household Finance and Consumption Survey (HFCS), as detailed in Appendix B. In both the SOEP and the HFCS, our main sample consists of non-retired homeowners aged 36 to 65. We estimate the income process and the tax function with the SOEP income data, as explained in the respective Appendix D andE.

We require a data counterpart for the three wealth variables in the model: the house value, pension savings, and liquid equity.[15] Mapping the house value and pension savings from the model to the data

[14]There is a risk associated with the choice of the timing. As equation (17) shows, contributing to voluntary pension savings becomes more attractive if the covariance between tomorrow's marginal utility of consumption and marginal tax rate is negative.

[15]Appendix Section B.1 explains in more detail how we construct these variables.

is straightforward as there are direct counterparts in the data. Because the model has two endogenous state variables, i.e., illiquid pension savings and liquid equity, we need to take a stand which items from the household balance sheets in the data we include in liquid equity. Liquid equity in the model consolidates liquid assets and the mortgage debt associated with the primary residence. We define the data counterpart of liquid equity as the sum of liquid assets (deposits, mutual funds, bonds, and shares) and the outstanding balance on the mortgage of the main residence and other non-mortgage debt.

This mapping implies that model net worth ($h + a + a_p$) does not necessarily coincide with total net worth in the data because we do not include other illiquid assets in our measure of liquid equity. In practice, the net worth based on the mapping described above covers most of the wealth reported in the HFCS. In our sample, the net worth implied by our mapping accounts for 85.9% of total net worth for the average household and for 89.9% for the median household.

The definition of a mortgagor through the lens of the model also differs slightly from a purely data-driven definition. In the model, a mortgagor is a homeowner with negative liquid equity ($a < 0$) whereas, in the data, a mortgagor is typically defined as a household with outstanding mortgage debt on its primary residence. In practice, the two definitions imply similar outcomes. In our sample, the mortgage incidence is 52.2% applying the typical data-driven definition and it is 50.7% when mapping the model to the data. Moreover, 90.2% of households classified as mortgagors through the lens of the model are also classified as mortgagors according to the purely data-based definition.

## 4.2 Parameter Values

We report the parameter values in Table 1.

**Externally determined.** We assume a period utility function with constant relative risk aversion. We set risk aversion ($\sigma$) to the standard value of 2.

We specify a risk-free rate ($\iota$) of 0.5%, consistent with the real return on long-term government bonds in Germany during the 2010s. The risk-adjusted interest spread for mortgages ($\zeta_\ell$) is 3.5 percentage points (pp) and the risk-adjusted illiquidity premium for pension savings ($\zeta_p$) is 0.5 pp in line with Drudi et al. (2009) and OECD (2007, 2023). The value of the interest spread for mortgages is specified in the context of the related modeling assumption that homeowners have the possibility to borrow against the full value of their house and thus may be highly leveraged.[16]

The cap for tax-deductible contributions ($\bar{p}$) equals €2,500 and the pay-as-you-go pension replacement rate ($\chi$) is 39.9%. We provide the institutional background for these parameter values in Appendix A.

We allow homeowners to borrow up to the full value of their house by setting the maximum LTV ratio ($\bar{\mu}$) to 100%.[17] As discussed in Section 2, we do not allow the deduction of mortgage interest payments ($\theta_\ell = 0$), as is the case in Germany. The house value ($h$) is set to the median house value among homeowners in our HFCS sample.

**Externally estimated.** We estimate the income process using SOEP income data, as detailed in Appendix D. Both the deterministic and stochastic components are estimated from non-retired homeowners aged 36-65.

The parameters of the tax function are also estimated based on the SOEP data (Appendix E). The estimates imply that taxes in Germany are higher in terms of their level and also more progressive than in the US.

[16]In Appendix Section G.3, we show that the main results of Section 6 are robust to using different values for the mortgage spread (1.5 pp, 2.5 pp, or 4.5 pp).

[17]In the benchmark calibration, only 0.6% of agents have an LTV ratio of 95% or higher. In Appendix Section G.4, we show that the main results of Section 6 are robust to using different values for the maximum LTV ratio (80%, 90%, or 110%).

**Internally calibrated.** We calibrate the remaining parameters using SMM. All agents enter the model as mortgagors at age 25, earn the median income, own a house of value $h$, and are endowed with the same initial level of pension savings ($a_{p,0}$) and liquid equity ($a_0$).

Table 1: Parameter values

| | | |
|---|---|---|
| Externally set | | |
| Risk aversion | $\sigma$ | 2.0 |
| Risk-free interest rate | $\iota$ | 0.5% |
| Mortgage spread | $\zeta_\ell$ | 3.5 pp |
| Illiquidity premium | $\zeta_p$ | 0.5 pp |
| Cap deductible pension contributions | $\bar{p}$ | €2,500 |
| Public pension replacement rate | $\chi$ | 39.9% |
| Borrowing constraint, as max. loan-to-value ratio | $\bar{\mu}$ | 100% |
| Non-deductible interest payments | $\theta_\ell$ | 0 |
| House value | $h$ | €140,102 |
| Externally calibrated | | |
| Income age ($j$) profile: $y(j) = \exp\left(\sum_{i=0}^{4} \psi_i \cdot j^i + \hat{y}\right)$ | | |
| Constant | $\psi_0$ | -0.245 |
| 1st degree coefficient | $\psi_1$ | -0.003 |
| 2nd degree coefficient | $\psi_2$ | 0.002 |
| 3rd degree coefficient | $\psi_3$ | -5.3e-05 |
| 4th degree coefficient | $\psi_4$ | 1.3e-07 |
| Income process: $\hat{y}' = \rho\hat{y} + \epsilon$, where $\epsilon \sim \mathcal{N}(0, \sigma_\epsilon^2)$ | | |
| Persistance | $\rho$ | 0.806 |
| Variance of innovations | $\sigma_\epsilon^2$ | 0.078 |
| Tax function: $T(y_\tau) = y_\tau - \nu_0 y_\tau^{1-\nu_1}$ | | |
| Level | $\nu_0$ | 0.814 |
| Progressivity | $\nu_1$ | 0.171 |
| Internally calibrated | | |
| Discount factor | $\beta$ | 0.984 |
| Cost of outstanding mortgage debt at retirement | $\upsilon$ | 1.314 |
| Initial liquid equity | $a_0$ | €-96,151 |
| Initial pension savings | $a_{p,0}$ | €7,518 |

We choose the initial portfolio position ($a_0$ and $a_{p,0}$), the discount factor ($\beta$), and the parameter ($\upsilon$) governing the cost of outstanding mortgage debt at retirement to match the observed age profiles of mortgage incidence, liquid equity, and pension savings.[18] For mortgage incidence and liquid equity, we target the age bins 36-40 and 61-65. For pension savings, we match the age bins 36-40 and 51-55 because a pension reform in Germany in the beginning of the 2000s affects the comparability of pension savings for older individuals.[19] Furthermore, the calibration implies an initial LTV ratio of 69%, closely

[18]In the benchmark calibration, 37.4% of agents reach retirement with outstanding mortgage debt. Among these agents, the median cost for outstanding mortgage debt at retirement ($\upsilon\frac{a^2}{2}$) is €5,817, and the mean is €23,969.

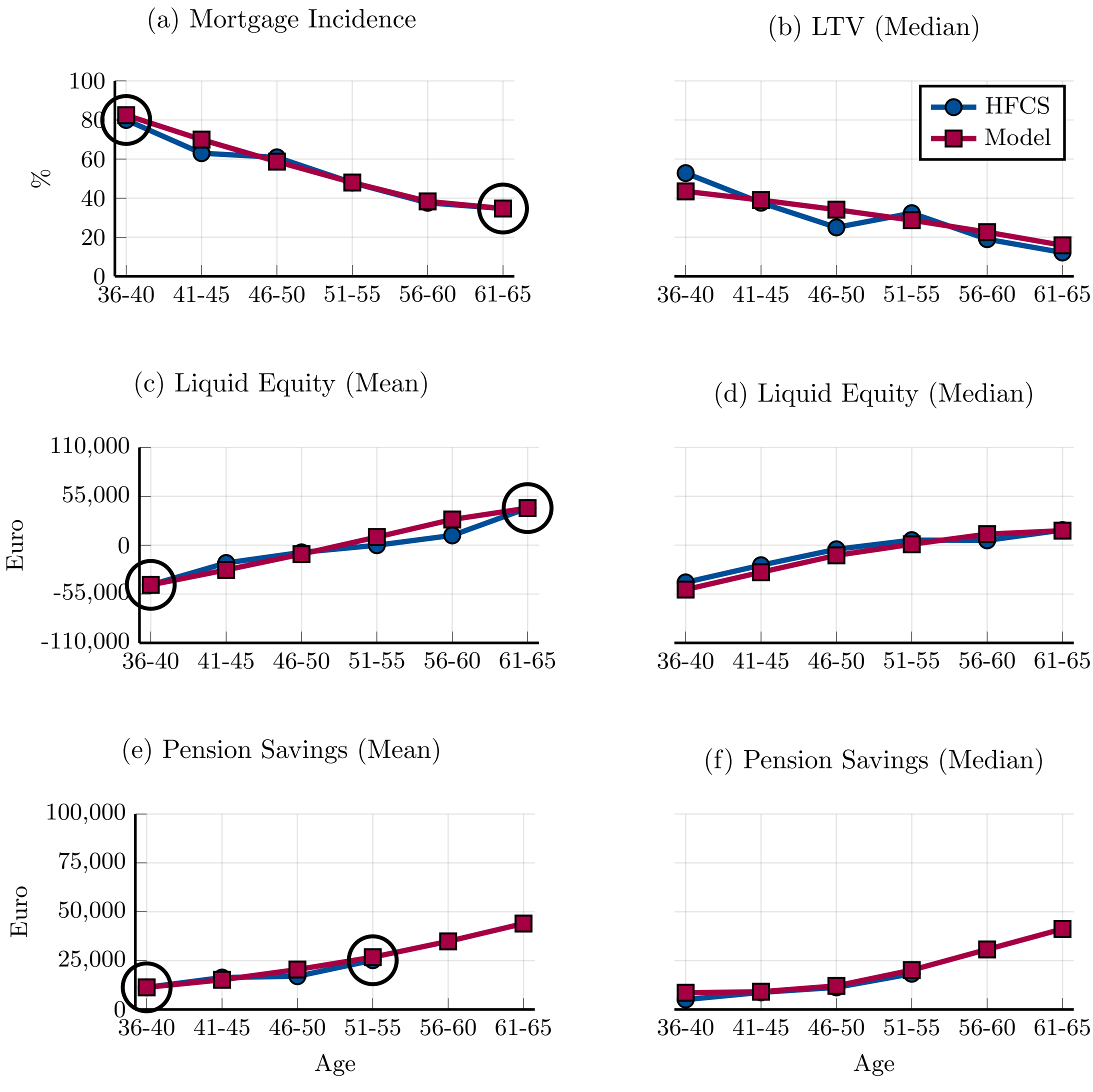
[19]The tax deductible voluntary pension savings (*Riester-Rente*), as specified in our calibration, were introduced

matching the loan-to-value of the typical first-time buyer in Germany (see Section 2).

Throughout the analysis, we focus on ages 36 to 65. That is, we let the model generate an endogenous, non-degenerate distribution of portfolios and income trajectories between ages 25 and 35 before comparing it to the data. The joint distribution of expected lifetime income and current portfolio composition plays a central role in lifecycle portfolio choice models, yet it is not directly observable. Our calibration strategy disciplines this distribution using key empirical moments once the model has populated the state space.

### 4.3 Model Fit

Figure 2: Data vs. model age profiles




**Notes**: HFCS 2014. All monetary values are equivalized and in 2015 euros. The blue lines are HFCS data estimates. The red lines are model counterparts. The black circles indicate the six data targets in the SMM calibration. The remaining data moments are untargeted.

Figure 2 compares the age profiles in the data and in the model for mortgage incidence, mortgagors' LTV ratios, liquid equity, and pension savings. We compute the empirical profiles by grouping observations into five-year age bins from 36-40 to 61-65. The figure shows 32 moments in total, of which 6 are targeted in the calibration (marked with black circles), as discussed in Section 4.2.

in the context of these reforms.

The model matches the targeted moments well and closely reproduces the age profiles for all four variables. Firstly, the model replicates both the extensive and intensive margin of household debt. It generates the decline in mortgage incidence by age observed in the data (Panel 2a); and it closely matches the median LTV ratio among mortgagors, despite this profile not being directly targeted (Panel 2b).

Secondly, the model reproduces the increase in liquid equity across age groups, as displayed in the middle panels of Figure 2. Because liquid equity consolidates mortgage debt and liquid assets, matching this pattern implies that the model captures both the gradual mortgage amortization and the accumulation of liquid savings. The model fits both the mean and median profiles well.

Finally, the bottom panels of Figure 2 show that the model accurately matches the increase of pension savings with age, again both at the mean and the median.

**The role of specific parameters for the model fit.** Because we calibrate 4 parameters to match 6 moments, the parameters are jointly identified by the moments. Nevertheless, we can explain further how the SMM-calibrated parameters shape the lifecycle profiles in Figure 2.

The discount factor $\beta$ primarily governs the pace of asset accumulation over the life cycle. A higher $\beta$ leads to steeper growth in liquid equity and pension savings and, correspondingly, a faster decline in mortgage incidence. The cost of outstanding mortgage debt at retirement (associated with the parameter $\upsilon$) plays a similar role, but it mainly affects agents with negative liquid equity. Therefore, it influences mortgage incidence and the slope of the liquid equity profile for indebted agents.

The initial endowments (at model entry at age 25) of liquid equity $a_0$ and pension savings $a_{p,0}$ help to match the levels of mortgage incidence, liquid equity, and pension savings at ages 36 to 40. Whereas $\beta$ and $\upsilon$ primarily determine the slopes of the lifecycle profiles, $a_0$ and $a_{p,0}$ mainly determine their intercepts.

# 5 The Effect of Tax Incentives on Household Portfolios

In this section, we assess the impact of tax incentives on household portfolios based on the calibrated model. As motivated in Section 2, we consider two policy changes: an increase of the cap on tax-deductible voluntary pension contributions and the introduction of a tax deduction for mortgage interest payments. To better understand the effect of these policies, we analyze them separately before assessing their combined effect. In AppendixG.1, we illustrate some of the mechanisms analytically in a very simple example without uncertainty, (il)liquidity, and occasionally binding constraints.

In the first counterfactual, we increase the cap on deductible pension contributions to the level observed in Switzerland (normalized by average income), whereas mortgage interest payments remain non-deductible. Quantitatively, we raise the cap from 6.8% to 13.5% of average income in the calibrated economy, corresponding to an increase from €2,500 to €4,950. To maintain tax-revenue neutrality, we also increase the level of taxes (by decreasing the parameter $\nu_0$ of the tax function), keeping progressivity constant, so that the total tax revenue equals the revenue in the benchmark economy.[20]

In the second counterfactual, we allow mortgage interest payments to be deducted from taxable income (thus setting $\theta_\ell = 1$), but we maintain the pension contribution cap at its benchmark level. We combine the interest deduction with the taxation of the imputed rent to keep tax revenue unchanged, analogously to the first counterfactual. As a result, the expected tax burden of a homeowner at the beginning of the life cycle, and thus the value of home ownership, remains approximately unchanged.

The third counterfactual combines the higher pension cap and the mortgage interest deduction. We retain the taxation of imputed rent as in the second counterfactual, and again adjust the level of taxation by changing the parameter $\nu_0$ to ensure tax-revenue neutrality.

Note that the taxation of the imputed rent introduced in the third counterfactual is in the range of values implemented in the cantons of Switzerland.[21] Therefore, we can use the third counterfactual

[20] Appendix F provides further details on the parameter changes to implement tax-revenue neutrality.

[21] The taxed imputed rent varies across Swiss cantons and, by law, should not be less than 60% of the market

to gauge the extent to which differences in tax incentives explain the differences between Germany and Switzerland observed in the data.

Table 2 shows how household portfolios change in each of the counterfactuals. We report the mortgage incidence, the average LTV among mortgagors, and the average shares of pension savings, home equity, and liquid assets in net worth.[22] Concerning average household debt and average net worth, Table 2 reports the changes relative to the value in the benchmark, which we normalize to 100% ('Benchmark' column). In what follows, we discuss the results for each counterfactual and illustrate the mechanisms that generate the findings presented in Table 2.

Table 2: Portfolio changes between benchmark and counterfactuals

| | Benchmark | Higher pension cap | Mortgage interest deduction | Joint changes |
|---|---|---|---|---|
| Mortgagor incidence | 55.4% | 56.5% | 63.5% | 66.1% |
| Household debt | 100.0% | 97.3% | 110.8% | 108.1% |
| Net worth | 100.0% | 105.9% | 94.9% | 101.5% |
| LTV | 36.7% | 35.7% | 40.6% | 39.6% |
| Share in pension | 15.3% | 19.8% | 19.7% | 25.4% |
| Share in home equity | 75.4% | 73.0% | 72.8% | 69.2% |
| Share in liquid assets | 9.3% | 7.2% | 7.5% | 5.5% |

**Notes**: Statistics are reported for homeowners aged 36 to 65. Mortgagor incidence denotes the share of mortgagors, i.e., homeowners with $a < 0$. Household debt is the average absolute value of liquid equity ($|a|$) for mortgagors, normalized with respect to the benchmark value. Net worth is the average of net worth ($h + a + a_p$), normalized with respect to the benchmark value. LTV is the mean of ($|a|/h$) conditional on being a mortgagor. The share in pension is the mean share of pension savings over net worth ($a_p/(h + a + a_p)$) across homeowners. The share in home equity is the mean share of home equity relative to net worth across outright owners and mortgagors (i.e., $h/(h+a+a_p)$ for outright owners and $(h+a)/(h+a+a_p)$ for mortgagors). The share in liquid assets is the mean share of liquid assets over net worth ($a/(h + a + a_p)$) across outright owners. Household debt and net worth are normalized to their values in the benchmark economy.

## Higher Pension Cap

Figure 3 illustrates the mechanisms behind the portfolio changes reported in Table 2 if we compare the 'Benchmark' column to the counterfactual economy with a higher pension cap. The higher pension cap increases incentives for wealth accumulation. It not only increases the share of pension savings in the portfolio but also net worth.

To illustrate the changed incentives driving this portfolio change, Figure 3a shows the after-tax return on pension savings, as defined on the right-hand side of equation (17) in Section 3. Like all model objects, the after-tax return is a multidimensional function of several state variables. To facilitate the exposition, we proceed as follows. We use the distribution of agents over the state space, $\Gamma(a, a_p, j, y)$, to construct percentiles along the liquid equity dimension ($a$). For each percentile, we compute the average

rent (Eidgenössische Steuerverwaltung, 2021). The value of the imputed rent in the representative canton of Bern, for example, is in the range of $70 - 77\%$ of the market value (Galli et al., 2025). The imputed rent implied by the value of $\zeta_h$ reported in Appendix F is consistent with the empirically observed wedge between the imputed rent added to the taxable income and the market rent under the common assumption that the market rent is determined by the risk-free rate plus a depreciation rate of 1%-1.5% times the house value.

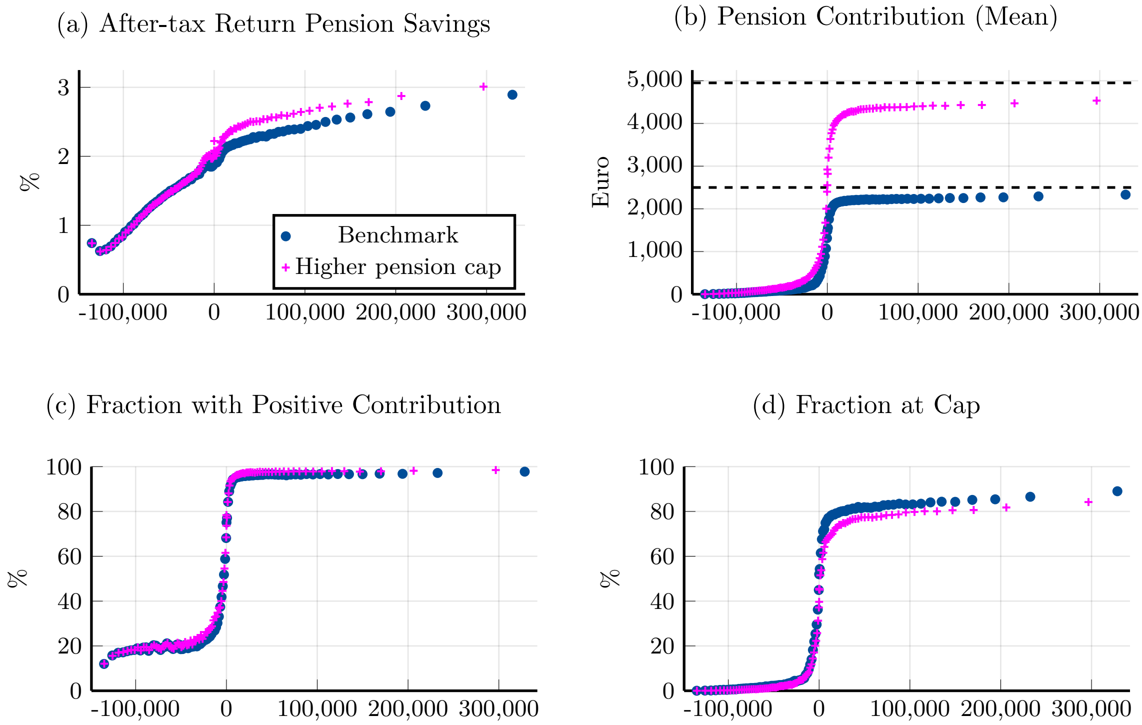
[22] As noted in Table 2, portfolio shares need not sum to 100% because we report the unweighted average of individual portfolio shares for each component. Note further that we classify mortgagors and outright owners according to the position of the state variable current liquid equity ($a$) rather than their choice of liquid equity ($a'$) in the next period, for the statistics to be more easily comparable with the illustrations in Figures 3 to 7.

after-tax return across all remaining dimensions. We apply an analogous procedure for all panels in Figures 3, 4, and 5.

Figure 3a shows how the realized after-tax return on pension savings, which drives the pricing relevant for the expected marginal rate of intertemporal substitution, varies on average across the liquid-equity distribution. The higher pension cap increases the implied after-tax returns primarily for outright owners ($a \geq 0$), as mortgagors contribute only modestly to their pension accounts; thus, the tighter pension cap in the benchmark is not binding for most of them.

This finding is further illustrated in Figure 3c, which shows that a minority of mortgagors makes positive voluntary pension contributions, whereas almost all outright owners do so. In the benchmark, 23.9% of mortgagors and 94.7% of outright owners make positive contributions to voluntary pension savings. With the higher cap, these fractions increase to 25.6% and 95.1%, respectively. The higher cap thus only has a quantitatively modest effect on the extensive margin of tax-deductible voluntary pension contributions.

Figure 3: The effects of a higher pension cap




**Notes**: In each plot, we display the average values for each percentile of the liquid equity distribution (horizontal axis) for the benchmark economy and the counterfactual with a higher pension cap. We compute the after-tax return of accumulating pension savings using the right-hand side of equation (17) in Section 3. The pension contribution is $q_p a'_p - a_p$. The fraction with a positive contribution is the share of agents in each percentile of the liquid equity distribution for whom $q_p a'_p - a_p > 0$. The fraction at the cap is the share of agents in each percentile of the liquid equity distribution for whom $q_p a'_p - a_p \approx \bar{p}$ (numerically, the contribution is higher than 95% of $\bar{p}$).

By contrast, Figure 3b shows that the higher cap increases the average contributions substantially, especially among outright owners. In the benchmark, the average contribution among mortgagors is €190, and €2,155 among outright owners. The higher cap increases these values to €378 and €4,109, respectively.

Figure 3d shows that the fraction of agents contributing the maximum amount declines. The higher cap relaxes a portfolio-choice constraint, allowing fewer households to be constrained by it. The figure also shows that outright owners find tax-deductible voluntary pension savings so attractive that even the higher cap still constrains the portfolio choice for many of them.

These insights allow us to interpret the results reported in Table 2 further. The higher cap raises the share of net worth allocated to pension savings from 15.3% to 19.8%. Because this increase is driven mainly by outright owners, as illustrated in Figure 3d, and outright owners choose between accumulating liquid assets or pension savings, the share of net worth held in liquid assets falls from 9.3% to 7.2%.

The higher cap also affects the decisions of mortgagors, particularly those close to repaying their debt (i.e., with $a < 0$ but close to 0). As shown in Figure 3, the higher cap implies a higher after-tax return for low-leverage mortgagors, slightly higher average contributions, and a modest increase in the share of contributors to pension savings.

Despite its limited effect on mortgagors, the higher cap increases the mortgage incidence by 1.1 pp but lowers household debt and mortgagors' LTVs by 2.7% and 1 pp, respectively. A subset of mortgagors combines higher pension contributions with faster amortization to satisfy their liquidity needs while taking advantage of the high after-tax returns on pension savings. Overall, Table 2 shows that the higher cap increases average net worth by 5.9%, as the higher after-tax return on pension saving strengthens the incentives to save.

## Mortgage Interest Deduction

Figure 4 illustrates the mechanisms behind the portfolio changes reported in Table 2 if we compare the 'Benchmark' to the counterfactual economy with tax-deductible mortgage interest payments. The tax deductibility reduces incentives for wealth accumulation. Household debt increases, and portfolio shares shift from home equity to pension savings.

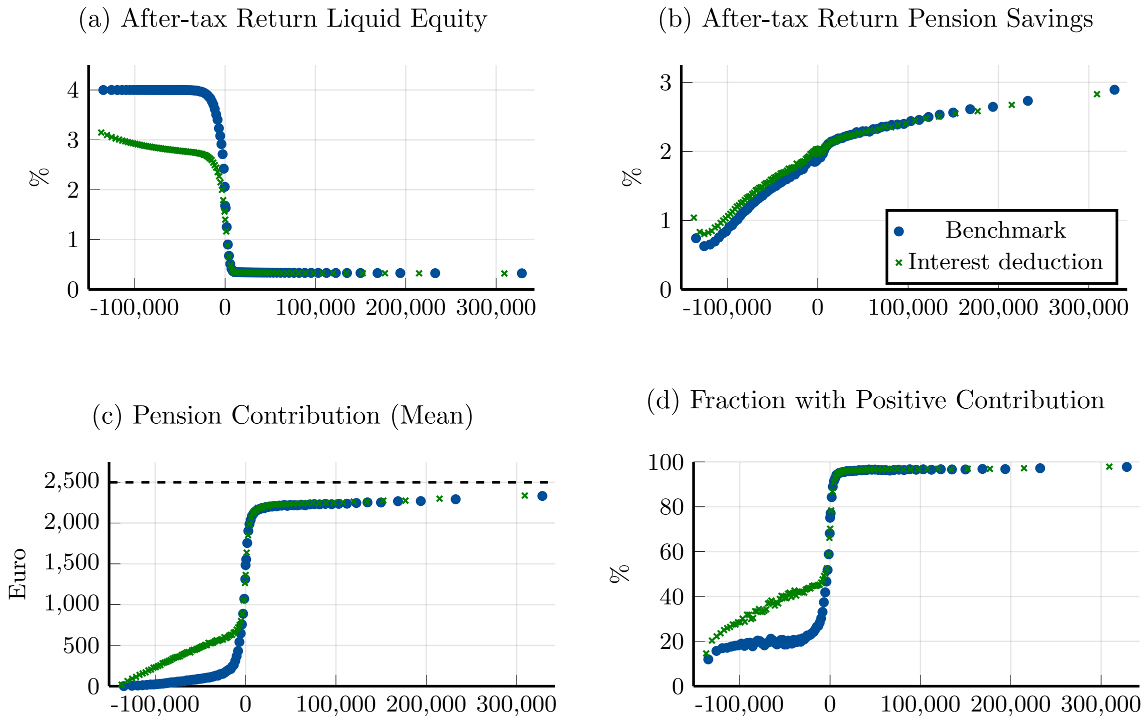
To illustrate the changed incentives driving this portfolio change, Figure 4a displays the after-tax interest rate on liquid equity, computed analogously to Figure 3a but using the right-hand side of equations (15) and (16) in Section 3. For mortgagors, this represents the after-tax cost of holding debt, whereas for outright owners, it is the after-tax return on saving in liquid assets.

Figure 4a shows that in the benchmark, without the interest deduction, the after-tax cost of holding debt approximately equals the rate $\iota + \zeta_\ell = 4\%$.[23] With the interest deduction, the after-tax cost of holding debt falls significantly. On average, it declines by 1.1 pp, from 3.8% to 2.7%. As reported in the 'Mortgage interest deduction' column in Table 2, this reduction increases the mortgage incidence by 8.1 pp, increases household debt by 10.8%, and increases the average mortgagor LTV ratio by 3.9 pp.

The interest deduction also alters the relative incentives to accumulate home equity versus pension savings. As we can see in Panel 4b, the interest deduction raises the after-tax returns of accumulating pension savings among mortgagors. Mortgagors have an incentive to reduce taxable income by shifting their portfolio from home equity to pension savings. This shift reduces taxable income not only because mortgage interest payments are tax-deductible but also because voluntary pension contributions can be deducted from taxable income.

[23] Note that the right-hand side of equation (16) depends on next-period liquid equity $a'$, while Figure 4a plots the return as a function of current liquid equity $a$. For agents who transition from being mortgagors in the current period to being outright owners in the next period, their after-tax return depends on the cost of debt and the return on liquid assets. As a result, in percentiles of the liquid-equity distribution close to $a = 0$, which contain a relatively larger fraction of such *switchers*, the average after-tax return on liquid equity falls slightly below $\iota + \zeta_\ell$. The analogous argument applies to outright owners with liquid equity slightly above $a = 0$ who may switch to become mortgagors in the next period. As Figure 4a shows, such switches are quantitatively less relevant in the benchmark economy.

Figure 4: The effects of tax-deductible mortgage interest payments




**Notes**: In each plot, we display the average values for each percentile of the liquid equity distribution (horizontal axis) for the benchmark economy and the counterfactual with the interest deduction. We compute the after-tax return of accumulating liquid equity using the right-hand side of equations (15) and (16) in Section 3. We compute the after-tax return of accumulating pension savings using the right-hand side of equation (17). The pension contribution is $q_p a_p' - a_p$. The fraction with a positive contribution is the share of agents in each percentile of the liquid equity distribution for whom $q_p a_p' - a_p > 0$.

Among mortgagors, the average voluntary pension contribution increases to €458, a 141% increase relative to the benchmark, and the share of mortgagors who contribute to pension savings increases from 23.9% to 37.8%. Consistent with these patterns, Table 2 shows that the interest deduction increases the average share of net worth held in pension savings from 15.3% to 19.7%, an increase comparable in magnitude to that generated by the higher pension cap. Despite the increase in pension savings among mortgagors, the rise in household debt implies that the interest deduction results in a 5.1% decline in average net worth.

## Joint Changes

Figure 5 illustrates the mechanisms behind the portfolio changes reported in Table 2 if we compare the 'Benchmark' column to the counterfactual economy with the joint changes, which combine the higher pension cap with the mortgage interest deduction. These joint changes imply a shift of portfolios from home equity to pension savings, an increase in household debt, but leave the average net worth almost unchanged.

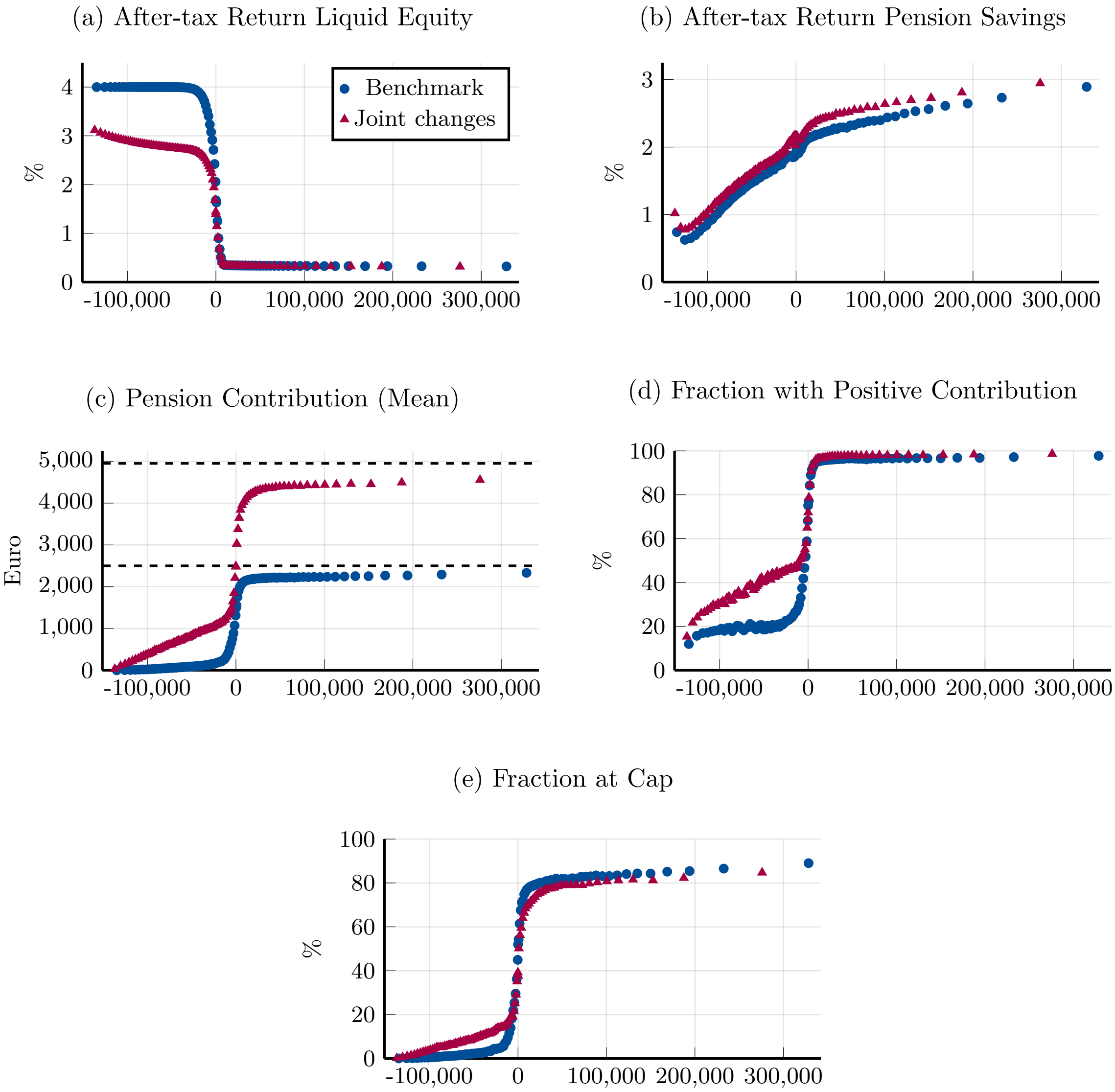
Again, we illustrate the changes in the after-tax returns to illustrate the changed incentives driving this portfolio change. Comparing Figure 5a to Figure 4a shows that the changes in the after-tax returns on liquid equity are almost entirely driven by the mortgage interest tax deduction, with the higher pension cap playing only a negligible role quantitatively.

By contrast, the effects on pension savings reflect the interaction of both policy changes. Comparing Figures 3, 4, and 5, we find that the higher cap for tax-deductible pension contributions primarily affects outright owners, whereas the interest tax deduction mainly impacts mortgagors.

The more generous tax deductions jointly increase pension contributions for both groups substantially.

Among mortgagors, the average contribution increases from €190 in the benchmark to €831 in the counterfactual. Among outright owners, it increases from €2,155 to €4,155. In the benchmark, 23.9% of mortgagors and 94.7% of outright owners contribute to pension savings. The more generous deductions increase these shares to 39.8% and 95.2%, respectively. Furthermore, only 0.6% of mortgagors contribute at the cap in the benchmark. In the counterfactual, this fraction increases to 10.1%, although the cap is also higher. Among outright owners, the share contributing up to the cap decreases from 79.0% to 73.1%, reflecting the higher cap.

Figure 5: The effects of a higher cap and the introduction of the interest deduction




**Notes**: In each plot, we display the average values for each percentile of the liquid equity distribution (horizontal axis) for the benchmark economy and the counterfactual with the joint changes (higher pension cap and interest deduction). We compute the after-tax return of accumulating liquid equity using the right-hand side of equations (15) and (16) in Section 3. We compute the after-tax return of accumulating pension savings using the right-hand side of equation (17) in Section 3. The pension contribution is $q_p a_p' - a_p$. The fraction with a positive contribution is the share of agents in each percentile of the liquid equity distribution for whom $q_p a_p' - a_p > 0$. The fraction at the cap is the share of agents in each percentile of the liquid equity distribution for whom $q_p a_p' - a_p \approx \bar{p}$ (numerically, the contribution is higher than 95% of $\bar{p}$).

Table 2 shows that the more generous deductions increase the average share of net worth invested in pension savings by about 10 pp, from 15.3% to 25.4%. This higher share of pension savings is accompanied by a decline in the portfolio share of home equity (from 75.4% to 69.2%) and liquid assets (from 9.3% to

5.5%). Thus, the more generous deductions lead to more illiquid portfolios on average, leaving average net worth almost unchanged.

At the same time, the joint changes increase household debt by 8.1% and raise the average LTV among mortgagors by 2.9 pp. The mortgage incidence also increases substantially, from 55.4% in the benchmark to 66.1%, an increase of 10.7 pp.

Among homeowners close to retirement (aged 51 to 65), the mortgage incidence increases even more, by 12.4 pp from 40.3% to 52.7%. In the data, the mortgage incidence for the same subpopulation differs by 53.1 pp between Germany and Switzerland (see Figure 1 in Section 2). Through the lens of our model, our results indicate that approximately a quarter of this gap can be accounted for by the more generous tax deductions (for mortgage interest payments and voluntary pension contributions) in Switzerland.

# 6 Implications for Macroprudential Risks

We have shown in the previous section that more generous tax deductions for mortgage interest payments and voluntary pension contributions lead to more illiquid portfolios and higher household debt in the calibrated economy, while net worth remains almost unchanged. In this section, we examine the implications of these more generous deductions for macroprudential risks.

As highlighted in Section 3, the analyzed tax deductions affect the intertemporal trade-off, which is at the heart of the consumption-saving decision, as well as the portfolio choice between assets with different liquidity. The tax deductions matter not only for the strength of the trade-offs over the lifecycle but also for how homeowners adjust consumption in response to the shocks they face.

We illustrate the quantitative implications of the tax deductions by focusing on the following policy-relevant questions. Given that the more generous deductions increase illiquidity and debt, (i) how do the deductions affect the consumption response to a house price change, and (ii) how is this related to the households' ability to smooth consumption in the presence of income shocks?

## 6.1 The Consumption Response to a House Price Change

To compute the consumption response to a house price change, we follow the approach in Berger et al. (2018). They show that, in incomplete-markets models such as ours, the elasticity of consumption to a permanent house price shock is well approximated by the product of the MPC and the ratio of the house value to consumption. Importantly, their approximation performs well across a broad class of models, including settings with housing markets featuring adjustment costs.

For a given combination of state variables $(a, a_p, y, j)$ in the context of our model, the elasticity of consumption to a permanent house price shock ($\eta$) is thus approximated by:

$$\eta\left(a, a_p, y, j\right) = \mathrm{mpc}\left(a, a_p, y, j\right) \frac{h}{c\left(a, a_p, y, j\right)}, \tag{18}$$

where $\mathrm{mpc}\left(a, a_p, y, j\right)$ is given by the marginal change of consumption with respect to a marginal increase in liquid resources, $\partial c\left(a, a_p, y, j\right) / \partial a$, $c\left(a, a_p, y, j\right)$ is the consumption function evaluated at the state variables $(a, a_p, y, j)$, and $h$ is the representative house value specified in Section 4. Combining (18) with the distribution of agents over the state space ($\Gamma\left(a, a_p, j, y\right)$) allows us to compute the average elasticity for all homeowners, or for the subpopulations of mortgagors or outright owners.

Equation (18) shows that more generous tax deductions change the elasticities through two channels. Firstly, holding the state variables constant, the more generous tax deductions change the consumption policy function and, thus, the MPC. We denote with $\hat{\eta}\left(a, a_p, y, j\right)$, $\widehat{\mathrm{mpc}}\left(a, a_p, y, j\right)$, and $\hat{c}\left(a, a_p, y, j\right)$ the elasticity, MPC, and consumption functions in the counterfactual with the more generous deductions, whereas the notation without " ˆ " refers to the functions in the benchmark case.

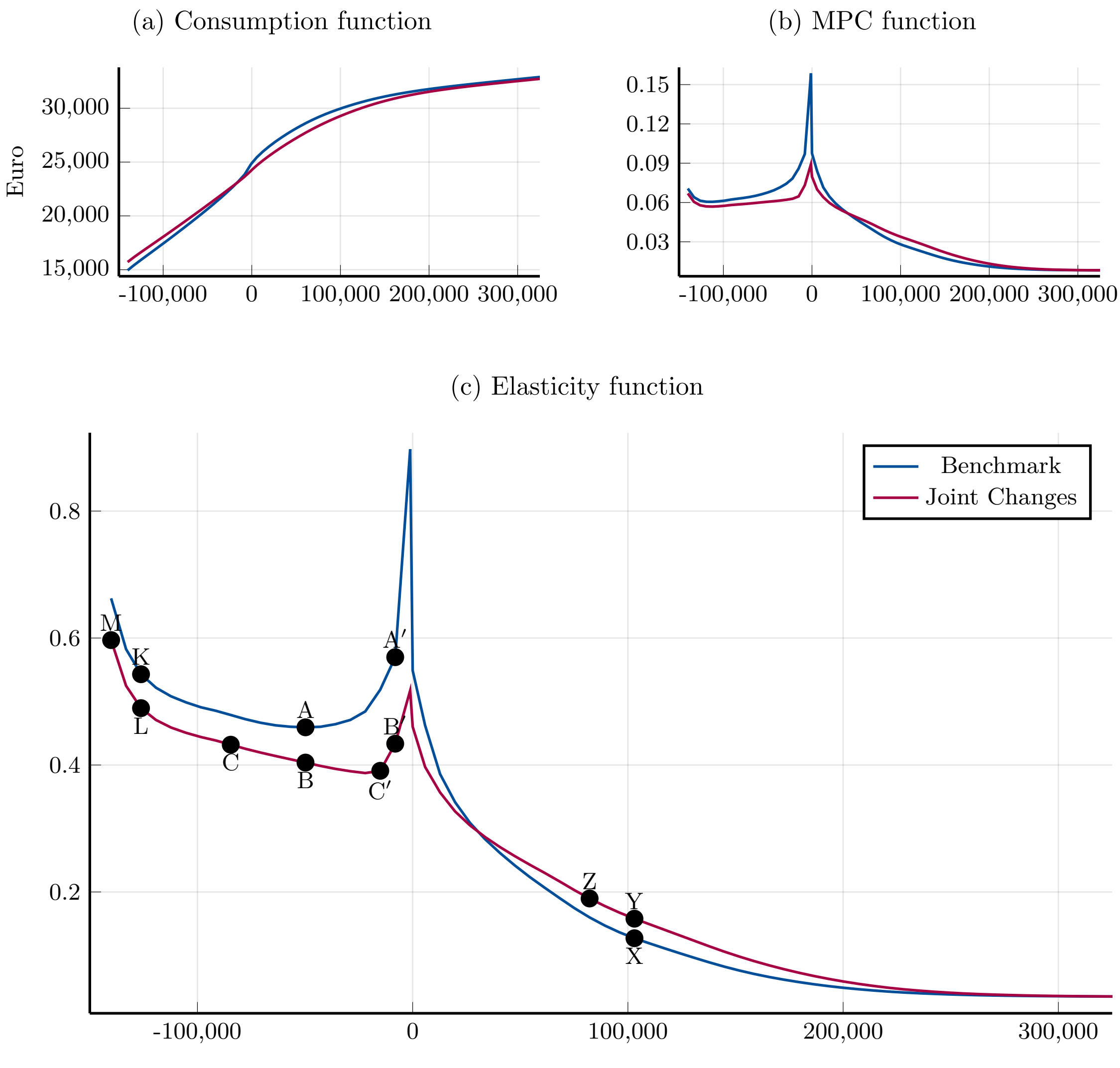
Secondly, as shown in Section 5, the more generous deductions shift the distribution of agents across the state space. Let $\hat{\Gamma}(a, a_p, j, y)$ denote the distribution in the counterfactual with the interest deduction and the higher pension cap.

In the results we present, we separate these two channels. Computing counterfactual elasticities while holding the benchmark distribution fixed enables us to gauge the effect of the more generous deductions in the short run before households adjust their portfolios, and helps clarify the underlying mechanisms.

### Illustration of Mechanisms

Figure 6 helps to explain the quantitative results presented below. We plot consumption, the MPC, and the elasticity of consumption to a house price change as functions of liquid equity, conditioning on the median levels of pension savings, income, and age. We plot both the benchmark and counterfactual functions. Conditional on liquid equity, pension savings have only a quantitatively small effect on these functions. Thus, although the figure fixes pension savings at their median value for ease of exposition, the qualitative insights apply across the entire distribution of pension savings.

Figure 6: Illustration of mechanisms behind the consumption response to house price changes




**Notes**: Panel 6a plots in blue $c\left(a, \tilde{a}_p, \tilde{y}, \tilde{j}\right)$ and in red $\hat{c}\left(a, \tilde{a}_p, \tilde{y}, \tilde{j}\right)$ as a function of liquid equity ($a$ is on the horizontal axis), where $\tilde{a}_p$ is the median level of pension savings in the benchmark economy, $\tilde{y}$ is the median level of the income shock, and $\tilde{j}$ is the median age. Analogously, Panel 6b plots $\text{mpc}\left(a, \tilde{a}_p, \tilde{y}, \tilde{j}\right)$ and $\widehat{\text{mpc}}\left(a, \tilde{a}_p, \tilde{y}, \tilde{j}\right)$, and Panel 6c plots $\eta\left(a, \tilde{a}_p, \tilde{y}, \tilde{j}\right)$ and $\hat{\eta}\left(a, \tilde{a}_p, \tilde{y}, \tilde{j}\right)$. *Joint changes* refers to the counterfactual with a higher pension cap and a tax deduction for mortgage interest payments.

Panel 6a shows that the more generous deductions flatten the consumption function, as the spread between after-tax returns of liquid equity for mortgagors (agents with $a < 0$) and outright owners (agents with $a \geq 0$) decreases. Mortgagors consume more in the counterfactual, while outright owners consume less. These changes translate into lower MPCs for all mortgagors and for outright owners with low liquid asset levels (Panel 6b). By contrast, wealthy outright owners exhibit higher MPCs. The MPC function displays the two usual spikes in a setup like ours. It approaches one near the borrowing constraint, and as liquid equity approaches zero, i.e., where the interest rate spread renders the consumption Euler equation slack.

Because the MPC is a key determinant of the consumption response to a house price change, as shown in equation (18), the patterns in Panel 6b carry over to the elasticity displayed in Panel 6c. The more generous deductions increase consumption resilience (i.e., reduce the elasticity) for all mortgagors and for outright owners with low liquid assets, whereas they reduce resilience (i.e., increase the elasticity) for wealthy outright owners.

Panel 6c helps to illustrate not only the short-run changes in the elasticity (holding benchmark portfolios fixed) but also the longer-run changes once agents adjust their portfolios in response to the more generous deductions.

For most mortgagors, the sequences A $\to$ B $\to$ C and A$'$ $\to$ B$'$ $\to$ C$'$ summarize how the more generous deductions change their elasticities. Consider mortgagors with the average LTV in the benchmark. Their elasticity is 0.46 at point A. This implies that a 10% house price decline lowers consumption by 4.6%. In the short run (holding the portfolio fixed), the more generous deductions reduce the elasticity to 0.40 (point B). As noted in Section 5, the deductions also induce more debt (i.e., lower liquid equity). Suppose the agent ends up at point C. The elasticity thus increases to 0.43 relative to B, but it remains below the benchmark value at A.

A similar pattern arises in the sequence A$'$ $\to$ B$'$ $\to$ C$'$. However, in this case, the reduction of liquid equity further lowers the elasticity. The elasticity falls from 0.57 in the benchmark to 0.43 in the short run and then to 0.39 after the portfolio adjusts. Thus, a 10% price drop reduces benchmark consumption by 5.7%, and the more generous deductions lower this response to 3.9% when portfolio adjustments are taken into account.

For highly-leveraged mortgagors, however, the pattern differs. Although the elasticity declines in the short run, it eventually increases once indebtedness increases. This case is illustrated by the sequence K $\to$ L $\to$ M in Figure 6. The elasticity falls from 0.54 to 0.49 in the short run, but then increases to 0.60 as the mortgagors accumulate more debt.[24] Outright owners with low liquid assets exhibit a similar pattern of higher resilience in the short run, followed by lower resilience once their portfolios shift.

For the majority of outright owners, the sequence X $\to$ Y $\to$ Z illustrates the effects of the more generous deductions. Resilience decreases in the short run, illustrated by the increase in the elasticity (X $\to$ Y). As outright owners shift their wealth accumulation from liquid assets to pension savings, resilience decreases further (Y $\to$ Z).

To summarize, more generous tax deductions induce one of three patterns for most agents: (i) higher resilience in the short- and long-run (sequences A $\to$ B $\to$ C and A$'$ $\to$ B$'$ $\to$ C$'$), (ii) lower resilience in the short and long-run (sequence X $\to$ Y $\to$ Z), (iii) higher resilience in the short-run and lower resilience in the long-run (sequence K $\to$ L $\to$ M).[25]

[24] The elasticity function becomes very steep near the borrowing constraint. Berger et al. (2018) show that this feature is remarkably robust in many model settings. Furthermore, as discussed in their paper, homeowners who are underwater and have the option to default have smaller consumption elasticities than implied by the approximation in (18). If the incidence of these types of homeowners is small, however, so is the deviation of the true average elasticity from the corresponding elasticity as approximated in (18).

[25] There is a fourth case, which we do not illustrate in Figure 6 because it is only relevant for a small fraction of agents. Some agents exhibit lower resilience in the short run and higher resilience in the long run. In this case, the elasticity function is increasing in liquid equity and, at the same time, shifts up in the counterfactual, i.e., conditional on liquid equity, the elasticity increases relative to the benchmark. This case accounts for 5.7% of the agents, 92% of whom are outright owners.

### Quantitative Results

In Table 3, we report how the more generous deductions change the elasticities for mortgagors (top panel), outright owners (middle panel), and all homeowners (bottom panel). The first row of each panel displays the median elasticity in the benchmark (in the column labeled 'Benchmark'), in the counterfactual with the more generous deductions, holding the benchmark portfolio distribution fixed (in the column labeled 'Benchmark Distribution'), and finally in the counterfactual including the portfolio reallocation induced by the more generous deductions (in the column labeled 'Endogenous Distribution'). The row that follows reports the percentage changes relative to the benchmark. We then present the corresponding means and their percentage changes.

Each panel also shows the share of agents who become more or less resilient (i.e., display a lower or higher elasticity) in each scenario, along with the shares of agents classified by how their elasticities change between the short and long run in the counterfactual. For example, an agent labeled 'More resilient → Less resilient' exhibits a lower elasticity than in the benchmark when portfolios are held fixed, but a higher elasticity once portfolio adjustments with the more generous deductions are taken into account.

Table 3 shows that the more generous deductions improve the consumption resilience of most mortgagors after a house price decline. In the short run, 96% of mortgagors exhibit a lower elasticity than in the benchmark. The more generous deductions decrease the median elasticity for mortgagors by 15.3% (from 0.481 to 0.408) and the mean elasticity by 10.8% (from 0.622 to 0.555). However, as the more generous deductions induce mortgagors to hold more debt, a subset of highly indebted mortgagors becomes less resilient in the long run. This group represents 15.6% of mortgagors. Nonetheless, both the median and mean elasticity for mortgagors remain below their benchmark levels once portfolios have adjusted.

For the majority of outright owners, the more generous deductions reduce consumption resilience, although a sizable minority becomes more resilient. In the short run, the more generous deductions increase the median elasticity for outright owners by 14.2% (from 0.177 to 0.203). However, 32.6% of outright owners exhibit lower elasticities, reducing the mean elasticity by 5.7% (from 0.265 to 0.250). In the long run, the share of outright owners with higher resilience declines to 26.6%, and both the median and mean elasticities are higher than in the benchmark (by 57.0% and 22.8%, respectively).

For all homeowners (i.e., both mortgagors and outright owners, labeled as *everyone* in the table), the bottom panel of Table 3 shows that more generous deductions increase the resilience in the short run, both at the median and mean. This is mainly driven by the improved resilience of (almost all) mortgagors. Overall, the more generous deductions reduce the elasticity of 67.7% of homeowners in the short run. In the long run, as the deductions increase illiquidity and indebtedness, the share of agents with higher resilience falls to 56.8%, of which 94.5% are mortgagors. So, in the long run, the average elasticity is 3.5% higher than the benchmark.[26]

[26]Table 9 in Appendix G.2 shows that for the group of homeowners with a higher resilience in the regime with more generous deductions, the higher resilience is mostly resulting from the tax deduction of mortgage interest rates. For the group of outright owners with a lower resilience in the regime with more generous deductions, the increase of the cap for voluntary pension contributions has a quantitatively more important role in relative terms.

Table 3: The effect of more generous deductions on the elasticities

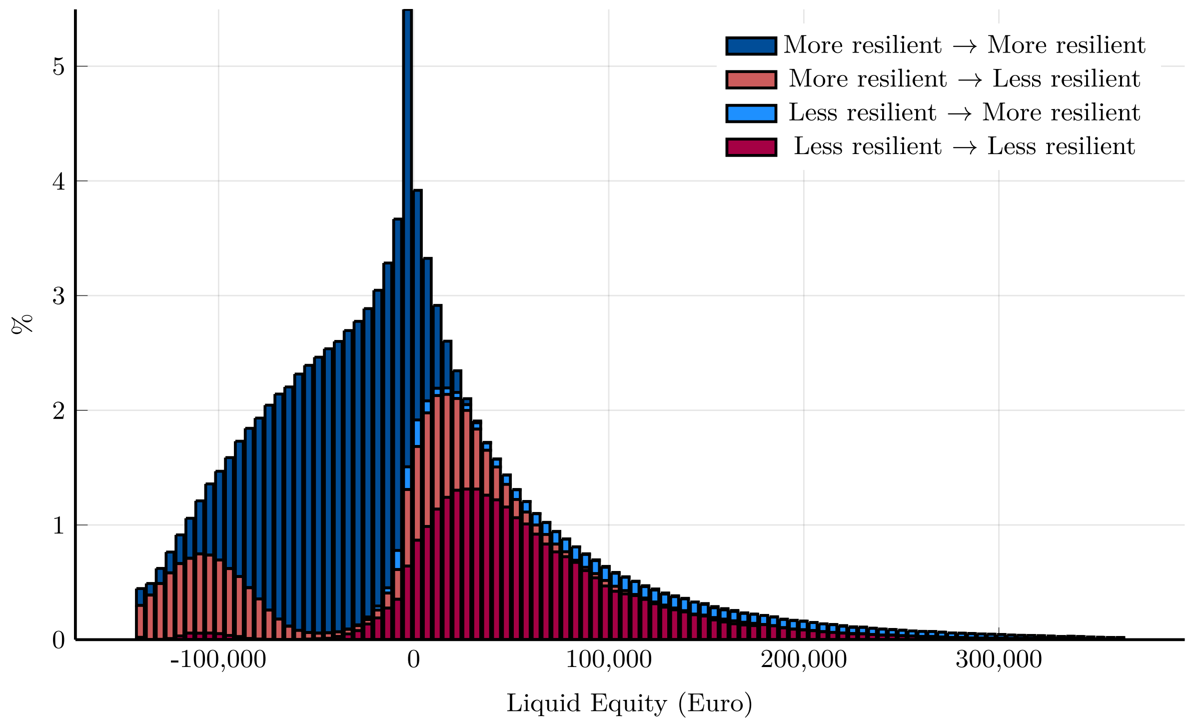
| | Benchmark | Benchmark Distribution | Endogenous Distribution |
|---|---|---|---|
| | | **Mortgagors** | |
| Median | 0.481 | 0.408 | 0.425 |
| | | -15.3% | -11.7% |
| Mean | 0.622 | 0.555 | 0.602 |
| | | -10.8% | -3.1% |
| | More resilient | 96.0% | 81.2% |
| | | More resilient → More resilient | 80.4% |
| | | Less resilient → More resilient | 0.8% |
| | Less resilient | 4.0% | 18.8% |
| | | More resilient → Less resilient | 15.6% |
| | | Less resilient → Less resilient | 3.2% |
| | | **Outright owners** | |
| Median | 0.177 | 0.203 | 0.278 |
| | | 14.2% | 57.0% |
| Mean | 0.265 | 0.25 | 0.326 |
| | | -5.7% | 22.8% |
| | More resilient | 32.6% | 26.6% |
| | | More resilient → More resilient | 14.8% |
| | | Less resilient → More resilient | 11.8% |
| | Less resilient | 67.4% | 73.4% |
| | | More resilient → Less resilient | 17.7% |
| | | Less resilient → Less resilient | 55.7% |
| | | **Everyone** | |
| Median | 0.42 | 0.351 | 0.375 |
| | | -16.4% | -10.7% |
| Mean | 0.463 | 0.419 | 0.479 |
| | | -9.5% | 3.5% |
| | More resilient | 67.7% | 56.8% |
| | | More resilient → More resilient | 51.2% |
| | | Less resilient → More resilient | 5.6% |
| | Less resilient | 32.3% | 43.2% |
| | | More resilient → Less resilient | 16.6% |
| | | Less resilient → Less resilient | 26.6% |

**Notes**: Agents are classified as mortgagors ($a < 0$) or outright owners ($a \geq 0$) based on their liquid equity holdings in the benchmark economy. 'Everyone' is the label for all homeowners (i.e., both mortgagors and outright owners). 'More resilient' indicates that, for a given agent $i$, the elasticity of consumption to a house price change is *lower* in the counterfactual with more generous deductions than in the benchmark. Using the benchmark distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(a^i, a_p^i, y^i, j^i\right)$, where $\left(a^i, a_p^i\right)$ is the agent's portfolio in the benchmark, and $\left(y^i, j^i\right)$ is the agent's realization of the income shock and age, which do not change between the counterfactual and the benchmark. Using the endogenous distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(\hat{a}^i, \hat{a}_p^i, y^i, j^i\right)$, where $\left(\hat{a}^i, \hat{a}_p^i\right)$ is the portfolio in the counterfactual. 'Less resilient' indicates a *higher* elasticity in the counterfactual than in the benchmark.

Figure 7 illustrates the incidence of the homeowners classified into the respective groups of resilience, along the distribution of liquid equity. The figure reveals that homeowners who become more resilient after a house price change in the regime with more generous deductions, even when the endogenous changes of the portfolio distribution are taken into account (the group labeled as 'More resilient → More resilient' in the figure), are mostly mortgagors with moderate amounts of debt. The group labeled 'More resilient → Less resilient', i.e., homeowners whose response to a decrease in the house price becomes less resilient once we account for the changes of the portfolio, are mostly homeowners with liquid equity in the vicinity of either the collateral constraint or zero liquid equity, where the interest rate spread renders the consumption Euler equation slack. As illustrated in Figure 6, these are the homeowners for whom the elasticity of consumption to house price changes increases when they hold less liquid equity in the regime with more generous deductions.

Figure 7 further shows that homeowners who become less resilient mostly hold positive liquid equity. Most of them remain less resilient if we account for the endogenous shifts of the portfolio in the new regime. As illustrated in Figure 6, many of them are outright owners with a relatively low elasticity so that they are quite resilient to begin with. In the new regime with more generous deductions, however, they become somewhat less resilient as they hold more illiquid pension assets.

Figure 7: Changes in resilience to a house price shock along the liquid equity distribution




**Notes**: Each stacked bar represents the percentage of agents in the liquid equity distribution. Within each stacked bar, agents are classified according to how their consumption elasticity to a house price shock changes with respect to the benchmark economy. 'More resilient' indicates that, for a given agent $i$, the elasticity of consumption to a house price change is *lower* in the counterfactual with more generous deductions than in the benchmark. Using the benchmark distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(a^i, a_p^i, y^i, j^i\right)$, where $(a^i, a_p^i)$ is the agent's portfolio in the benchmark, and $(y^i, j^i)$ is the agent's realization of the income shock and age, which do not change between the counterfactual and the benchmark. Using the endogenous distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(\hat{a}^i, \hat{a}_p^i, y^i, j^i\right)$, where $(\hat{a}^i, \hat{a}_p^i)$ is the portfolio in the counterfactual. 'Less resilient' indicates a *higher* elasticity in the counterfactual than in the benchmark.

Figure 9 in Appendix G.2 illustrates that, along the income distribution, more resilience is associated with homeowners in the middle of the distribution of income realizations whereas less resilience is relatively more common at the top of the distribution. This is consistent with our findings that portfolio shifts towards illiquid pension wealth are more attractive in high income states with high marginal tax rates, and also when homeowners have higher liquid equity, which is positively correlated with income given that income shocks are persistent.[27]

Tables 10 to 15 in Appendices G.3 and G.4 show that the main results are robust if we set different values for the interest spread or the maximum loan-to-value ratio and recalibrate the model to match the targets discussed in Section 4. Quantitatively, we find that the share of mortgagors, who become more resilient in the regime with more generous deductions, increases if the spread or the maximum loan-to-value ratio are larger.[28] Although we recalibrate the model and the effects may be non-monotonic, these results may be expected because a higher maximum LTV ratio tends to decrease the incidence of mortgagors with debt close to the borrowing constraint, and a higher spread increases the reduction in the after-tax cost of debt resulting from the tax deductibility.

## 6.2 The Sensitivity of Consumption to Labor Income Shocks

As shown in Section 5, the more generous deductions lead households to hold more debt and more illiquid portfolios. Furthermore, we have just seen that the effect of deductions on the MPCs is heterogeneous across mortgagors and outright owners. Because most homeowners are mortgagors when young and may become outright owners as they age, a natural question is whether the more generous tax deductions, which we have analyzed, impair homeowners' ability to smooth labor-income shocks over their life cycle.

To answer this question, we proceed as follows. For each agent in the model's simulation for the benchmark economy, we compute the coefficient of variation of consumption over the life cycle. This statistic measures the sensitivity of consumption to income shocks. We then compute the coefficient of variation also for the counterfactual economy, where we expose each agent to the same sequence of income shocks as in the benchmark economy. The difference in the coefficient of variation of consumption between the two economies reflects changes induced by the deductions, as both expected and realized income risk are the same in both economies.

To separate the effect of the more generous deductions on the consumption function from their impact on portfolio choice, we also construct an intermediate counterfactual in which we evaluate consumption using the counterfactual consumption policy function while holding portfolio positions fixed at their benchmark values.

We present the results in Table 4. Letting the more generous deductions affect both the consumption function and portfolio choices (in the column labeled 'Endogenous Distribution'), the median and mean coefficient of variation among homeowners is 2.1 pp lower than the benchmark, with 90.1% of agents displaying smoother consumption in the counterfactual. Holding constant the benchmark distribution using only the changes in the consumption function (in the column labeled 'Benchmark Distribution'), the median and mean coefficient of variation are even (slightly) lower with a higher share of agents exhibiting smoother consumption (96%).

These findings show that greater debt and more illiquid portfolios induced by the deductions indeed *weaken* households' ability to smooth shocks (as demonstrated by comparing the results in the columns labeled 'Benchmark Distribution' and 'Endogenous Distribution'). This effect is, however, more than offset by the change in the consumption policy function resulting from the more generous deductions. Overall, the more generous deductions thus result in smoother consumption for the vast majority of homeowners.

[27]See Section 5 and also the illustration within the simple example in Appendix G.1.

[28]An exception is that the share of resilient mortgagors declines slightly if the spread increases from 3.5 pp to 4.5 pp, once we account for the change of the portfolio distribution. Such non-monotonic effects are to be expected given the non-linearity of the elasticities as a function of liquid equity, visible in Figure 6.

Table 4: The effect of more generous deductions on homeowners' ability to smooth consumption

| | Benchmark | Benchmark Distribution | Endogenous Distribution |
|---|---|---|---|
| | | Coefficient of variation of consumption | |
| Median | 17.961% | 15.784% | 15.83% |
| | | -2.2 p.p. | -2.1 p.p. |
| Mean | 18.573% | 16.421% | 16.495% |
| | | -2.2 p.p. | -2.1 p.p. |
| | Smoother | 96.0% | 90.1% |
| | | Smoother → Smoother | 90.1% |
| | | Less smooth → Smoother | 0.0% |
| | Less smooth | 4.0% | 9.9% |
| | | Smoother → Less smooth | 5.8% |
| | | Less smooth → Less smooth | 4.1% |

**Notes**: For each agent, we compute the coefficient of variation by dividing the standard deviation of consumption over the lifecycle by the average consumption over the lifecycle. We classify an agent as having smoother consumption if the coefficient of variation of consumption is *lower* in the counterfactual economy than in the benchmark economy. Agents are exposed to the same sequence of income shock realizations in both economies.

# 7 Conclusions

We have analyzed how tax deductions for mortgage interest payments and voluntary pension contributions shape household portfolios and macroprudential risks. Our analysis has revealed three main findings, of which many aspects seem relevant beyond the quantitative application that we have chosen.

First, more generous deductions reallocate household portfolios. The interest deduction lowers the effective cost of holding debt, while the higher cap increases the incentives to accumulate pension savings. Together, these policies shift portfolios away from home equity and liquid assets and toward pension savings, while net worth remains nearly unchanged.

Second, more generous deductions change consumption policy functions and MPCs, which, in turn, determine consumption responses to house price movements. In the short run, before portfolio choices have changed household balance sheets, more generous deductions increase the consumption resilience of most mortgagors to a house price bust, whereas they decrease the resilience of the majority of outright owners. Once endogenous portfolio adjustments are accounted for, resilience decreases for highly leveraged mortgagors and for a larger fraction of outright owners.

Third, more generous deductions help homeowners smooth consumption over the life cycle, although indebtedness and the share of illiquid assets in their portfolios increase. The lower effective cost of debt introduced by the interest deduction relaxes liquidity constraints and helps homeowners cope with shocks.

These findings are relevant for economic policy. They imply that an unexpected temporary increase in the generosity of tax deductions can serve as an additional macroprudential instrument to stabilize consumption in the immediate aftermath of a housing bust. Moreover, the findings illustrate the limits of relying on aggregate household debt as an indicator for macroprudential risk originating from the household sector. We have shown that more generous tax deductions increase debt but also make most mortgagors more resilient to a housing bust.

From a macroprudential perspective, the non-linearity of the effects, revealed by our analysis, imply that it is crucial how the aggregate debt is distributed across homeowners. If relatively high aggregate household debt results from a high incidence of mortgagors with moderate amounts of debt, the high level of aggregate debt is associated with household consumption that is resilient to adverse shocks. If the aggregate debt results from debt that is concentrated among highly leveraged mortgagors instead, their strong consumption response to adverse shocks should be a matter of concern for macroprudential regulators. These insights suggest that macroprudential regulation could benefit from conditioning incentives for mortgage amortization on household leverage, for example by providing stronger incentives for amortizing second mortgages, which are associated with higher leverage, than for first mortgages. We leave further analysis of such issues to future research.

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# A Pension Systems

The German pension system primarily consists of a pay-as-you-go component. We account for the pay-as-you-go component with a gross replacement rate of 39.9% (OECD, 2007).

The tax deductability of contributions to voluntary pension plans in Germany (within the so-called *Riester-Rente*) is capped at €2,100 per year (Schneider et al., 2021). In the calibration described in Section 4, we increase the deduction to €2,500 to capture subsidies to other illiquid saving instruments such as contributions to capital formation (*vermögenswirksame Leistungen*).

The Swiss pension system comprises three pillars: a pay-as-you-go pension plan with more progressive replacement rates than in Germany, a funded pension plan, and a private pension scheme (OECD, 2007, 2023). For employed households, participation in the first two pillars is compulsory. Additional voluntary contributions can be made to the second pillar if there is a gap between the current pension wealth in that pillar and the contributions that would have accrued from age 24 at the current income level. In 2015, voluntary contributions to the third pillar could be tax-deductible up to a maximum amount of CHF 6,768 for households that also contributed to the second pillar.

# B The Data

## B.1 The HFCS Sample

The second wave of the HFCS comprises a representative sample of 4,461 German households, which were primarily surveyed in 2014. To construct the sample of homeowners, we proceed as follows. We begin by mapping the model variables to their corresponding data counterparts, as detailed in Table 5. For pension savings and house values, there is a one-to-one link between the model and data counterparts. Instead, liquid equity contains all liquid assets and liabilities, including the mortgage on the main residence. Specifically, these are deposits, mutual funds, bonds, shares, and the outstanding balances on the main residence mortgage, as well as other non-mortgage debt.

Table 5: Mapping of model variables into their data counterparts

| HFCS variable | Group | Model variable |
|---|---|---|
| DA1110: Value of household's main residence | House value | $h$ |
| DL1110: Balance main residence mortgages<br>DL1200: Balance other, non-mortgage debt<br>DA2101: Deposits<br>DA2102: Mutual funds<br>DA2103: Bonds<br>DA2105: Shares, publicly traded | Liquid Equity | $a$ |
| DA2109: Voluntary pension / whole life insurance | Pension savings | $a_p$ |
| DL1120: Balance mortgages other properties<br>DA1120: Value of other real estate property<br>DA1130: Value of household's vehicles<br>DA1131: Valuables<br>DA1140: Value of self-employment businesses<br>DA2199: Other types of financial assets | Other net assets | *Not included* |

As we show in Table 5, there is a group of variables that are included in the conventional definition of net worth that we do not use to construct model variables. We label these variables 'other net assets,' which include net positions in real estate other than the main residence, vehicles, valuables, the value of self-employment businesses, and other financial assets.

Having established the data counterpart of the model variables, we apply the following sample selection criteria. First, we exclude households receiving pension income (HFCS variable *DI1500i*). We also remove households that are homeowners and hold outstanding mortgages larger than the value of their main residence, in other words a negative position $h + a$. Second, we trim the top 5% of the net worth distribution to reduce the relevance of asset classes not considered in the model. To apply this sample restriction, we use the conventional definition of net worth based on the sum of all HFCS variables in Table 5. Finally, we restrict the sample to homeowners who are 36 to 65.

Table 6 compares summary statistics for all households in the HFCS, including homeowners and renters, who do not receive pension income and whose household head has an age between 36 and 65, with our sample. The table shows that our sample does not select an unusual subset of households, and that the model variables account for the vast majority of household wealth. Net worth is moderately higher in our sample, as it includes only homeowners.

Among homeowners in both samples, the model's definition of a mortgagor (a household with $a < 0$) aligns closely with the standard definition of a mortgagor in the data (a household with an active mortgage associated with the primary residence). In our sample, 50.7% of households are mortgagors according to the model's definition, and 52.2% are mortgagors according to the data-driven definition. Moreover, 87.6% of mortgagors, using the data-driven definition, are also mortgagors based on the model definition, which implies that 90.2% of those with a position of $a < 0$ in the model are also mortgagors based on the data-driven definition. The incidence of mortgagors, based on the model definition and the data-driven definition, is very similar in both samples considered in Table 6.

On average, model-defined net worth includes 85.9% of net worth in our sample. The coverage is slightly higher, 89.9%, at the median. That is, the model's definition of net worth covers most of the wealth of households in the HFCS.

Table 6: HFCS Summary Statistics

| | All HFCS (36-65) | Our sample |
|---|---|---|
| Household size, mean | 2.33 | 2.62 |
| Head's age, mean | 49.2 | 50.1 |
| Share male head | 70.2% | 80.8% |
| Net worth, mean | €175,805 | €197,809 |
| Net worth, median | €64,573 | €144,020 |
| Share homeowners | 51.8% | 100.0% |
| Homeowners' mortgage incidence | 53.6% | 52.2% |
| Homeowners' share with $a < 0$ | 52.7% | 50.7% |
| Share mortgagors with $a < 0$ | 89.1% | 87.6% |
| $h + a + a_p$, mean | €106,975 | €154,625 |
| $h + a + a_p$, median | €42,714 | €126,376 |
| $h + a + a_p$ over net worth, mean | 67.9% | 85.9% |
| $h + a + a_p$ over net worth, median | 86.8% | 89.9% |

**Notes**: HFCS 2014. All monetary values are in adult equivalent units, based on the OECD equivalence scale (OECD, 2013) and in 2015 euro. *Net worth* refers to the sum of all variables listed in Table 5, defining total net worth as observed in the data. *Homeowners' mortgage incidence* refers to households with an outstanding mortgage associated with their primary residence, as observed in the data. *Homeowners' share of* $a < 0$ refers to the share of homeowners with negative liquid equity ($a$), defining a mortgagor in the model. The *share of mortgagors with* $a < 0$ is the share of mortgagors, as observed in the data, who are also mortgagors as defined in the model. $h + a + a_p$ is net worth based on the wealth components in the model.

## B.2 The SOEP Sample

We use the data from the Cross-National Equivalent Files (CNEF) of the SOEP to estimate the income process (Appendix D) and the tax function (Appendix E). We use SOEP waves from 2000 to 2018, following the introduction of the euro, which comprises 275,340 observations.

We proceed as follows to construct the variables required to estimate the income process and the tax function, based on a sample of homeowners that is consistent with the sample containing information on household wealth in Appendix B.1. We start by creating four income variables based on those available in the SOEP:[29]

- Direct taxes: total taxes (*I11109*) minus social security taxes (*I11112*).
- Taxable labor income: labor income (*I11103*) plus public transfers (*I11107*) minus social security taxes (*I11112*).
- Taxable total income: taxable labor income plus asset income (*I11104*).
- Disposable income: Taxable income minus direct taxes.

We use the CPI to convert all income variables into 2015 euro.

In addition to the data on income, we use variables for the household's reference person's age, the number of children in the household, the state of residency, and housing tenure.

We exclude observations with missing information in any of these variables. We also exclude households receiving social security pensions (*I11108*) or those with non-positive values in taxable labor income, taxable total income, and disposable income.

[29] We provide the variable identifier from the CNEF-SOEP in brackets.

Finally, we restrict the sample to homeowners aged 36 to 65, resulting in 64,212 observations. Table 7 presents summary statistics for our final sample of homeowners, along with the sample of all households with a reference person aged 36 to 65 in the SOEP. The table shows that our sample of homeowners consists of slightly larger households with moderately higher incomes and tertiary education.

Table 7: SOEP Summary Statistics

| | All SOEP (36–65) | Our sample |
|---|---|---|
| Average household size | 2.36 | 2.72 |
| Average number of kids | 0.51 | 0.60 |
| Share with tertiary education | 29% | 34% |
| Taxable labor income, mean | €31,130 | €36,704 |
| Taxable labor income, median | €27,932 | €33,032 |
| Disposable income, mean | €25,839 | €30,178 |
| Disposable income, median | €24,035 | €27,808 |

**Notes**: SOEP 2015. All monetary values are in adult equivalent units, based on the OECD equivalence scale (OECD, 2013) and in 2015 euro. The share with tertiary education is consutructed using the education level of the households' reference person.

# C Numerical Solution

We solve the model numerically using backward induction and applying the endogenous grid point method with occasionally binding constraints (Hintermaier and Koeniger, 2010). The model described in Section 3 features three occasionally binding constraints, two of which depend on an endogenous state variable ($a_p$). In order to alleviate the burden of dealing with the occasionally binding constraints associated to $a_p$, we solve an auxiliary, equivalent model with adjustment costs on pension savings:

$$V^j(a, a_p; y) = \max_{c, a', a'_p} \left\{ u(c) + \beta \mathbb{E}_{y'} V^{j+1}(a', a'_p; y') \right\}$$

$$\begin{aligned}
\text{s.t.} \quad & c^{a' \geq 0} = y - T(y_\tau^{a' \geq 0}) - (q_p a'_p - a_p) - (q_a a' - a) - \Psi(a_p, a'_p), \\
& c^{a' < 0} = y - T(y_\tau^{a' < 0}) - (q_p a'_p - a_p) - (q_\ell a' - a) - \Psi(a_p, a'_p), \\
& y_\tau^{a' \geq 0} = y + \theta_\ell(\iota + \zeta_h) h - (q_p a'_p - a_p) + \iota q_a a', \\
& y_\tau^{a' < 0} = y + \theta_\ell(\iota + \zeta_h) h - (q_p a'_p - a_p) + \theta_\ell(\iota + \zeta_\ell) q_\ell a', \\
& q_a = 1/(1+\iota),\ q_\ell = 1/(1+\iota+\zeta_\ell),\ q_p = 1/(1+\iota+\zeta_p), \\
& a' \geq -\bar{\mu} h, \\
& y(j) = \exp\left( \sum_{i=0}^{4} \psi_i \cdot j^i + \hat{y} \right), \\
& \hat{y}' = \rho \hat{y} + \epsilon, \text{ where } \epsilon \sim \mathcal{N}(0, \sigma_\epsilon^2), \text{ and} \\
& \Psi(a_p, a'_p) = \begin{cases} \frac{\alpha}{2} \left( \frac{q_p a'_p - (a_p + \bar{p})}{a_p + \bar{p}} \right)^2 (a_p + \bar{p}) & a'_p > \frac{a_p + \bar{p}}{q_p}, \\ \frac{\alpha}{2} \left( \frac{q_p a'_p - a_p}{a_p} \right)^2 a_p & a'_p < \frac{a_p}{q_p}, \\ 0 & \text{otherwise.} \end{cases}
\end{aligned}$$

In the implementation, we set $\alpha$, the parameter determining the cost of choosing an $a'_p$ that violates the inequality constraints associated with pension savings, to numerical infinity. Thus, agents always optimally choose next period pension savings ($a'_p$) such that $(\bar{p} + a_p)/q_p \geq a'_p \geq a_p/q_p > 0$.

The algorithm we use to numerically solve the model can be summarize as follows.

1. Set a grid for all state variables besides age ($j$). For liquid equity ($a$) and pension savings ($a_p$), we use grids of 101 points. For income shocks ($\hat{y}$), we use 31 grid points and the Tauchen (1986) method to discretize the $AR(1)$ process.
2. Start in the period before retirement and iterate backwards to the first period. For each combination of income shock ($\hat{y}$) and current period pension savings ($a_p$):
   (a) Use the grid for current-period liquid equity ($a$) to specify the grid for next-period liquid equity ($a'$) used in the next step.
   (b) Use the first-order conditions described in equations (10), (11), and (12) to compute the optimal value of next-period pension savings ($a'_p$) associated to each value of next-period liquid equity ($a'$) from step 2a.
   (c) Using the values of next-period liquid equity ($a'$) from step 2a and next-period pension savings ($a'_p$) from step 2b, together with the first-order conditions (10) and (11), compute the value of the marginal utility of consumption.
   (d) Invert the marginal utility to compute the value of consumption associated to the marginal utility of consumption from step 2c.
   (e) Use the budget constraint to compute the value of current-period liquid equity, and interpolate the policy functions on the exogenous grid of current-period liquid equity.
   (f) Repeat steps 2b through 2e for each grid point of liquid equity.

Note that the value function could be non-concave, depending on the non-linear tax function and the spread between the borrowing and lending rate. Therefore, we add concavity checks for each set of parameter values. All parameter values used throughout the paper imply that the value functions are concave.

# D The Income Process

We proceed as follows to estimate the parameters governing the income process described in Section 3. We use the variable 'taxable labor income' (see Appendix Section B.2), in adult equivalents, dividing taxable labor income by the square root of household size.[30]

We then estimate the income process in logs, and assume that the deterministic and stochastic income components are characterized by:

$$\log y_{i,t,j} = \alpha_j + \gamma_t + \mathbf{x}'\delta + \tilde{y}_{i,t}, \text{ and}$$
$$\tilde{y}_{i,t} = \rho\tilde{y}_{i,t-1} + \epsilon_{i,t}, \text{ with } \epsilon_{i,t} \sim \mathcal{N}(0, \sigma^2_\epsilon).$$

$\alpha_j$ denotes age effects that we approximate by a fourth-order polynomial, $\gamma_t$ controls for time effects that are common across households, and $\mathbf{x}$ is a vector of controls including dummies for education and state of residence. The estimates are reported in Table 1 in the main text.

# E The Tax Function

We estimate the tax function with constant progressivity proposed by Heathcote, Storesletten, and Violante (2017):

$$T(y_\tau) = y_\tau - \nu_0 y_\tau^{1-\nu_1},$$

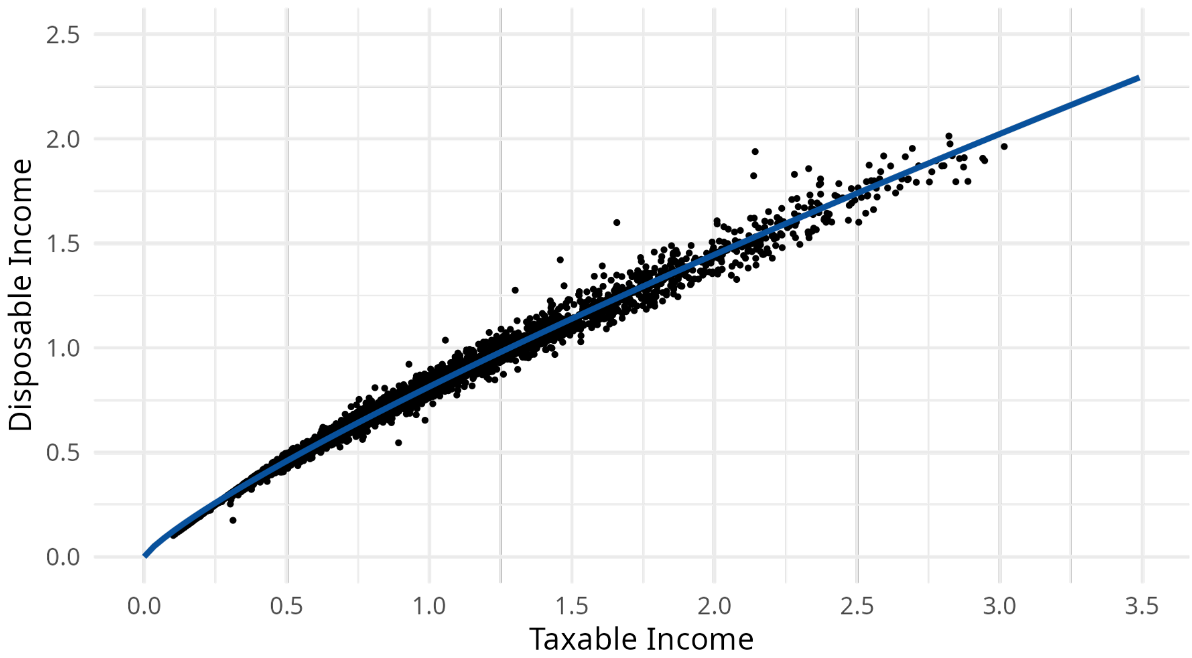
[30]We use the OECD equivalence scale (OECD, 2013), commonly used in the literature, which is similar to the equivalence scale used in Fernández-Villaverde and Krueger (2007).

with $y_\tau$ denoting taxable income. The tax function is characterized by two parameters, $\nu_0$ and $\nu_1$, where $\nu_0$ determines the tax level and $\nu_1$ the degree of progressivity.

We measure taxable and disposable income in the data as described in Appendix Section B.2. Given the tax function, disposable income is $\nu_0 y_\tau^{1-\nu_1}$. We estimate the parameters using a Poisson pseudo maximum likelihood (PPML) estimator as proposed by König (2023), who shows that an estimation in logs using OLS would yield estimates that are biased and inconsistent.

Figure 8 presents the data (black dots) and the estimated tax function (blue line). The estimated values of $\nu_0$ and $\nu_1$ are reported in Table 1 in the main text.

Figure 8: Tax function estimation fit




**Notes**: SOEP 2000-2018. Values are in adult equivalent units, based on the OECD equivalence scale (OECD, 2013), and normalized to the average income in the sample (€36,704). The data are the black dots. The estimated tax function is the blue line.

# F Revenue Neutrality across Counterfactuals

Table 8 reports the tax changes that ensure revenue neutrality in the counterfactual economies. We report the two parameters that (i) determine the level of taxes in the tax function ($\nu_0$), and (ii) the spread ($\zeta_h$) determining the imputed rent $(\iota + \zeta_h)h$, which enters taxable income in equations (3) and (4). We also report the level of the total tax revenue, normalized by its benchmark value, with and without the parameter adjustment.

The first row in Table 8 presents the level of taxes in the benchmark economy, estimated as described in Section 4 and Appendix E, and indicates that there is no imputed rent in the benchmark economy ($\zeta_h$ is coded as not applicable 'N/A').

The subsequent rows display the respective required parameter changes to achieve tax-revenue neutrality. We highlight in bold font the parameter that we adjust in each counterfactual. We use the bisection algorithm to search for the parameter change required for the tax revenue to equal its benchmark value.

Table 8: Tax parameters across counterfactuals

| | $\nu_0$ | $\zeta_h$ | Tax revenue *before* parameter adjustment | Tax revenue *after* parameter adjustment |
|---|---|---|---|---|
| Benchmark | 0.814 | N/A | 100.0% | 100.0% |
| Higher pension cap | **0.807** | N/A | 96.0% | 100.0% |
| Interest deduction | 0.814 | **0.733 pp** | 95.1% | 100.0% |
| Joint changes | **0.806** | 0.733 pp | 95.9% | 100.0% |

**Notes**: The counterfactuals are described in Section 5; *pp* denotes percentage points. We use a bisection algorithm to find the new tax parameter ($\nu_0$ or $\zeta_h$) that ensures that the total tax revenue in each counterfactual equals that of the benchmark. We use a numerical tolerance of $10^{-4}$.

# G Further Results and Robustness

## G.1 Analytic Example on the Effect of Tax Incentives on Portfolio Choice

It is instructive to consider a simple example to illustrate how tax incentives shape portfolio choices of homeowners before retirement. The example allows us to illustrate mechanisms resulting from differences in the after-tax returns of the portfolio items. For this purpose, we consider agents with linear utility who only care about the (expected) after-tax return of the portfolio items. Uncertainty, (il)liquidity and occasionally binding constraints do not play a role in the example but are accounted for in the calibrated model.

Let us first consider the case without tax incentives through deductions, in which portfolio choices are not distorted by taxes. The plausible assumption that the risk-adjusted interest spread is higher for mortgage debt than for pension assets, i.e., $\zeta_\ell > \zeta_p > 0$, then implies that agents prefer to accumulate home equity by amortizing the mortgage because $q_\ell < q_p < q_a$. Home equity has the highest return and thus the lowest price.

How do tax incentives with more generous deductions change this portfolio choice? Agents prefer to accumulate pension assets rather than to amortize their mortgage if the after-tax prices for the assets, implied by the first-order conditions (10), (11) and (12) together with the assumptions of linear utility and no uncertainty, are such that:

$$q_p \frac{1-\frac{\partial T(y_\tau)}{\partial y_\tau}}{1-\frac{\partial T(y'_\tau)}{\partial y'_\tau}} < q_\ell \left(1+(\iota+\zeta_\ell)\frac{\partial T(y_\tau)}{\partial y_\tau}\right) < q_a \left(1+\iota\frac{\partial T(y_\tau)}{\partial y_\tau}\right). \tag{19}$$

The inequality on the left in (19) allows us to compute the critical marginal tax rate at which homeowners prefer to accumulate pension assets rather than home equity. For this purpose, it is useful to consider proportional taxes with a tax rate $\tau$, for which the inequalities in (19) simplify to:

$$q_p < q_\ell\left(1+(\iota+\zeta_\ell)\tau\right) < q_a\left(1+\iota\tau\right). \tag{20}$$

It then follows that homeowners prefer to accumulate pension assets rather than home equity if

$$\tau > \frac{\zeta_\ell-\zeta_p}{(1+\iota+\zeta_p)(\iota+\zeta_\ell)} \equiv \tau^*_{\ell,a_p}, \tag{21}$$

where we have substituted the prices of the different assets using (5). It follows that homeowners with higher income, implying higher marginal tax rates, have less strong incentives to amortize their mortgage and rather invest into illiquid pension savings. Galli et al. (2025) provide empirical evidence in support of this mechanism based on administrative tax data in Switzerland.

Equation (20) further implies that homeowners prefer to accumulate home equity rather than liquid assets if

$$\tau < 1 \equiv \tau^*_{\ell,a}, \tag{22}$$

and they prefer to accumulate pension assets rather than the risk free asset at any tax rate if $\zeta_p > 0$.

The illustrative simple example shows that accumulating asset $a$ is dominated once the debt is paid back, i.e., for outright owners, because accumulating the pension asset offers a higher return. In the example, consumption is a perfect substitute across time for generating utility (but for discounting) so that homeowners do not value the higher liquidity which asset $a$ offers if they do not have motives for consumption smoothing or precautionary saving.

For mortgagors, the portfolio choice simplifies to a choice between home equity and the pension asset, where the choice depends on the strength of tax incentives. The pension asset dominates if the agent wants to accumulate wealth after the debt has been paid off.

The illustrative example highlights the important role of tax-incentivized pension contributions, which change the portfolio choice in a crucial way. If we abstracted from these contributions, (22) shows that homeowners with more generous tax deductions would prefer to accumulate home equity rather than to accumulate the risk-free asset (for any tax rate below 100%). Despite the different tax incentives, the model then would predict similar levels of (mortgage) debt of homeowners with or without more generous deductions.

With more generous deductions, homeowners facing a tax rate $\tau > \tau^*_{\ell,a_p}$ instead accumulate pension assets rather than home equity and thus do not amortize their mortgage. Only if they reach the maximum tax-deductible pension contribution and have fully amortized the mortgage, it is optimal for them to accumulate risk-free assets.

Furthermore, (21) shows that amortization becomes relatively *more* attractive relative to pension contributions at a *lower* interest rate $\iota$. This is because the interest rate $\iota$ and the marginal tax $\tau$ enter in a complementary fashion in the factor, which multiplies $q_\ell$ in (20) and determines the size of the after-tax return of mortgage amortization relative to pension contributions.

If taxation is progressive, then the factor

$$\phi_\tau \equiv \frac{1 - \frac{\partial T(y_\tau)}{\partial y_\tau}}{1 - \frac{\partial T(y'_\tau)}{\partial y'_\tau}} \tag{23}$$

in (19) makes accumulation of pension assets through tax-deductible contributions more attractive if $\phi_\tau < 1$, i.e., if the marginal change of the tax burden after an increase of taxable income in the current period is higher than in the future period. Hence, agents with currently high income who expect lower income in the future have an additional motive to use accumulation of pension assets for tax smoothing purposes.

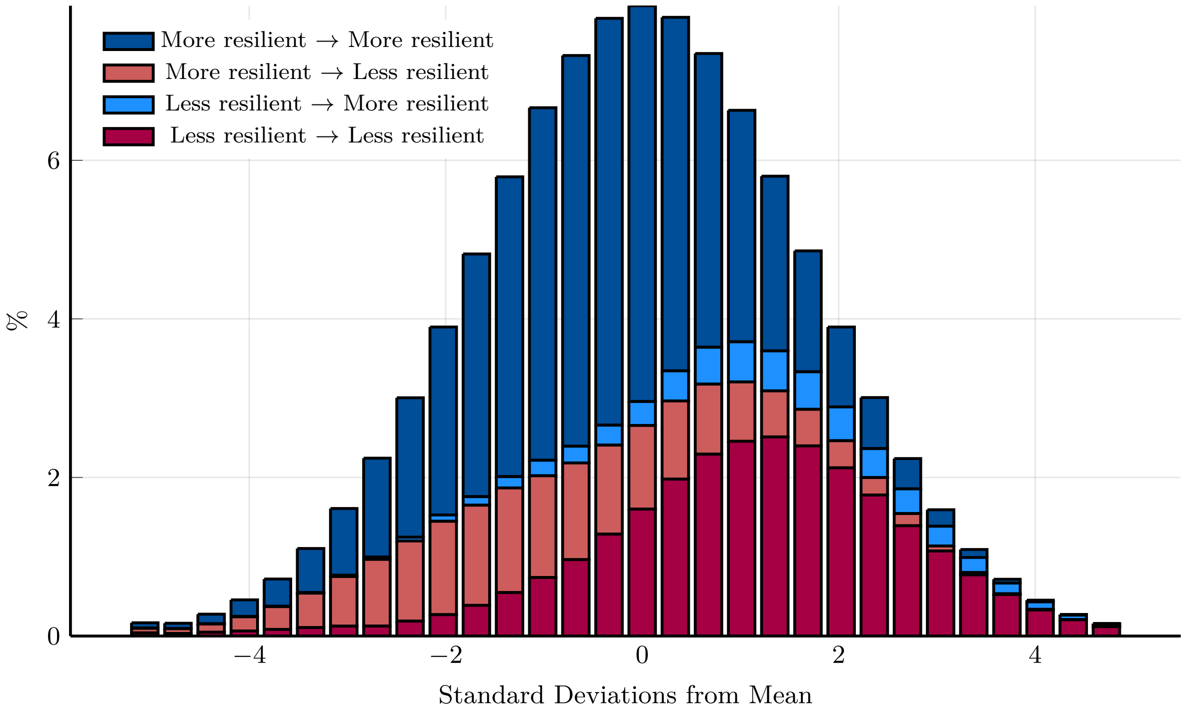
## G.2 Further Quantitative Results

Table 9: Decomposition of the effect of the deductions on the resilience of homeowners

| | **Mortgagors** | | **Outright owners** | |
|---|---|---|---|---|
| | Benchmark Distribution | Endogenous Distribution | Benchmark Distribution | Endogenous Distribution |
| More resilient | 96.0% | 81.1% | 32.6% | 26.5% |
| Always | 70.5% | 68.6% | 14.5% | 6.6% |
| Interest deduction | 24.5% | 11.6% | 16.3% | 4.5% |
| Higher pension cap | 0.5% | 0.6% | 1.5% | 11.3% |
| Interaction | 0.5% | 0.4% | 0.2% | 4.2% |
| Less resilient | 4.0% | 18.9% | 67.4% | 73.5% |
| Always | 2.1% | 4.0% | 45.1% | 65.2% |
| Interest deduction | 0.5% | 14.3% | 12.2% | 5.7% |
| Higher pension cap | 1.1% | 0.2% | 10.0% | 1.9% |
| Interaction | 0.4% | 0.3% | 0.1% | 0.6% |

**Notes**: Decomposition of the effect of the different changes implemented in the regime with more generous deductions on the resilience of homeowners after a decrease in house prices. Agents are classified as mortgagors ($a < 0$) and outright owners ($a \geq 0$) based on their liquid equity holdings in the benchmark economy. 'Everyone' is the label for all homeowners (i.e., both mortgagors and outright owners). 'More resilient' indicates that, for a given agent $i$, the elasticity of consumption to a house price change is *lower* in the counterfactual with more generous deductions than in the benchmark. Using the benchmark distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(a^i, a_p^i, y^i, j^i\right)$, where $(a^i, a_p^i)$ is the agent's portfolio in the benchmark, and $(y^i, j^i)$ is the agent's realization of the income shock and age, which do not change between the counterfactual and the benchmark. Using the endogenous distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(\hat{a}^i, \hat{a}_p^i, y^i, j^i\right)$, where $(\hat{a}^i, \hat{a}_p^i)$ is the portfolio in the counterfactual. 'Less resilient' indicates a *higher* elasticity in the counterfactual than in the benchmark. 'Always' denotes the share of agents who are more/less resilient with respect to the benchmark in the three possible counterfactuals: with the mortgage interest deduction only, with the higher pension cap only, and with the interest deduction and the higher pension cap. 'Interest deduction' indicates the share of agents who are more/less resilient with respect to the benchmark only in the counterfactual with the mortgage interest deduction. 'Higher pension cap' denotes the share of agents who are more/less resilient with respect to the benchmark only in the counterfactual with a higher pension cap. 'Interaction' indicates the share of agents who are more/less resilient with respect to the benchmark only in the counterfactual in which the two deductions are in place.

Figure 9: Changes in resilience to a house price shock along the distribution of income shocks




**Notes**: Each stacked bar represents the percentage of agents in the distribution of income shocks. Within each stacked bar, agents are classified according to how their consumption elasticity to a house price shock changes with respect to the benchmark economy. 'More resilient' indicates that, for a given agent $i$, the elasticity of consumption to a house price change is *lower* in the counterfactual with more generous deductions than in the benchmark. Using the benchmark distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(a^i, a_p^i, y^i, j^i\right)$, where $(a^i, a_p^i)$ is the agent's portfolio in the benchmark, and $(y^i, j^i)$ is the agent's realization of the income shock and age, which do not change between the counterfactual and the benchmark. Using the endogenous distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(\hat{a}^i, \hat{a}_p^i, y^i, j^i\right)$, where $(\hat{a}^i, \hat{a}_p^i)$ is the portfolio in the counterfactual. 'Less resilient' indicates a *higher* elasticity in the counterfactual than in the benchmark.

## G.3 Changes in the Mortgage Spread ($\zeta_\ell$)

Table 10: The effect of more generous deductions on the elasticities of *Mortgagors*, for different interest spreads $\zeta_\ell$

| | | Benchmark | Benchmark Distribution | Endogenous Distribution |
|---|---|---|---|---|
| $\zeta_\ell = 1.5$ pp | Median | 0.412 | 0.4 | 0.414 |
| | | | -2.8% | 0.6% |
| | Mean | 0.604 | 0.588 | 0.6 |
| | | | -2.6% | -0.6% |
| | | More resilient | 88.2% | 65.3% |
| | | Less resilient | 11.8% | 34.7% |
| $\zeta_\ell = 2.5$ pp | Median | 0.44 | 0.398 | 0.416 |
| | | | -9.4% | -5.3% |
| | Mean | 0.6 | 0.56 | 0.59 |
| | | | -6.6% | -1.7% |
| | | More resilient | 94.2% | 80.6% |
| | | Less resilient | 5.8% | 19.4% |
| $\zeta_\ell = 3.5$ pp (Benchmark) | Median | 0.481 | 0.408 | 0.425 |
| | | | -15.3% | -11.7% |
| | Mean | 0.622 | 0.555 | 0.602 |
| | | | -10.8% | -3.1% |
| | | More resilient | 96.0% | 81.2% |
| | | Less resilient | 4.0% | 18.8% |
| $\zeta_\ell = 4.5$ pp | Median | 0.522 | 0.427 | 0.438 |
| | | | -18.2% | -16.0% |
| | Mean | 0.661 | 0.566 | 0.628 |
| | | | -14.4% | -5.0% |
| | | More resilient | 96.9% | 78.9% |
| | | Less resilient | 3.1% | 21.1% |

**Notes**: Agents are classified as mortgagors ($a < 0$) or outright owners ($a \geq 0$) based on their liquid equity holdings in the benchmark economy. 'Everyone' is the label for all homeowners (i.e., both mortgagors and outright owners). The spread between the borrowing and lending rate is $\zeta_\ell$ in percentage points (pp). 'More resilient' indicates that, for a given agent $i$, the elasticity of consumption to a house price change is *lower* in the counterfactual with more generous deductions than in the benchmark. Using the benchmark distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(a^i, a_p^i, y^i, j^i\right)$, where $(a^i, a_p^i)$ is the agent's portfolio in the benchmark, and $(y^i, j^i)$ is the agent's realization of the income shock and age, which do not change between the counterfactual and the benchmark. Using the endogenous distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(\hat{a}^i, \hat{a}_p^i, y^i, j^i\right)$, where $(\hat{a}^i, \hat{a}_p^i)$ is the portfolio in the counterfactual. 'Less resilient' indicates a *higher* elasticity in the counterfactual than in the benchmark.

Table 11: The effect of more generous deductions on the elasticities of *Outright owners*, for different interest spreads $\zeta_\ell$

| | | Benchmark | Benchmark Distribution | Endogenous Distribution |
|---|---|---|---|---|
| $\zeta_\ell = 1.5$ pp | Median | 0.182 | 0.209 | 0.274 |
| | | | 14.5% | 50.2% |
| | Mean | 0.279 | 0.295 | 0.406 |
| | | | 5.7% | 45.6% |
| | | More resilient | 21.8% | 22.8% |
| | | Less resilient | 78.2% | 77.2% |
| $\zeta_\ell = 2.5$ pp | Median | 0.18 | 0.205 | 0.277 |
| | | | 14.0% | 53.7% |
| | Mean | 0.265 | 0.263 | 0.356 |
| | | | -0.8% | 34.1% |
| | | More resilient | 29.9% | 27.0% |
| | | Less resilient | 70.1% | 73.0% |
| $\zeta_\ell = 3.5$ pp (Benchmark) | Median | 0.177 | 0.203 | 0.278 |
| | | | 14.2% | 57.0% |
| | Mean | 0.265 | 0.25 | 0.326 |
| | | | -5.7% | 22.8% |
| | | More resilient | 32.6% | 26.6% |
| | | Less resilient | 67.4% | 73.4% |
| $\zeta_\ell = 4.5$ pp | Median | 0.175 | 0.2 | 0.28 |
| | | | 14.8% | 60.7% |
| | Mean | 0.272 | 0.249 | 0.313 |
| | | | -8.5% | 15.2% |
| | | More resilient | 32.7% | 23.1% |
| | | Less resilient | 67.3% | 76.9% |

**Notes**: Agents are classified as mortgagors ($a < 0$) or outright owners ($a \geq 0$) based on their liquid equity holdings in the benchmark economy. 'Everyone' is the label for all homeowners (i.e., both mortgagors and outright owners). The spread between the borrowing and lending rate is $\zeta_\ell$ in percentage points (pp). 'More resilient' indicates that, for a given agent $i$, the elasticity of consumption to a house price change is *lower* in the counterfactual with more generous deductions than in the benchmark. Using the benchmark distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(a^i, a_p^i, y^i, j^i\right)$, where $(a^i, a_p^i)$ is the agent's portfolio in the benchmark, and $(y^i, j^i)$ is the agent's realization of the income shock and age, which do not change between the counterfactual and the benchmark. Using the endogenous distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(\hat{a}^i, \hat{a}_p^i, y^i, j^i\right)$, where $(\hat{a}^i, \hat{a}_p^i)$ is the portfolio in the counterfactual. 'Less resilient' indicates a *higher* elasticity in the counterfactual than in the benchmark.

Table 12: The effect of more generous deductions on the elasticities of *Everyone*, for different interest spreads $\zeta_\ell$

| | | Benchmark | Benchmark Distribution | Endogenous Distribution |
|---|---|---|---|---|
| $\zeta_\ell = 1.5$ pp | Median | 0.349 | 0.336 | 0.366 |
| | | | -3.6% | 4.9% |
| | Mean | 0.471 | 0.468 | 0.521 |
| | | | -0.6% | 10.6% |
| | | More resilient | 61.0% | 47.9% |
| | | Less resilient | 39.0% | 52.1% |
| $\zeta_\ell = 2.5$ pp | Median | 0.38 | 0.338 | 0.365 |
| | | | -11.1% | -3.8% |
| | Mean | 0.456 | 0.433 | 0.489 |
| | | | -5.2% | 7.2% |
| | | More resilient | 66.6% | 57.6% |
| | | Less resilient | 33.4% | 42.4% |
| $\zeta_\ell = 3.5$ pp (Benchmark) | Median | 0.42 | 0.351 | 0.375 |
| | | | -16.4% | -10.7% |
| | Mean | 0.463 | 0.419 | 0.479 |
| | | | -9.5% | 3.5% |
| | | More resilient | 67.7% | 56.8% |
| | | Less resilient | 32.3% | 43.2% |
| $\zeta_\ell = 4.5$ pp | Median | 0.468 | 0.374 | 0.394 |
| | | | -20.0% | -15.7% |
| | Mean | 0.482 | 0.42 | 0.483 |
| | | | -12.9% | 0.2% |
| | | More resilient | 67.3% | 53.2% |
| | | Less resilient | 32.7% | 46.8% |

**Notes**: Agents are classified as mortgagors ($a < 0$) or outright owners ($a \geq 0$) based on their liquid equity holdings in the benchmark economy. 'Everyone' is the label for all homeowners (i.e., both mortgagors and outright owners). The spread between the borrowing and lending rate is $\zeta_\ell$ in percentage points (pp). 'More resilient' indicates that, for a given agent $i$, the elasticity of consumption to a house price change is *lower* in the counterfactual with more generous deductions than in the benchmark. Using the benchmark distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(a^i, a_p^i, y^i, j^i\right)$, where $(a^i, a_p^i)$ is the agent's portfolio in the benchmark, and $(y^i, j^i)$ is the agent's realization of the income shock and age, which do not change between the counterfactual and the benchmark. Using the endogenous distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(\hat{a}^i, \hat{a}_p^i, y^i, j^i\right)$, where $(\hat{a}^i, \hat{a}_p^i)$ is the portfolio in the counterfactual. 'Less resilient' indicates a *higher* elasticity in the counterfactual than in the benchmark.

## G.4 Changes in the Maximum Loan-to-Value Ratio ($\bar{\mu}$)

Table 13: The effect of more generous deductions on the elasticities of *Mortgagors*, for different maximum loan-to-value ratios $\bar{\mu}$

| | | Benchmark | Benchmark Distribution | Endogenous Distribution |
|---|---|---|---|---|
| $\bar{\mu} = 80\%$ | Median | 0.485 | 0.422 | 0.45 |
| | | | -13.0% | -7.3% |
| | Mean | 0.797 | 0.741 | 0.848 |
| | | | -7.1% | 6.4% |
| | | More resilient | 87.3% | 64.7% |
| | | Less resilient | 12.7% | 35.3% |
| $\bar{\mu} = 90\%$ | Median | 0.493 | 0.421 | 0.443 |
| | | | -14.6% | -10.2% |
| | Mean | 0.691 | 0.626 | 0.695 |
| | | | -9.4% | 0.5% |
| | | More resilient | 94.7% | 76.2% |
| | | Less resilient | 5.3% | 23.8% |
| $\bar{\mu} = 100\%$ (Benchmark) | Median | 0.481 | 0.408 | 0.425 |
| | | | -15.3% | -11.7% |
| | Mean | 0.622 | 0.555 | 0.602 |
| | | | -10.8% | -3.1% |
| | | More resilient | 96.0% | 81.2% |
| | | Less resilient | 4.0% | 18.8% |
| $\bar{\mu} = 110\%$ | Median | 0.473 | 0.398 | 0.412 |
| | | | -15.9% | -12.8% |
| | Mean | 0.578 | 0.51 | 0.542 |
| | | | -11.8% | -6.3% |
| | | More resilient | 96.4% | 85.2% |
| | | Less resilient | 3.6% | 14.8% |

**Notes**: Agents are classified as mortgagors ($a < 0$) or outright owners ($a \geq 0$) based on their liquid equity holdings in the benchmark economy. 'Everyone' is the label for all homeowners (i.e., both mortgagors and outright owners). The maximum loan-to-value ratio is $\bar{\mu}$. 'More resilient' indicates that, for a given agent $i$, the elasticity of consumption to a house price change is *lower* in the counterfactual with more generous deductions than in the benchmark. Using the benchmark distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(a^i, a_p^i, y^i, j^i\right)$, where $(a^i, a_p^i)$ is the agent's portfolio in the benchmark, and $(y^i, j^i)$ is the agent's realization of the income shock and age, which do not change between the counterfactual and the benchmark. Using the endogenous distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(\hat{a}^i, \hat{a}_p^i, y^i, j^i\right)$, where $(\hat{a}^i, \hat{a}_p^i)$ is the portfolio in the counterfactual. 'Less resilient' indicates a *higher* elasticity in the counterfactual than in the benchmark.

Table 14: The effect of more generous deductions on the elasticities of *Outright owners*, for different maximum loan-to-value ratios $\bar{\mu}$

| | | Benchmark | Benchmark Distribution | Endogenous Distribution |
|---|---|---|---|---|
| $\bar{\mu} = 80\%$ | Median | 0.157 | 0.181 | 0.257 |
| | | | 15.2% | 63.0% |
| | Mean | 0.239 | 0.222 | 0.287 |
| | | | -7.2% | 20.1% |
| | | More resilient | 32.6% | 27.8% |
| | | Less resilient | 67.4% | 72.2% |
| $\bar{\mu} = 90\%$ | Median | 0.178 | 0.204 | 0.278 |
| | | | 14.1% | 55.7% |
| | Mean | 0.266 | 0.251 | 0.325 |
| | | | -5.7% | 22.3% |
| | | More resilient | 32.8% | 27.0% |
| | | Less resilient | 67.2% | 73.0% |
| $\bar{\mu} = 100\%$ (Benchmark) | Median | 0.177 | 0.203 | 0.278 |
| | | | 14.2% | 57.0% |
| | Mean | 0.265 | 0.25 | 0.326 |
| | | | -5.7% | 22.8% |
| | | More resilient | 32.6% | 26.6% |
| | | Less resilient | 67.4% | 73.4% |
| $\bar{\mu} = 110\%$ | Median | 0.176 | 0.202 | 0.279 |
| | | | 14.6% | 58.2% |
| | Mean | 0.264 | 0.249 | 0.326 |
| | | | -5.6% | 23.3% |
| | | More resilient | 32.4% | 26.2% |
| | | Less resilient | 67.6% | 73.8% |

**Notes**: Agents are classified as mortgagors ($a < 0$) or outright owners ($a \geq 0$) based on their liquid equity holdings in the benchmark economy. 'Everyone' is the label for all homeowners (i.e., both mortgagors and outright owners). The maximum loan-to-value ratio is $\bar{\mu}$. 'More resilient' indicates that, for a given agent $i$, the elasticity of consumption to a house price change is *lower* in the counterfactual with more generous deductions than in the benchmark. Using the benchmark distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(a^i, a_p^i, y^i, j^i\right)$, where $(a^i, a_p^i)$ is the agent's portfolio in the benchmark, and $(y^i, j^i)$ is the agent's realization of the income shock and age, which do not change between the counterfactual and the benchmark. Using the endogenous distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(\hat{a}^i, \hat{a}_p^i, y^i, j^i\right)$, where $(\hat{a}^i, \hat{a}_p^i)$ is the portfolio in the counterfactual. 'Less resilient' indicates a *higher* elasticity in the counterfactual than in the benchmark.

Table 15: The effect of more generous deductions on the elasticities of *Everyone*, for different maximum loan-to-value ratios $\bar{\mu}$

| | | Benchmark | Benchmark Distribution | Endogenous Distribution |
|---|---|---|---|---|
| $\bar{\mu} = 80\%$ | Median | 0.421 | 0.351 | 0.378 |
| | | | -16.5% | -10.2% |
| | Mean | 0.56 | 0.52 | 0.61 |
| | | | -7.1% | 8.9% |
| | | More resilient | 64.0% | 49.0% |
| | | Less resilient | 36.0% | 51.0% |
| $\bar{\mu} = 90\%$ | Median | 0.426 | 0.357 | 0.382 |
| | | | -16.2% | -10.2% |
| | Mean | 0.502 | 0.459 | 0.53 |
| | | | -8.6% | 5.6% |
| | | More resilient | 67.2% | 54.4% |
| | | Less resilient | 32.8% | 45.6% |
| $\bar{\mu} = 100\%$ (Benchmark) | Median | 0.42 | 0.351 | 0.375 |
| | | | -16.4% | -10.7% |
| | Mean | 0.463 | 0.419 | 0.479 |
| | | | -9.5% | 3.5% |
| | | More resilient | 67.7% | 56.8% |
| | | Less resilient | 32.3% | 43.2% |
| $\bar{\mu} = 110\%$ | Median | 0.416 | 0.347 | 0.37 |
| | | | -16.4% | -11.1% |
| | Mean | 0.438 | 0.394 | 0.445 |
| | | | -10.1% | 1.7% |
| | | More resilient | 67.7% | 58.9% |
| | | Less resilient | 32.3% | 41.1% |

**Notes**: Agents are classified as mortgagors ($a < 0$) or outright owners ($a \geq 0$) based on their liquid equity holdings in the benchmark economy. 'Everyone' is the label for all homeowners (i.e., both mortgagors and outright owners). The maximum loan-to-value ratio is $\bar{\mu}$. 'More resilient' indicates that, for a given agent $i$, the elasticity of consumption to a house price change is *lower* in the counterfactual with more generous deductions than in the benchmark. Using the benchmark distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(a^i, a_p^i, y^i, j^i\right)$, where $\left(a^i, a_p^i\right)$ is the agent's portfolio in the benchmark, and $\left(y^i, j^i\right)$ is the agent's realization of the income shock and age, which do not change between the counterfactual and the benchmark. Using the endogenous distribution, 'More resilient' implies $\eta\left(a^i, a_p^i, y^i, j^i\right) > \hat{\eta}\left(\hat{a}^i, \hat{a}_p^i, y^i, j^i\right)$, where $\left(\hat{a}^i, \hat{a}_p^i\right)$ is the portfolio in the counterfactual. 'Less resilient' indicates a *higher* elasticity in the counterfactual than in the benchmark.

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