When Higher Rates Increase Risk-Taking: Evidence from Mortgage Resets

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Abstract

We study how persistent interest-rate hikes affect household risk-taking via mortgage restructuring. Using Danish administrative data and predetermined five-year reset dates during the 2021–2022 exit from low-for-long rates, we show that borrowers facing higher reset rates shorten fixations, reducing rate insurance, and shift toward interest-only loans when affordability tightens. A simple model rationalizes these choices. This risk materializes: as rates continued rising, high-debt-service borrowers who increased rate exposure experienced a differential increase in financial distress of 150 percent relative to the pre-reset baseline two years after reset. We uncover a household balance-sheet risk-taking channel of monetary policy, where tightening reshapes existing liabilities, increasing fragility and making transmission stronger and path-dependent.

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> *"Low-for-long interest rates can have adverse effects on financial institutions and markets through a number of plausible channels [...]. After all, low interest rates are intended to encourage some risk-taking."*
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> — Jerome H. Powell, "Low Interest Rates and the Financial System,"
> American Finance Association, Chicago, January 7, 2017.

1 Introduction

How do large and persistent increases in interest rates affect household balance-sheet risk? The existing literature, largely focused on the low-rate environment of the housing boom and the Great Financial Crisis, shows that falling mortgage rates can fuel housing demand and borrowing against housing wealth through cash-out refinancing and home-equity extraction, raising leverage and financial fragility risk (Taylor, 2007; Bhutta and Keys, 2016; Khandani et al., 2013). Yet this literature offers little guidance for the opposite regime, when interest rates rise persistently. In this paper, we uncover a distinct household balance-sheet risk-taking channel: persistent rate hikes need not make household balance sheets safer. Indeed, for households with inherited mortgage debt facing a scheduled rate reset, higher rates can induce a shift toward cheaper but riskier mortgage contracts, subsequently increasing financial fragility risk, even without expanded borrowing. The exposure of households to this channel is quantitatively significant. In the euro area alone, 33 percent of outstanding debt at the start of 2022 carried a fixation period of five years or less, exposing them to imminent rate resets as central banks raised interest rates persistently.

This risk-taking channel arises because, for such borrowers, leverage is difficult to adjust quickly, so tighter monetary conditions need not produce balance-sheet repair. Instead, higher rates can make safer mortgage choices harder to sustain. The utility cost of rate protection rises with interest rates, because paying the same insurance premium requires giving up current cash flow when current consumption is already lower. When affordability tightens, higher rates can also make amortization harder to maintain. Households may then respond by choosing cheaper but riskier mortgage structures along two margins: they reduce rate insurance by shortening fixation, and they backload repayment through interest-only borrowing. We develop a simple model of these mechanisms and test them in the Danish mortgage market, where scheduled reset dates generate quasi-exogenous variation in borrowing conditions. We find that persistent tightening induces precisely this form of restructuring, increasing the riskiness of existing mortgage debt and making monetary transmission stronger and more path dependent.

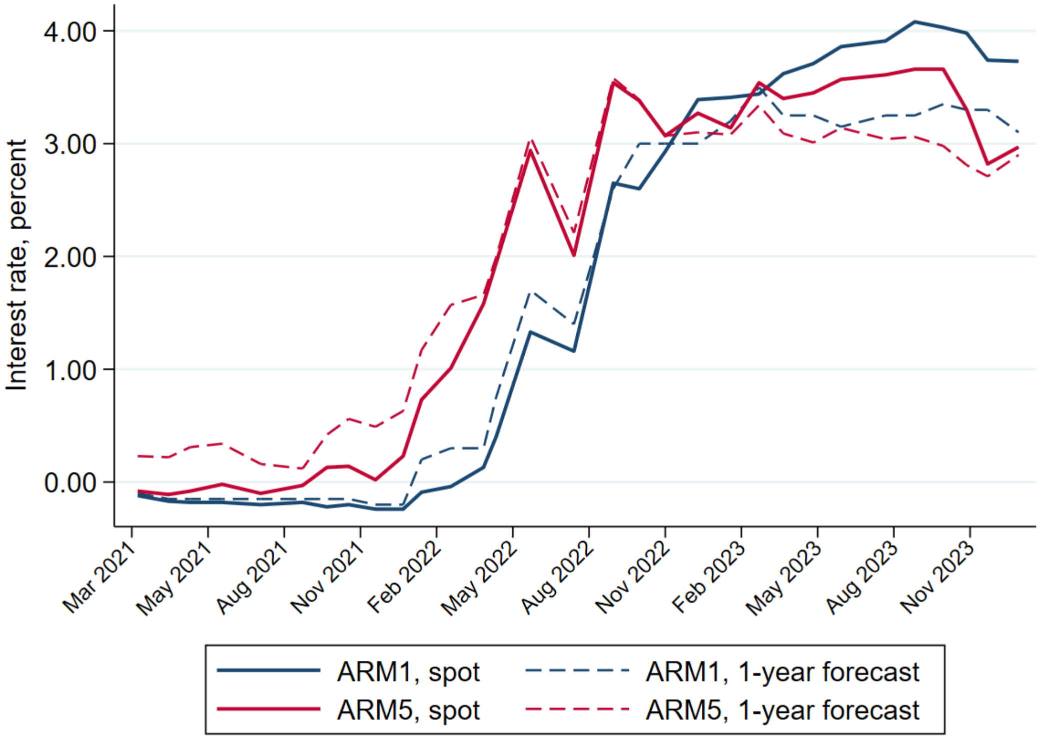
To identify these mechanisms, we exploit a feature of the Danish mortgage market that comes unusually close to the ideal experiment of exposing otherwise identical borrowers to different borrowing conditions. Our analysis uses loan-level data on rate resets for existing mortgages. After almost a decade of near-zero policy rates and exceptionally low mortgage costs, financial markets in 2021–2022 began to price in a sustained normalization of interest rates rather than a temporary spike. In Denmark, the reset dates of adjustable-rate mortgages are fixed at origination, and interest rates are repriced at scheduled market-based reset auctions, leaving no room for household-specific pricing at the reset. This institutional structure turns the end of low-for-long into a natural experiment: otherwise similar cohorts are differentially exposed to the new rate environment depending on whether their reset occurs just before or just after the regime change.

Figure 1 illustrates the resulting shift in both current mortgage rates and the expected path of future rates for a representative mortgage with a five-year fixation period. Mortgage rates, which had remained close to zero for several years, increased sharply in early 2022, with little sign of prior anticipation. The figure also documents that at that point in time, the increase was perceived as persistent rather than transitory. Central to our paper, the figure also reveals the interest rate difference between maintaining a five-year fixation and switching to a one-year (or shorter) fixation at reset, highlighting the immediate interest-rate savings from choosing a shorter fixation period. A simple decomposition of yields shows that the 2022 rate increase was driven primarily by expected short rates rather than term premia.

To organize our thinking about how shifts in the rate environment affect household mortgage choices, we start from a bare-bones two-period model. A borrower inherits a stock of debt from the past and, when restructuring the mortgage, chooses along two dimensions: the interest-rate structure (fixed versus flexible) and the repayment profile (how much principal to repay up front versus backload). These correspond to the two margins that are central in the data: the insurance margin and the amortization margin.

Choosing a fixed rate is an insurance decision: it raises the interest rate in both periods by a constant premium, but eliminates uncertainty about future payments.

Figure 1: The figure shows the interest rate on an adjustable-rate mortgage with a five-year fixation period (red line) and a one-year fixation period (blue line). The solid lines shows the spot rate while the dashed line shows the twelve-month-ahead forecasts as communicated to bank customers. Data: Danske Bank Research, *Renteudsigter*.



A flexible rate avoids the insurance premium but leaves the household exposed to future rate shocks. The model isolates two opposing forces. On the one hand, as the level and expected path of rates rise, the premium becomes more painful in terms of current consumption, since higher debt-service payments raise the marginal utility of consumption today (a cost-of-insurance effect). On the other hand, higher rates, holding dispersion fixed, increase the value of eliminating payment risk, because adverse rate realizations occur when consumption is already lower and marginal utility is therefore higher (an insurance-value effect). When uncertainty about future rates is not too large, the former locally dominates: risk-averse households optimally reduce rate insurance and shift toward cheaper but more interest-sensitive contracts.

Mortgage choice also involves a cash-flow trade-off in principal repayment. Repaying more principal up front reduces future payments, but tightens current consumption; backloading repayment through lower amortization or interest-only borrowing provides immediate cash-flow relief at the cost of slower deleveraging. This margin is more sharply state-dependent. When an affordability constraint becomes relevant, a rise in rates increases required interest payments and crowds out principal repayment. As a result, higher rates can shift adjustment toward backloaded repayment, leaving borrowers with higher outstanding balances and greater exposure of future payments to subsequent rate changes.

We take these insights to the data using Danish administrative registers that link the universe of mortgage contracts to household income, demographics, and credit records. Our baseline design compares ARM5 borrowers whose first scheduled reset falls in Q3–Q4 of 2021 with borrowers whose first scheduled reset falls in Q3–Q4 of 2022. Both groups had chosen the same five-year product before the regime change, but reached reset at sharply different points in the rate cycle: the former while mortgage rates remained near zero, the latter after current rates and the expected path of future rates had moved decisively out of the low-for-long environment. The comparison is disciplined by two institutional features. Reset timing was fixed by origination choices made in 2016–2017, before borrowers could foresee the 2021–2022 normalization; and reset rates are set mechanically in covered-bond auctions, so borrowers with the same product in the same auction face the relevant bond yield plus an administrative fee, with no scope for household-specific bargaining. Thus, the variation we exploit is the exposure of inherited mortgage debt to different market borrowing conditions at a predetermined reset date.

Because the cohorts nevertheless reach reset in different calendar years, a remaining concern is that the comparison may capture factors correlated with the rate environment rather than behavior triggered by the reset. We address this concern directly in the empirical analysis. Mortgage outcomes exhibit no differential pre-trends, and outcomes that can adjust outside the mortgage reset date—including labor supply and bank debt—do not display anticipatory adjustment before the high-rate reset. The response therefore appears when households reach the scheduled reset and confront the new borrowing conditions, rather than earlier in calendar time. We also show that our findings are robust to including regional inflation controls to absorb local demand conditions that may have co-moved with the rate environment.

Our empirical analysis delivers three main findings. First, households exposed to the higher 2022 reset rates restructure their mortgages along two distinct contractual margins. They reduce rate insurance by shifting toward shorter fixation and, when current affordability becomes tighter, backload repayment by making greater use of interest-only contracts. These choices lower current payments but increase future vulnerability: the stock of debt held by the high-reset cohort becomes substantially more sensitive to subsequent rate hikes. Benchmarking the estimated differential response against the cohort's average pre-reset baseline exposure implies that interest-rate exposure—that is, the elasticity of future mortgage payments to an additional one-percentage-point increase in rates—almost doubles for the high-reset cohort relative to the low-reset cohort. Importantly, these riskier contract choices are not offset elsewhere on the household balance sheet. Households exposed to higher reset rates do not deleverage more aggressively and do not build larger liquid buffers. This matters because it implies that the observed shift in mortgage structure translates into a genuine increase in net vulnerability, rather than a mere reshuffling of risk that is neutralized through self-insurance.

Second, the heterogeneity patterns support the mechanism emphasized by the model. The response is strongest among households with tighter pre-reset cash-flow positions, exactly where the consumption-smoothing motive is most powerful. Households with high debt-service burdens are particularly likely to adjust on the amortization margin by shifting into interest-only borrowing. This pattern also speaks to interpretation: if borrowers were simply expecting future rate declines, the response should be strongest among the most optimistic borrowers, and not among those facing the tightest affordability constraints. Additional evidence based on liquid wealth shows that liquidity differences matter more for whether households continue to amortize than for the broad choice between fixed- and adjustable-rate borrowing. In Denmark, borrower-based regulation limits the ability of the riskiest households to combine very low rate insurance with low amortization, so the strongest heterogeneity appears on the margin that remains most feasible in practice: backloaded repayment through interest-only contracts.

Third, the risk-taking channel we identify has material consequences once the additional rate exposure created at reset is realized. The restructuring we document is not driven by immediate repayment distress: financial distress does not rise significantly at the reset itself. Instead, distress increases with a lag, after borrowers who shortened fixation become exposed to further increases in short-term rates. For borrowers resetting in 2022Q3 and 2022Q4, the rate on one-year-or-shorter fixation loans rose to about 3.5 and 4.1 percent, respectively, over the following two years, while borrowers who retained five-year fixation had locked in rates of roughly 1.9 and

2.7 percent. This realized divergence in borrowing costs is followed by repayment problems. In the full sample, financial distress rises significantly five to seven quarters after reset, with the point estimate seven quarters after reset of 0.36 percentage points corresponding to approximately 40 percent of the pre-reset baseline distress rate. Among borrowers with high pre-reset debt-service burdens who also increased their interest-rate exposure, the effects are much larger: seven quarters after reset, the difference in financial distress between the high- and low-rate cohorts amounts to 2.94 percentage points, equivalent to approximately 150 percent of the pre-reset baseline distress rate. These magnitudes show that the risk created at reset is not merely a change in the composition of liabilities. It creates genuine balance-sheet fragility: when subsequent rate increases materialize, that fragility shows up as economically meaningful repayment distress.

Related Literature Our paper relates to the literature on household monetary transmission through mortgage markets. A large empirical literature shows that interest-rate changes affect household cash flows and real outcomes through mortgage contract structure, with important heterogeneity across borrowers and mortgage types (Di Maggio et al., 2017; Cloyne et al., 2020). Recent work strengthens identification by exploiting predetermined reset or refinancing dates across countries during the post-2021 tightening cycle, and shows that households often cushion payment shocks through renegotiation, lender switching, prepayment, term extensions, information-driven refinancing, drawing down liquidity buffers built up in anticipation of the reset, or some combination of these margins (Adelino et al., 2026; Bracke et al., 2024; Elias et al., 2025; Kartashova and Zhou, 2025; Fuster et al., 2026; Andersen et al., 2026). We build on this literature, but shift the focus away from the contemporaneous spending response and toward the endogenous evolution of household balance-sheet risk at reset.

More closely, our paper relates to work showing that the mortgage channel of monetary policy is state dependent and path dependent. The strength of transmission depends on the distribution of unhedged interest-rate exposure across households (Auclert, 2019), a distribution that, as we show, is itself endogenously reshaped by the tightening episode at reset. Berger et al. (2021) show that, with fixed-rate prepayable mortgages, the power of monetary easing depends on the past path of interest rates, because prior refinancing changes the distribution of outstanding mortgage coupons and hence future policy space. Eichenbaum et al. (2022) similarly show that the effects of monetary policy depend on the distribution of potential savings from refinancing, and that a prolonged period of low interest rates can reduce the potency of future policy even after rates renormalize. Recent cross-country evidence further shows that monetary policy affects the flow composition of FRMs and ARMs and, through this channel, the subsequent composition of the mortgage stock and the strength of transmission (De Stefani and Mano, 2026).

We complement this literature by identifying a distinct source of path dependence within the stock of existing mortgage debt. Whereas De Stefani and Mano (2026) use a cross-country panel to show that monetary policy affects the aggregate composition of new mortgage originations and thereby gradually reshapes the outstanding mortgage stock, our mechanism operates at scheduled resets of inherited debt. Using loan-level administrative data, we observe borrowers reaching predetermined reset dates and trace how they restructure existing liabilities in response to higher rates. When borrowers reach reset in a high-rate environment, they reduce fixation and, when affordability tightens, slow amortization. These choices lower current payments but raise the sensitivity of future household cash flows to subsequent rate hikes. By documenting this endogenous restructuring at reset, and linking it to subsequent financial distress, we uncover a new path-dependent margin of household monetary transmission: persistent tightening reshapes the riskiness of existing mortgage debt, making future transmission stronger and more path dependent.

Second, our paper relates to household finance research on mortgage contract choice and mortgage design. Classic models frame the choice between fixed- and adjustable-rate borrowing as a household risk-management problem, while empirical work shows that contract shares respond to the level and expected path of interest rates (Campbell and Cocco, 2003; Badarinza et al., 2018). A parallel literature studies alternative mortgage designs, including interest-only contracts, as instruments that provide current payment relief at the cost of slower equity accumulation and potentially higher default risk (Piskorski and Tchistyi, 2010; Cocco, 2013; Amromin et al., 2018; Campbell et al., 2021; Guren et al., 2021). We complement these contributions by using scheduled reset dates to isolate the restructuring of inherited debt—rather than mortgage choice at origination—and by tracing how that restructuring changes the riskiness of household liabilities.

Finally, our results connect more broadly to work on financial fragility and the risk-taking channel of monetary policy. Existing household-finance research, largely in the low-rate environment of the housing boom and the GFC, shows that falling mortgage rates can stimulate borrowing against housing wealth through cash-out refinancing and home-equity extraction, raising leverage and potentially fragility (Taylor, 2007; Bhutta and Keys, 2016; Khandani et al., 2013). A related literature emphasizes that low rates stimulate risk-taking on the intermediary side through weaker lending standards and greater credit supply (e.g. Borio and Zhu, 2012; Adrian and Shin, 2011; Jiménez et al., 2014; Dell'Ariccia et al., 2017). Our contribution is to show that, on household balance sheets, persistent tightening can generate a distinct risk-taking channel of its own: even without expanding borrowing, higher rates can induce borrowers at reset to choose mortgage structures with less insurance and weaker amortization, thereby increasing exposure to future shocks.

2 A Simple Model of Mortgage Risk-Taking

This section develops a simple two-period model to guide the interpretation of our empirical analysis. Our empirical setting concerns households that reach a mortgage reset at the end of a low-for-long environment, so the model is designed to isolate the key trade-offs they face at that point. We abstract from earlier decisions about housing demand, tenure, and initial borrowing, and instead take the household's housing position and outstanding mortgage debt as predetermined. The central choice is then how to *restructure* the existing mortgage contract along two dimensions: the interest-rate structure (fixed versus flexible) and the repayment profile (how much principal to repay up front versus backload, including the limiting case of an interest-only mortgage). We represent these decisions in a stylized two-period framework in which period 0 captures the reset or refinancing decision and period 1 the remaining mortgage horizon.

The model is deliberately bare-bones and not meant to provide a fully realistic description of household balance-sheet management at reset. Its purpose is to isolate two mechanisms that discipline our empirical interpretation: the insurance trade-off embedded in the fixation choice, and the cash-flow trade-off embedded in principal repayment when affordability constraints become relevant. Accordingly, we abstract from liquid asset accumulation and focus on the fixation margin and a parsimonious representation of amortization/interest-only through a single repayment share.[1]

2.1 Environment

Assume a household that enters period 0 with an outstanding mortgage principal $B > 0$ and receives deterministic income $y > 0$ in each period. Time is discrete, $t = 0, 1$. Preferences over non-housing consumption c_t are

$$U \;=\; u(c_0) + \beta \mathbb{E}\big[u(c_1)\big], \tag{1}$$

with discount factor $\beta \in (0, 1]$. Period utility $u(c_t) \to \mathbb{R}$ is strictly increasing and strictly concave, with $u'(c) > 0$, $u''(c) < 0$ and $u'''(c) \geq 0$. We assume that period utility satisfies the Inada condition $\lim_{c \to 0} u(c) = -\infty$.[2]

In $t = 0$, the household makes a two-dimensional contract choice to service the inherited balance B: it selects the interest-rate structure (fixed versus flexible) and the repayment profile. We summarize the latter by an amortization share $\alpha \in [0, 1]$, so that the household repays αB at $t = 0$ and the remaining $(1 - \alpha)B$ at $t = 1$, with $\alpha = 0$ corresponding to an interest-only mortgage over the horizon.

Monetary policy sets the short-term nominal interest rate $\kappa_t \geq 0$. To ease notation, we define $\kappa_0 = \kappa$ and $\kappa_1 = \kappa + \varepsilon_\sigma$, where the $\{\varepsilon_\sigma\}_{\sigma > 0}$ is a family of random interest-rate shocks with mean $\mathbb{E}[\varepsilon_\sigma] = 0$ and variance $\mathbb{E}[\varepsilon_\sigma^2] = \sigma^2$.[3] While κ and σ are known to households in $t = 0$, the interest-rate shocks create ex-ante uncertainty over the level of interest rates in period $t = 1$.

Let $T \in \{V, F\}$ denote the set of available contracts. At $t = 0$ the household chooses between a flexible-rate contract V and a fixed-rate contract F. Under the flexible-rate contract V, the mortgage rate tracks the policy level, such that $r_t^V(\kappa_t) = \kappa_t$ for $t = \{0, 1\}$. Under the fixed-rate contract F, the household locks in a deterministic rate that applies in both periods, $r_t^F(\kappa) = \kappa + \varphi$ for $t = \{0, 1\}$,

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[1] The institutional features of the Danish mortgage market and the mortgage choices households face at reset are described in more detail in Section3.

[2] A canonical example is CRRA utility,

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma}, \tag{2}$$

where $\gamma \geq 1$ is the coefficient of risk aversion.

[3] We assume that ε_σ has a symmetric distribution around zero. Its support is contained in $[-K\sigma, K\sigma]$ for some $K > 0$. This assumption ensures that as $\sigma \to 0$ the support of the shocks shrinks to zero uniformly, which allows a clean second-order expansion of expected marginal utility.

where the price of interest-rate fixation is a constant spread $\varphi > 0$ above the nominal interest rate κ.

To allow for generic affordability considerations at reset, we also impose a reduced-form feasibility constraint on period-0 consumption,

$$c_0^T(\kappa, \alpha) \; \geq \; \underline{c}. \tag{3}$$

We impose (3) only at $t = 0$, interpreting it as a reduced-form underwriting/residual-income requirement evaluated at the reset (and/or reset-date committed expenses), rather than as a constraint that must hold in every future period. We interpret $\underline{c}$ as a floor for non-discretionary spending and minimum residual consumption—i.e. committed expenses that must be covered before discretionary adjustment can occur (e.g. utilities and housing-related bills, childcare/school fees, commuting costs, mandatory insurance premia, and minimum payments on other debts). We impose this constraint on period-0 consumption as a reduced-form affordability requirement at reset. Consistent with our empirical evidence, we treat it as slack for the fixation decision, but potentially binding for amortization and interest-only choices, where higher current principal payments can make the constraint relevant.

Let $B_1(\alpha) \equiv (1 - \alpha)B$ denote the remaining principal entering period 1. Total mortgage payments $P_t^T(\kappa, \alpha)$ combine interest payments and principal repayment:

$$P_0^T(\kappa, \alpha) = \begin{cases} \kappa B + \alpha B, \\ (\kappa + \varphi)B + \alpha B \end{cases} \qquad P_1^T(\kappa, \alpha) = \begin{cases} (\kappa + \varepsilon)B_1(\alpha) + B_1(\alpha), & \text{if} \quad T = V, \\ (\kappa + \varphi)B_1(\alpha) + B_1(\alpha), & \text{if} \quad T = F. \end{cases} \tag{4}$$

Note that at $t = 1$ the rate is uncertain if $T = V$, depending on the realization of the interest-rate shock ε. In each period, consumption is

$$c_t^T(\kappa, \alpha) = y - P_t^T(\kappa, \alpha),$$

subject to the feasibility condition (3) at $t = 0$.

This formulation shuts down self-insurance through liquid asset accumulation: mortgage payments map one-for-one into contemporaneous non-housing consumption. This is a deliberate simplification that keeps the two reset margins in sharp focus—rate insurance through fixation and cash-flow management through principal repayment. Allowing households to save would attenuate the quantitative importance of both margins by introducing an additional buffer-stock instrument. For the fixation choice, liquid assets provide a buffer-stock margin that changes the effective cost–benefit of insurance: households can finance the fixed-rate premium by drawing down wealth rather than cutting c_0 one-for-one, and they can also cushion high-payment realizations under flexible rates in period 1, reducing the insurance value of fixing.

For the amortization choice, liquid assets relax the cash-flow trade-off by allowing borrowers to fund principal repayment without an equivalent compression of contemporaneous consumption and, importantly, by making the reset affordability constraint less likely to bind; as a result, fewer households are forced into lower α or the interest-only corner when rates rise. Overall, self-insurance tends to attenuate the reliance on mortgage contract margins as tools for managing payment risk, without overturning the core intuitions developed below: fixed-rate borrowing remains qualitatively valuable because it insulates households from states in which the marginal value of liquidity is high, and when affordability constraints are relevant—for instance because short-run borrowing constraints limit the ability to smooth cash flow—higher rates can still shift adjustment toward backloaded repayment (lower α) as current cash flow tightens.

2.2 Fixed versus Flexible Mortgage Decision

In this subsection, we focus on the fixed-versus-flexible mortgage decision. For simplicity, we set $\alpha = 0$. We also assume that the affordability constraint (3) is slack for the contract choice considered here, so the fixed-versus-flexible decision reflects an unconstrained insurance trade-off. This normalization is not meant to make the interest-only margin the object of analysis; rather, it abstracts from amortization to keep the analysis transparent and isolate the fixation margin that drives the mechanism.

Using the payment equations above and setting $\alpha = 0$, utility under mortgage contract V is

$$U_V(\kappa;\sigma^2) = u\big(y - \kappa B\big) + \beta\,\mathbb{E}\big[u\big(y - (1+\kappa+\varepsilon_\sigma)B\big)\big], \tag{5}$$

where the expectation is taken under the distribution of ε_σ. Under mortgage contract F, utility is

$$U_F(\kappa) = u\big(y - (\kappa+\varphi)B\big) + \beta\,u\big(y - (1+\kappa+\varphi)B\big). \tag{6}$$

We restrict attention to levels of κ such that consumption is strictly positive under both contracts and for all shocks. Define $\bar{\kappa} \equiv \min\left\{\frac{y}{B} - \varphi,\ \frac{y}{B} - 1 - \varphi,\ \frac{y}{B} - 1 - K\sigma\right\}$ and consider $\kappa \in [0, \bar{\kappa})$. Then $c_t^F(\kappa) > 0$ for $t = 0, 1$, and $c_0^V(\kappa) = c_0^F(\kappa) + \varphi B > 0$, while $c_1^V(\kappa, \varepsilon_\sigma) \geq y - (1 + \kappa + K\sigma)B > 0$ for all ε_σ in the support.

It follows that the net utility gain from choosing a fixed-rate mortgage is $\Delta U(\kappa; \sigma^2) \equiv U_F(\kappa) - U_V(\kappa; \sigma^2)$, and the fixed-rate contract F is chosen if and only if $\Delta U(\kappa; \sigma^2) \geq 0$.

Using equations (5)–(6), $\Delta U(\kappa; \sigma^2)$ decomposes as

$$\begin{aligned}\Delta U(\kappa; \sigma^2) = &\Big[u\big(y - (\kappa + \varphi)B\big) - u\big(y - \kappa B\big)\Big] \\ &+ \beta\Big[u\big(y - (1 + \kappa + \varphi)B\big) - \mathbb{E}\, u\big(y - (1 + \kappa + \varepsilon_\sigma)B\big)\Big]. \qquad (7)\end{aligned}$$

The first term is the current utility cost of paying the premium φB at $t = 0$: since $y - (\kappa + \varphi)B < y - \kappa B$ and u is strictly increasing, it is strictly negative. The second term reflects the net effect at $t = 1$ of lowering mean consumption by φB while at the same time eliminating interest-rate risk. Concavity implies that removing risk is beneficial, but this benefit is offset by lower average consumption under the fixed mortgage contract, so the sign of the second term is a priori ambiguous. We impose a mild condition that fixing is attractive at some low rate level.

Assumption 1 (Fixing attractive at low rates) *There exists* $\sigma_0 > 0$ *and* $\kappa_0 \in [0, \bar{\kappa}(\sigma_0))$ *such that*

$$\Delta U(\kappa_0; \sigma_0^2) > 0.$$

■

Assumption 1 can be satisfied by choosing (y, B, β, φ) such that, when rates are low and dispersion is moderate, the insurance benefit at $t = 1$ dominates the small premium paid in both periods.

A Permanent Rate Increase: Theoretical Trade-offs We are interested in how a permanent increase in the level of interest rates κ affects the relative attractiveness of fixing versus flexing, for a given dispersion σ^2. Differentiating $\Delta U(\kappa; \sigma^2)$ with respect to κ and using equations (5)–(6) yields

$$\Delta U'(\kappa; \sigma^2) = -B\Big\{u'\big(c_0^F(\kappa)\big) - u'\big(c_0^V(\kappa)\big) + \beta\Big[u'\big(c_1^F(\kappa)\big) - \mathbb{E}\, u'\big(c_1^V(\kappa, \varepsilon_\sigma)\big)\Big]\Big\}. \qquad (8)$$

We can rewrite this as

$$\Delta U'(\kappa; \sigma^2) = -B\Big\{A(\kappa) - \beta\Big[\mathbb{E}\, u'\big(c_1^V(\kappa, \varepsilon_\sigma)\big) - u'\big(c_1^V(\kappa, 0)\big)\Big]\Big\}, \qquad (9)$$

where $A(\kappa) \equiv u'\big(c_0^F(\kappa)\big) - u'\big(c_0^V(\kappa)\big) + \beta\Big[u'\big(c_1^F(\kappa)\big) - u'\big(c_1^V(\kappa, 0)\big)\Big] > 0$. The term $A(\kappa)$ captures a *cost-of-insurance* effect: because the fixed contract lowers consumption by the premium φB in both periods relative to the flexible contract absent the period-1 shock, and u' is decreasing in consumption, the premium becomes more costly in marginal-utility terms as κ increases. The second bracket in (9) captures an *insurance-value* effect: interest-rate risk raises expected marginal utility under the flexible contract relative to the deterministic benchmark, increasing the value of eliminating period-1 payment risk.

In general, the sign of $\Delta U'(\kappa;\sigma^2)$ is therefore ambiguous and depends on the dispersion of the interest-rate shock. When dispersion is sufficiently small, the cost-of-insurance effect dominates locally, so that higher rates reduce the net benefit from fixing and push households toward flexing. The following proposition formalises this result.

Proposition 1 (Local effect of permanent rate increase for small σ) *Fix parameters (y, B, β, φ) and a rate level $\kappa > 0$ such that consumption is strictly positive under both contracts and for all shocks for all sufficiently small σ. Suppose Assumption 1 holds and u satisfies the regularity and prudence conditions stated above. Then there exists a threshold $\bar{\sigma}(\kappa) > 0$ such that, for all $\sigma \in (0, \bar{\sigma}(\kappa))$,*

$$\Delta U'(\kappa;\sigma^2) < 0.$$

That is, when the dispersion of interest-rate shocks is sufficiently small, a permanent increase in the level of rates locally reduces the net utility gain from fixing and makes flexible contracts more attractive. For larger dispersion, the sign of $\Delta U'(\kappa;\sigma^2)$ is in general ambiguous and depends on the amount of interest-rate risk.

Proof in Appendix C. ■

The proof, provided in Appendix C, uses a second-order Taylor expansion of marginal utility under the flexible contract around the period-1 deterministic benchmark and exploits the fact that the shocks are mean-zero, symmetric, and bounded in $[-K\sigma, K\sigma]$. Intuitively, when dispersion is small, the insurance-value term in (9) is of order σ^2, whereas the cost-of-insurance term $A(\kappa)$ is strictly positive and independent of σ. For sufficiently small σ, the cost-of-insurance effect therefore dominates, and a higher level of rates reduces the demand for rate insurance.

Proposition 1 provides the core comparative-static that underpins our empirical analysis: in an environment with limited interest-rate dispersion, an upward shift in the level and expected path of rates—such as the exit from a low-for-long regime—can rationally induce households to move away from long-fixation "insurance" and toward more interest-sensitive contracts, even when preferences remain strictly risk-averse and the shock distribution is unchanged. A key advantage of this simple model is that it also delivers a sharp *heterogeneity prediction* that we take to the data. Because both the insurance premium and the consequences of payment risk scale with the inherited debt stock, the strength of this rate-induced shift should vary systematically with households' balance sheets.

Corollary 1 (Debt burdens amplify the cost-of-insurance channel) *Fix* (y, β, φ) *and consider an admissible debt level* $B > 0$ *and rate level* $\kappa > 0$ *such that consumption is strictly positive under both contracts and for all shocks for all sufficiently small* σ*. Under the assumptions of Proposition 1, there exists a threshold* $\bar{\sigma}(\kappa, B) > 0$ *such that, for all* $\sigma \in (0, \bar{\sigma}(\kappa, B))$*, the sensitivity of the net benefit of fixing to a rate increase is strictly decreasing in inherited debt* B*:*

$$\frac{\partial}{\partial B}\Delta U'(\kappa; \sigma^2) < 0.$$

Equivalently, when the cost-of-insurance effect dominates, a given increase in κ *reduces the net utility gain from fixing more strongly for households with larger inherited debt.*

Proof in Appendix C. ■

2.3 The Amortization Margin

We now turn to the amortization decision and study how the principal-repayment share α responds to a permanent increase in the level of rates. To isolate this margin, we focus on the case in which the household remains in the fixed-rate contract at reset but can adjust principal repayment. This choice is without loss of generality for the mechanism of interest: the key force is that higher rates tighten current cash flow at reset, while amortization primarily shifts repayment toward the future. The same logic applies under flexible-rate contracts, since principal repayment affects the payment path in both contract types.

Fixed-rate payments with amortization. Let $r(\kappa) \equiv \kappa + \varphi$ denote the fixed mortgage rate at reset, with constant premium $\varphi > 0$. The household chooses an amortization share $\alpha \in [0, 1]$, repaying αB at $t = 0$ and $(1 - \alpha)B$ at $t = 1$. The remaining balance entering period 1 is $B_1(\alpha) = (1 - \alpha)B$. Under the fixed-rate contract, total mortgage payments are

$$P_0(\kappa,\alpha) = r(\kappa)B + \alpha B, \qquad P_1(\kappa,\alpha) = (1+r(\kappa))B_1(\alpha) = (1+r(\kappa))(1-\alpha)B,$$

so that consumption is

$$c_0(\kappa,\alpha) = y - r(\kappa)B - \alpha B, \qquad c_1(\kappa,\alpha) = y - (1+r(\kappa))(1-\alpha)B. \tag{10}$$

Utility is $U(\kappa,\alpha) = u(c_0(\kappa,\alpha)) + \beta u(c_1(\kappa,\alpha))$.

Trade-off (cost versus benefit of amortization). Amortizing an additional unit of principal has a current utility cost and a future utility benefit. Differentiating $U(\kappa,\alpha)$ w.r.t. α yields

$$\frac{\partial U(\kappa,\alpha)}{\partial \alpha} = -B\,u'\big(c_0(\kappa,\alpha)\big) + \beta(1+r(\kappa))B\,u'\big(c_1(\kappa,\alpha)\big). \tag{11}$$

The first term is the utility cost of lowering c_0 by $B\,d\alpha$ when the household marginally increases amortization (pays additional principal at reset). The second term is the utility benefit of raising c_1 by $(1+r(\kappa))B\,d\alpha$, reflecting the reduction in next period's principal and interest payments. In the frictionless problem, an interior optimum $\alpha^{uc}(\kappa)$ satisfies

$$u'\big(c_0(\kappa,\alpha^{uc}(\kappa))\big) = \beta(1+r(\kappa))\,u'\big(c_1(\kappa,\alpha^{uc}(\kappa))\big). \tag{12}$$

How $\alpha^{uc}(\kappa)$ responds to κ is generally ambiguous. A higher rate raises the gross return to repaying principal early through the factor $(1+r(\kappa))$, which tends to increase amortization. At the same time, it lowers current consumption, making additional repayment at reset more costly in utility terms, while also lowering future consumption, which increases the value of reducing future payments. Because these forces work in opposite directions, the unconstrained response of amortization to a rate increase is not pinned down. We use this unconstrained problem as a benchmark and next turn to the empirically relevant case in which the affordability constraint becomes relevant, generating a motive for payment relief at reset.

Affordability friction at reset. Assume that at reset the household must satisfy a minimum-consumption (affordability) requirement

$$c_0(\kappa,\alpha) \;\geq\; \underline{c}, \tag{13}$$

where $\underline{c} > 0$ is a reduced-form representation of liquidity/underwriting constraints (e.g. payment-to-income rules). Using (10), (13) is equivalent to an upper bound on amortization:

$$\alpha \;\leq\; \bar{\alpha}(\kappa) \;\equiv\; \frac{y-\underline{c}}{B} - r(\kappa) = \frac{y-\underline{c}}{B} - (\kappa+\varphi). \tag{14}$$

Hence, a higher policy rate mechanically tightens the amortization set at reset: $\bar{\alpha}'(\kappa) = -1$.

Proposition 2 (Rates and amortization when the reset constraint binds) *Consider the fixed-rate amortization problem with affordability constraint (13). Let $\alpha^{uc}(\kappa)$ denote the unconstrained optimal amortization choice (i.e. the optimizer absent (13)), and let $\alpha^*(\kappa)$ denote the optimal choice under (13). Suppose that at some κ the affordability constraint binds at the optimum, i.e. $\alpha^{uc}(\kappa) > \bar{\alpha}(\kappa)$, and that $\bar{\alpha}(\kappa) \in (0,1)$. Then*

$$\alpha^*(\kappa) = \bar{\alpha}(\kappa) \qquad \text{and} \qquad \frac{d\alpha^*(\kappa)}{d\kappa} = -1.$$

Proof. Using $c_0(\kappa,\alpha) = y - r(\kappa)B - \alpha B$, the affordability constraint $c_0(\kappa,\alpha) \geq \underline{c}$ is equivalent to $\alpha \leq \bar{\alpha}(\kappa) \equiv \frac{y-\underline{c}}{B} - r(\kappa)$. If the constraint binds at the optimum, then $\alpha^*(\kappa) = \bar{\alpha}(\kappa)$. Since $r(\kappa) = \kappa + \varphi$, we have $\bar{\alpha}'(\kappa) = -1$, implying $d\alpha^*(\kappa)/d\kappa = -1$. If $\bar{\alpha}(\kappa) \leq 0$, feasibility implies $\alpha^*(\kappa) = 0$. ■

Interpretation. Absent an affordability friction, the response of the unconstrained optimum $\alpha^{uc}(\kappa)$ to a rate increase is in general ambiguous: a higher rate raises the financial return to repaying principal early through the factor $(1 + r(\kappa))$ in (**??**), but it also tightens consumption at both dates for any given α, changing the marginal-utility weights in the first-order condition. With a binding affordability constraint, by contrast, the constrained optimum is $\alpha^*(\kappa) = \bar{\alpha}(\kappa)$, so higher rates raise interest payments at reset and crowd out principal repayment one-for-one. The household is therefore forced to backload repayment by lowering α. As $\bar{\alpha}(\kappa)$ approaches zero, this adjustment reaches the interest-only corner, $\alpha = 0$.

Debt burdens and heterogeneity. Proposition 2 delivers a particularly sharp implication for heterogeneity. The key is that the affordability friction translates into an *upper bound* on amortization, $\alpha \leq \bar{\alpha}(\kappa)$, and this bound depends on inherited debt through the reset budget. Larger B both (i) tightens the admissible amortization set and (ii) makes borrowers more likely to operate in the regime where the affordability constraint binds. As a result, rate hikes are more likely to translate into backloaded repayment (lower α) among more indebted households, including a higher propensity to hit the corner $\alpha = 0$ (interest-only over the horizon).

Corollary 2 (Debt burdens amplify the backloading-amortization channel) *Under the assumptions of Proposition 2, suppose the affordability constraint binds at the optimum and that* $\bar{\alpha}(\kappa) \in (0,1)$. *Then the optimal amortization share is strictly decreasing in inherited debt* B*:*

$$\frac{\partial}{\partial B}\alpha^*(\kappa) = \frac{\partial}{\partial B}\bar{\alpha}(\kappa) = -\frac{y-\underline{c}}{B^2} < 0.$$

Moreover, the threshold rate at which the borrower is forced into the corner $\alpha^*(\kappa) = 0$ *is*

$$\kappa^{IO}(B) \equiv \frac{y-\underline{c}}{B} - \varphi,$$

which is strictly decreasing in B. *Equivalently, more indebted households are pushed to* $\alpha = 0$ *(interest-only over the horizon) at lower interest-rate levels.*

Proof. *Under Proposition 2,* $\alpha^*(\kappa) = \bar{\alpha}(\kappa) = \frac{y-\underline{c}}{B} - (\kappa + \varphi)$ *when the constraint binds and* $\bar{\alpha}(\kappa) \in (0,1)$*, so differentiating w.r.t.* B *yields the first claim. The interest-only threshold solves* $\bar{\alpha}(\kappa) = 0$*, giving* $\kappa^{IO}(B) = \frac{y-\underline{c}}{B} - \varphi$*; differentiating shows* $d\kappa^{IO}(B)/dB < 0$. ■

Interpretation. In the binding regime, a higher policy rate crowds out amortization one-for-one because it raises required interest payments at reset; this intensive-margin response $d\alpha^*/d\kappa = -1$ does not itself depend on B. Corollary 2 shows how debt nevertheless generates strong heterogeneity: higher inherited debt tightens the reset constraint and shifts borrowers closer to (or onto) the boundary, so that a given rate increase is more likely to force them into substantially lower amortization—and to the interest-only corner—than for otherwise similar low-debt households.

2.4 Discussion: omitted margins and interpretation

A useful way to interpret the model is as a benchmark that isolates the two reset margins that are central for households at reset: the interest-rate structure (fixed versus flexible) and the repayment profile (amortizing versus backloading/interest-only). The goal is not a complete model of household balance sheets, but a transparent mapping from these two choices to (i) interest-rate insurance demand and (ii) cash-flow management when affordability becomes relevant.[4]

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[4] We abstract from maturity as a choice variable since, as documented in Section 3, Danish mortgages are almost universally 30-year contracts. In other markets, maturity extensions could serve as an alternative way to backload repayment and manage the cash-flow burden following an

Self-insurance through liquid assets. If households could actively accumulate and draw down liquid assets around reset, contract choices would play a smaller quantitative role in managing payment risk: assets can finance premia and principal repayments at $t = 0$ and buffer high payments at $t = 1$. Empirically, however, we find limited evidence of liquid-wealth build-up around reset, and the shift toward more interest-sensitive contracts is similar for low- and high-liquidity households. Empirically, the shift toward more interest-sensitive contracts is very similar for low- and high-liquidity households, suggesting that affordability constraints are not first-order for the fixation margin. In contrast, as we will show, liquidity is more clearly related to repayment choices within fixed-rate contracts (amortizing versus interest-only), consistent with affordability constraints shaping the α margin.

3 Data and Institutional Setting

3.1 Institutional setting: The Danish mortgage market

The Danish mortgage system relies on market-based funding through covered bonds. Mortgage credit institutions fund loans directly through the issuance of covered mortgage bonds. The ARM loans of particular focus in our study are traded at quarterly auctions. A defining characteristic of the system is the match-funding principle: each mortgage loan is financed by bonds that replicate its cash-flow profile. When a household takes out a mortgage, the mortgage institution simultaneously issues bonds with the same maturity, amortization schedule, and interest-rate structure. Bond prices therefore mechanically determine the borrower's mortgage rate, creating a transparent link between mortgage pricing and conditions in the underlying bond market. In practice, borrowers face this market-based interest rate plus an administrative fee charged by the mortgage institution. This fee only varies with loan characteristics (e.g. the loan-to-value rate), but is independent of borrower characteristics.

Under the annuity principle, loan size, interest rate, and mortgage maturity jointly determine quarterly payments that remain constant over the underlying bond's lifetime. Mortgage installments are paid at the end of each quarter, with interest payments being tax deductible at an effective rate of approximately 25–37 percent. Borrowers additionally pay administrative margins on the outstanding loan balance. Be-

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interest-rate increase, similarly to interest-only loans.

cause mortgage institutions rely exclusively on bond issuance for funding, mortgage rates reflect market conditions at origination or at the interest rate reset. All mortgages funded in the same auction face identical rates, leaving no scope for individual negotiation. Consequently, changes in market interest rates are transmitted directly to new loans and to existing loans when their interest-rate fixation period expires.

This structure applies to both fixed-rate mortgages (FRM) and adjustable-rate mortgages (ARM); the key distinction is the bond maturity. ARMs are funded by shorter-maturity bonds and the entire loan is refinanced at the bond's maturity. Borrowers can select fixation periods from three months to ten years[5]. In this study, we focus on the most common adjustable-rate mortgage type, with a five year interest rate fixation (ARM5). Indeed, in early 2021, ARM5 loans accounted for just over half of outstanding ARM debt and approximately 23 percent of all total mortgage debt. After five years, the bond underlying an ARM5 loan matures and the loan is refinanced at prevailing market rates through a new bond issuance. At the rate reset, the existing bonds are redeemed at par and new bonds are issued at current yields. If issuance occurs below par, the borrower's nominal outstanding debt is adjusted to cover the refinancing amount. Unless the borrower actively restructures his debt, the mortgage remains a standard amortizing mortgage with unchanged maturity and fixation period. Although mortgages with 20-year maturities exist, virtually all Danish mortgages carry a 30-year term, and maturity is therefore not an active margin of adjustment for borrowers.[6]

Borrowers also have an interest-only (IO) option, which allows amortization to be deferred for up to 30 years. The IO period is fixed at origination; when it expires, amortization resumes unless the borrower applies for a new IO period, which requires renewed credit approval and in practice is counted as a new loan. IO loans are match-funded by bonds with identical deferred-amortization profiles, implying the same pricing mechanism as for standard amortizing loans, though administrative margins are typically higher.

A central feature of the Danish mortgage system is the option to prepay mortgages. For FRM loans, borrowers may at any time redeem their loan by either repaying the

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[5] Loans with very short fixation periods (typically 3-6 months) are based on longer maturity bonds (typically 3 years) that track an agreed reference interest rate.

[6] In January 2022, mortgages with 30-year maturities accounted for 95.7 percent of outstanding mortgages with remaining maturity above 20 years (Danmarks Nationalbank, Statbank DNVPDKR2).

outstanding debt at par, or buying the underlying bonds at their current market price.[7] While ARM loans may also be paid back before maturity, the borrower can only buy the underlying bond at market value. Refinancing is subject to a fixed fee, incentivizing borrows to only refinance when financial gains are large enough. However, for ARM loans, borrowers can avoid the refinancing fee for certain types of loan restructuring at the reset date, such as changes to interest fixation periods, without a renewed credit score assessment which includes new house valuation etc. This makes the rate reset date an obvious point in time to restructure mortgages.

The timing of rate reset and refinancing decisions is central for our study. In practice, the post-reset interest rate is determined by auctions held in the quarter preceding the scheduled reset, typically one month before the reset. Borrowers are usually notified up to six months before the reset, allowing time to consider changes to fixation period or loan size prior to auction. Deadlines for restructuring decisions are generally about two months before the reset date. For example, a rate reset in the third quarter of 2022 would affect payments at the end of the third quarter, that is 30 September 2022 and onwards. The auction for the new bond would be held within the second quarter of 2022, typically in late May. [8]

3.2 Data sources

For our analysis, we combine data from several administrative registries. Specifically, we obtain detailed loan-level data from the Credit Register collected by Danmarks Nationalbank. This data is complemented by income and demographic information from official registries maintained by Statistics Denmark. We match the data between registers via the social security number that uniquely identifies each individual in the Danish population.

The data on income and assets originate from annual tax returns recorded in the registers `IND` and `FORMPERS`. These data are third-party reported, highly reliable, and subject to minimal evasion (see, e.g., Kleven et al., 2011; Alstadsæter et al., 2019). All variables are measured at an annual frequency. Individual demographic characteristics are drawn from the population register (`BEF`), including information

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[7] Borrowers can thus reduce their outstanding debt when interest rates rise (fall) by repurchasing the bond below par (prepaying at par).

[8] See Figure A.1 for a graphical illustration of the timing of the notification from the bank of an upcoming reset, time of auction and interest rate reset around a scheduled rate reset.

on age, gender, household composition and municipality of residence.

We merge this data with loan-level information from the Danish Credit Register, accessed through Danmarks Nationalbank.[9] The register provides granular, loan-level information on all debt obligations, both bank loans and mortgages, held by each debtor, since the end of 2019. The data includes key mortgage attributes such as interest rate fixation period, outstanding balance, whether a loan is interest-only, as well as key dates of the mortgage, such as the end of an IO period, or the reset schedule. For mortgages with multiple co-debtors, the data also specify the share of the loan for which each individual is responsible.

Based on this data, we construct several variables for our analysis, for each individual debtor. First, we define outstanding debt as the book value of outstanding debt on a loan in a given quarter. Second, from information on the interest rate fixation on each loan, we construct an indicator on whether an individual has a mortgage with a lower fixation rate than the original ARM5 loan. Third, we define an individual's interest rate exposure as the amount of outstanding debt with a rate reset within one year or less. Importantly, we also include all bank debt with a rate fixation of one year or less. Fourth, to capture financial distress, we construct an indicator that captures whether a loan is in arrears or if the bank has renegotiated the loan's lending terms. Specifically, we define a loan to be in arrears if a payment of more than DKK 1.000 (EUR 134) has been missed for more than 45 days. Renegotiation of lending terms includes modifications to interest rates, repayment conditions, or refinancing of existing debt related to borrower difficulties.

3.3 Sample selection

In our analysis, we focus on individuals who hold an adjustable rate mortgage with a 5-year fixation period and face a rate reset in the second half (Q3 or Q4) of either 2021 and 2022.[10] These borrowers fixed their interest rate in either 2016 or 2017, for five years and are either scheduled for a rate reset when interest rates are still

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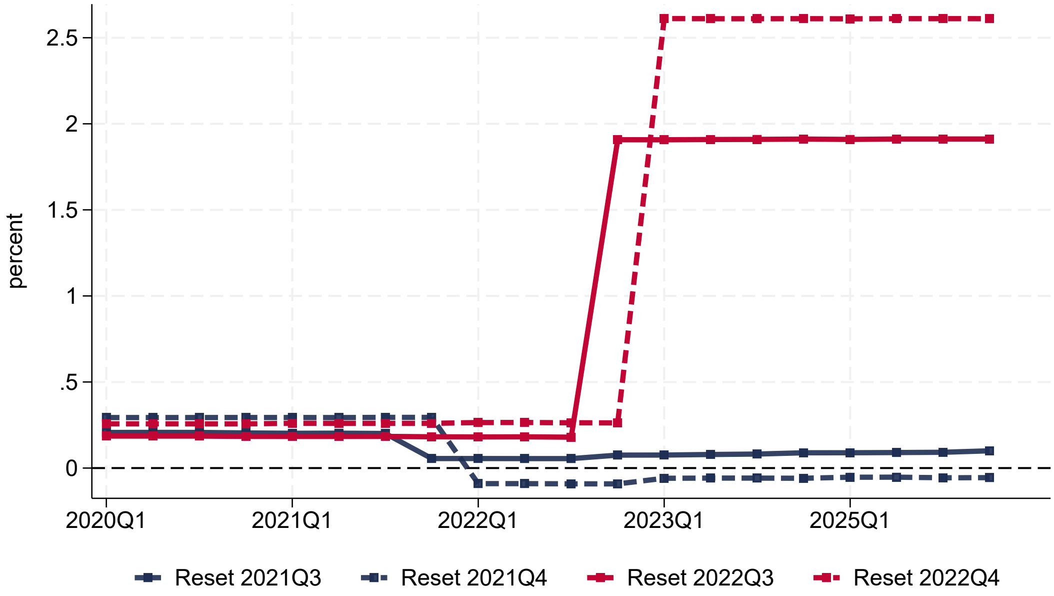
[9] Banks above a certain size report data on all Danish customers, with quarterly submissions for the largest institutions. The register is compiled for financial stability monitoring and is continuously quality-checked by the central bank. For a detailed description of the Credit Register, see Danmarks Nationalbank (2021).

[10] For the small number of individuals with multiple 5-year adjustable-rate mortgages resetting in different quarters, we define quarter of reset based on the mortgage with the earliest rate reset in our sample.

Figure 2: **Mortgage interest rates** Notes: The figure shows the average interest rate on five year adjustable rate mortgages, up for reset in either 2021 (black lines) or 2022 (red lines) before and after the reset. Solid lines indicate reset in Q2 of the respective year, while dashed lines represent reset in Q3. The figure includes only the ARM5 loans that continues as an ARM 5 loan after the reset. The figure shows the average interest rates across all ARM5 loans with a scheduled rate reset in either of the four quarters.



low (resets in 2021) or when interest rates are already high (resets in 2022). Figure 2 highlights the interest rate path of these individuals, showing for each group their initial interest rate and the potential interest rate if no refinancing decision is taken, and they opt for a renewed 5-year fixation ARM.

For our main empirical analysis, we apply an event study approach, following these individuals from 6 quarters before their rate reset until 8 quarters after the reset. To do so, let $t = 0$ denote the quarter of the scheduled reset and define $t - 3$ as the baseline quarter. For the purpose of our study, we exclude individuals who restructure their debt three or more quarters before their reset date and therefore no longer hold an ARM5 in the baseline period. Note that we do not require individuals to hold an ARM5 loan at the time of the scheduled reset itself, as refinancing decisions must be made before the reset (see the discussion in section 3.1). We further limit our sample to individuals aged 30 to 80 three quarters before their reset date, to exclude extreme life-cycle refinancing behavior.

We impose several sample restrictions to ensure comparability across groups and isolate the effect of the rate reset. First, individuals must not hold any fixed-rate mortgage in the baseline quarter (three quarters before reset). We focus on these individuals without FRM's such that our results are not contaminated by effects of rate hikes on other than ARM5.[11] We impose this restriction to eliminate the differential impact of higher interest rates due to the impact of interest rate increases on the market value of existing FRM debt. Second, we exclude individuals whose interest-only period expires within the three quarters before or at the rate reset to ensure that the treatment corresponds solely to the reset event rather than a simultaneous expiration of interest-only period. [12] In total, our sample consists of 23,611 individuals.

Table 1 reports characteristics of the individuals in our estimation sample separately for those who refinance at high and low rates. To ensure that we measure observables before any impact of the upcoming reset, we measure all characteristics three quarters before reset due to the timing of events around reset described in Section 3 above.[13] The table reveals that the two reset cohorts are comparable along a broad set of observables. Both groups are similar in age and household size. Gross income and pre-reset interest expenses and leverage are also comparable both in levels and in their distribution across the sample. On the balance sheet, the size of total outstanding mortgage debt, as well as the choices in terms of risk both related to interest rate risks as well as debt without amortizations are also similar between both groups. The average individual in our sample has an outstanding mortgage debt of around DKK 1.100k, equivalent to EUR 143k. Importantly, the outstanding debt affected by the scheduled rate reset is quite similar across both groups, as is the debt-to-income (DTI) ratio. Taken together, the patterns in Table 1 suggest that there are no large or systematic pre-reset differences in observable characteristics between the reset cohorts.

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[11] As discussed in 4

[12] The importance of expiration of IO periods are documented by Andersen et al. (2024) who show that e.g. IO expirations impact consumption.

[13] Since we only measure income and interest expenses annually, we refer to income in 2020 (2021) for individuals with a rate reset in 2021 (2022).

Table 1: **Sample characteristics one year before reset** Notes: Characteristics are measured three quarters before scheduled rate reset. For gross income and interest expenses we only observe annual income and interest expenses and these are therefore measured in the year before rate reset. All nominal values are measured in 2021 Danish Kroner. Outstanding debt denotes the book value of outstanding debt. DTI (debt-to-income) is defined as total debt relative to gross income. DSTI (debt-service-to-income) is defined as interest expenses relative to gross income. Observations in the table refer to individual X quarter.

	Reset at low rate	Reset at high rate
	Mean (SD)	Mean (SD)
Panel A: Demographics		
Age	54.84 (12.91)	53.65 (13.43)
Female Share	0.49 (0.50)	0.50 (0.5)
Panel B: Income and wealth		
Disposable income, 1000 DKK	419.60 (230.80)	419.22 (223.79)
Total wealth, 1000 DKK	4406.13 (4800.04)	4425.90 (4930.06)
Deposits, 1000 DKK	217.14 (499.21)	197.62 (687.78)
Panel C: Debt and mortgage characteristics		
Interest expenses, 1000 DKK	18.30 (14.74)	19.26 (14.58)
Outstanding debt, 1000 DKK	1294.82 (999.66)	1333.58 (974.35)
Interest rate exposure, 1000 DKK	167.72 (339.43)	164.96 (344.59)
Outstanding debt without amortizations, 1000 DKK	713.57 (769.60)	733.52 (784.19)
Outstanding debt affected by rate reset, 1000 DKK	927.24 (544.55)	965.44 (509.77)
Panel D: Leverage, risk, and constraints		
Debt-to-income	2.82 (2.79)	2.92 (2.87)
Loan-to-Value	0.40 (0.27)	0.41 (0.27)
Share with IO loan	0.65 (0.48)	0.65 (0.48)
Share liquidity constrained	0.18 (0.38)	0.20 (0.40)
In arrears, percent	0.69 (8.31)	0.43 (6.56)
Relaxed lending conditions, percent	0.44 (6.23)	0.34 (5.48)
N	14,412	15,247

4 Empirical model and identification

Our empirical strategy exploits the plausibly exogenous exposure of loans of heterogeneous interest rates, due to heterogeneous reset dates. For five-year adjustable-rate mortgages in Denmark, the timing of the interest-rate reset is mechanically determined by the origination date, while the reset rate is set by market conditions in the reset quarter. We use an event-study design comparing households whose scheduled resets occur in different calendar quarters. Importantly, borrowers who fixed their mortgage rates in 2016–17 could not have anticipated the sharp increase in interest rates in late 2022. As a result, variation in interest-rate exposure at reset in 2021 or 2022 is plausibly exogenous, allowing us to identify the causal effects of higher reset rates on mortgage contract choice and interest-rate exposure.

Let the subscript i index households and t quarters relative to rate reset. Further, we define a treatment indicator

$$HighRate_i \equiv \mathbf{I}\{\text{RateReset}_i = 2022\},$$

so that $HighRate_i = 1$ for households whose reset occurs in 2022 (either Q3 or Q4), the *treated* cohort. Instead, for the low reset, *control* cohort, $HighRate_i = 0$, the reset occurs in 2021 (either in Q3 or Q4). For each outcome y_{it}, we estimate the following standard event-study model:

$$\begin{aligned} y_{it} = \gamma HighRate_i &+ \sum_{q \neq -3} \beta_q \left(\mathbf{I}\{t = j\} \times HighRate_i \right) \\ &+ \sum_q \alpha_q \left(\mathbf{I}\{t = q\} \times X_i \right) + \mu_i + \theta_t + \varepsilon_{it}. \end{aligned} \tag{15}$$

where μ_i and θ_t are household and time fixed effects, respectively. The vector X_i collects demographic controls (e.g., age, municipality, gender). The indicator $\mathbf{I}\{t = q\}$ is equal to 1 if the time relative to reset t is equal to q, with $-6 \leq j \leq 8$. We interact demographic controls with the event time indicator. The parameter γ indicates the relative effect of being in the high reset group in the baseline period, in $t = -3$.[14] We define the coefficients of interest β_q as a difference in difference specification. β_q indicates the effect of being in the high reset group, relative to the low reset group, in quarter q relative to reset, relative to the baseline period. We can therefore interpret the coefficients β_q as the change in the outcome y in quarter q relative to three quarters before the rate reset for individuals whose reset occurs when interest rates have increased, relative to the corresponding change for individuals whose reset takes place when interest rates remain nearly unchanged. We estimate equation (15) as a

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[14] This is in line with the empirical findings but also reflects that in $q = -2$ individuals may have already started to re-optimise their debt following information from the mortgage institution, see Section 3.1.

standard OLS regression. The unit of observation is individual, while standard errors are clustered at the household level.

Our identifying assumption is that, absent the increase in interest rates in 2022, individuals whose mortgages reset in 2022 would have exhibited the same behavior around reset as those whose mortgages reset in 2021. The event-study specification in equation (15) allows us to assess this assumption by comparing pre-reset trends across cohorts. Specifically, we test whether the coefficients β_q for $q < -3$ are close to zero and statistically insignificant. Under this parallel-trends assumption, the post-reset coefficients ($q > 0$) trace out the dynamic causal effects of higher reset rates on outcomes such as mortgage structure, interest expenses, and debt-servicing exposure.

The comparison between borrowers whose mortgages reset in 2021 and 2022 is justified by the institutional feature that reset timing is mechanically determined by the origination date of the five-year fixation period: borrowers who fixed in 2016 reset in 2021, while those who fixed in 2017 reset in 2022. Although loan origination is not random across years, borrowers could not have selected into these reset windows based on expectations about interest rates five years ahead. Thus, while borrowers may differ across origination cohorts, they could not condition contract timing on the interest-rate environment at reset. As a result, the two groups are comparable except for the level of interest rates they face when their loans reset. Moreover, Denmark's market-based mortgage system implies that borrowers cannot negotiate individual reset rates, further strengthening the exogeneity of interest-rate exposure.

Equation (15) includes a rich set of controls to account for observable differences between cohorts. Measured three years prior to reset, we control nonparametrically for age, gender, and municipality, interacting these indicators with event time in the same way as the high-reset indicator. This flexible specification absorbs differential outcome dynamics associated with observable characteristics. Household fixed effects further account for all time-invariant heterogeneity across borrowers. However, in line with our empirical design, borrowers exposed to higher reset rates and those facing little rate change are highly similar in observables (Table 1).

A potential concern for identification is that because adjusting mortgage terms outside scheduled reset dates is costly, observed mortgage restructuring at reset could reflect earlier macroeconomic developments rather than the interest-rate increase realized at reset. Borrowers may optimally postpone mortgage adjustment even if economic conditions deteriorate earlier. Identification therefore hinges on whether behavioral responses emerge only once rates reset or already prior in calendar time.

We assess this concern using outcomes that are not mechanically tied to the reset date. We first consider labor-market outcomes. Focusing on borrowers resetting in 2021Q3 and 2022Q3, Appendix Figure A.2 shows that hours worked evolve similarly across the two groups until the reset of the later cohort. At that point, hours worked increase for borrowers resetting in 2022Q3, coinciding with the decline in disposable income induced by the larger rate increase.[15] There is no evidence of differential adjustment in hours worked prior to reset.[16] Furthermore, in Appendix Figure A.3, we provide evidence that bank-debt adjustment is also concentrated at reset even though borrowers can adjust this margin at any time. Taken together, the parallel pre-trends in continuously adjustable outcomes supports the interpretation that mortgage restructuring responses are driven by the rate increase realized at reset rather than by earlier macroeconomic developments.

Finally, Appendix Figure A.4 shows that the event-study estimates are robust to controlling for regional consumption inflation from Danmarks Statistik. Regional inflation provides an additional check that the results are not driven by differential local demand conditions across reset cohorts that happen to correlate with the timing of the rate increase. The estimates are virtually unchanged.

Another concern is that borrowers may differ in their beliefs about the persistence of the 2022 rate increase and adjust their mortgage choices accordingly, rather than responding to a tighter budget constraint. While a belief-based interpretation may rationalize the shift toward shorter fixation, it cannot rationalize the simultaneous shift toward interest-only borrowing: reducing amortization would only be rational for borrowers expecting rates to fall well below 2021 levels. Moreover, we show that borrowers with higher pre-reset debt-service-to-income ratios respond more strongly to interest-rate increases, exhibiting larger increases in interest-rate risk and a greater propensity to choose interest-only contracts than households facing similar rate shocks but with lower ex-ante debt burdens. This pattern is consistent with the theoretical mechanism in Corollary 2. It is harder to reconcile this pattern with explanations based on belief heterogeneity. Such an interpretation would require the most exposed households to expect future rate declines large enough to justify taking on additional

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[15] This is in line with evidence on labor market adjustments following interest rate increases shown by Zator (2025).

[16] Consistent with this pattern, we find no differential development in labor-market income between the two groups, either before or after the reset.

rate risk, even though the professional forecasts communicated to bank customers at the time pointed to rates remaining elevated (Figure 1). This is particularly demanding because these households had the strongest incentives to monitor interest-rate risk, and the subsequent increase in short-term rates shows that the additional exposure they took on was ex post consequential.[17]

Finally, a potential challenge to our identification is that the increase in interest rates between the low and high reset groups reflects a steepening of the yield curve driven by a rise in the term premium, φ, rather than an increase in expected short-term interest rates, κ, as assumed in the model described in Section 2. Term premia, the compensation investors demand for holding long-term fixed-rate debt, reflect the underlying interest-rate risk in the economy and are consistent with our mechanism. The only potential concern is a change in the price per unit of that risk: if the spread between fixed and adjustable rates widened not because rates were expected to rise or because underlying interest-rate risk increased, but purely because investors demanded more compensation per unit of that risk, observed contract changes could partly reflect shifts in market risk pricing rather than borrowers responding to higher payment burdens. Moreover, even if the term premium component were larger, it would not necessarily rationalize a shift away from fixing: higher term premia make fixing both more valuable, as they reflect greater uncertainty, and also more expensive, so the net effect on contract choice is ambiguous. A decomposition of comparable Danish government-bond yields shows that the 2022 increase was in any case predominantly driven by a rise in expected future short rates, consistent with our mechanism; see Appendix Figure B.1 along with details on the decomposition.

Taken together, these considerations support a causal interpretation of the estimates, and the event-study specification in equation (15) provides a flexible empirical counterpart to the theoretical framework in Section 2.

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[17] While directly observed consumer expectations data on mortgage rates is unavailable for Denmark, a survey of German households shows that in 2022 virtually no households expected interest rates to decline in the near term. Given the exchange rate peg between the Danish krone and the euro, interest rate conditions in the two countries are closely linked.

5 Empirical Results

5.1 Mortgage restructuring on the insurance margin

We begin by isolating the *insurance margin* of mortgage restructuring. Proposition 1 in Section 2 implies that when reset rates rise, interest-rate insurance becomes more expensive in current cash-flow terms. Borrowers can then partially offset the increase in current payments by moving into contracts with less rate insurance, accepting greater sensitivity to future rate movements in exchange for lower payments today. Our empirical setting allows us to isolate how restructuring at *scheduled* resets differs across the two cohorts. In particular, the 2021 cohort resets while the level of ARM5 rates is still close to its baseline (even slightly lower), whereas the 2022 cohort resets after the sharp regime change, with a large and persistent increase in reset rates (see Figure 2).[18]

Shorter fixation periods. We first examine adjustments in the interest-fixation period. The right panel of Figure 3 reports the event-study coefficients $\hat{\beta}_q$ from equation (15), where the outcome is an indicator for holding a mortgage with an interest-fixation period shorter than five years. The left panel plots the corresponding group-specific average paths, normalized to the baseline quarter, for the high- and low-reset cohorts. Two patterns stand out. First, in the pre-reset period, the estimated differences are small and statistically indistinguishable from zero, indicating parallel trends in fixation choices across cohorts. Second, at the reset, a sharp divergence emerges: households resetting in the high-rate environment become significantly more likely to hold mortgages with fixation periods shorter than five years relative to those resetting when rates remain low (right panel of Figure 3). In line with the timing of events described in Section 3, the figure reveals some adjustments before the actual reset, reflecting either anticipatory behavior following notifications of upcoming resets or reporting of mortgage restructuring by banks, as illustrated in Appendix Figure A.1.

The left panel of Figure 3 also shows that, at reset, both cohorts become more likely to hold mortgages with fixation periods shorter than five years. We interpret this common increase as the generic re-optimisation that takes place at scheduled

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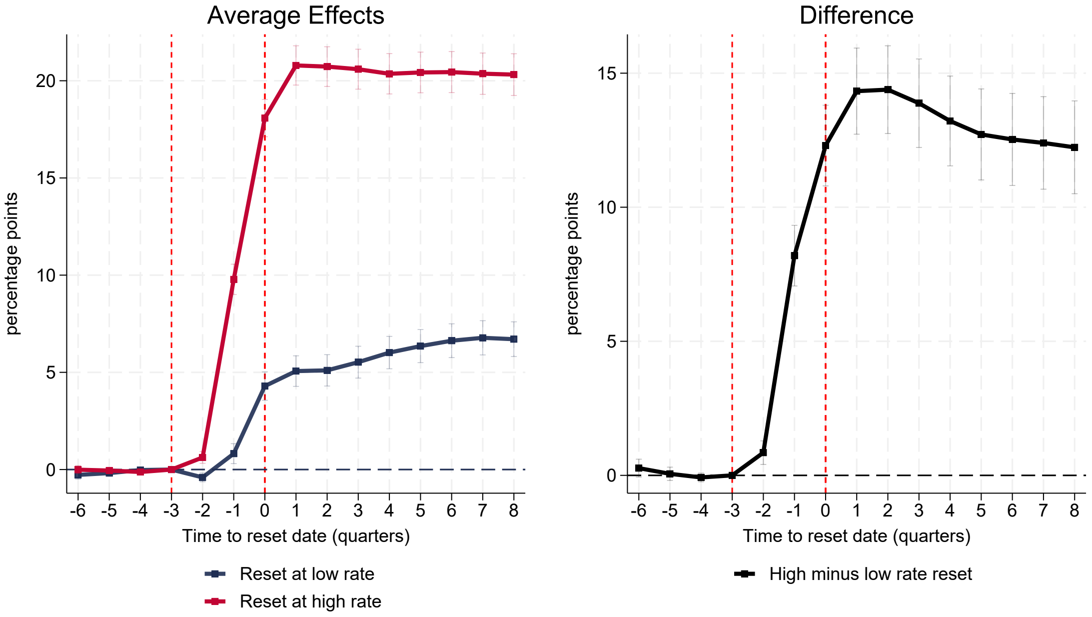
[18] Further, Figure 1 shows that the expected path of rates steepens markedly by 2022, reinforcing the shift in the rate environment faced at the later reset.

Figure 3: **Share of Individuals With a Mortgage with Interest Fixation Below 5 Years** Notes: The figure shows the development in the share of individuals with a interest rate fixation below five years around the rate reset in a high and a low interest rate environment. The fixation period of all mortgages are considered. The left panel presents the sample-average predicted values for the 2021 (reset at low rate) and 2022 cohorts (reset at high rate), obtained from the estimation of Model (15), relative to three quarter before their scheduled reset. The right panel shows the differences between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate), corresponding to the estimates of the β_j in Model (15). The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.



resets. Our sample consists of borrowers whose initial five-year fixation expires at reset; regardless of the interest-rate environment, some households naturally revise their contract choice at that point for idiosyncratic reasons. As discussed in Section 3.1, reset is also the lowest-cost moment to restructure, reinforcing this pattern even when ARM5 rates remain close to baseline (Figure 2). The identifying content of Figure 3 is therefore not that borrowers restructure at reset per se, but that they use the same reset opportunity differently when the price of rate insurance is much higher. Consistent with this interpretation, Appendix Table A.1 shows that even in the low-rate environment, the share of borrowers shortening their fixation increases by between 1.5 and 5 percent relative to three quarters before reset, across all 2021 reset quarters. Appendix Figure A.5 further shows that the share of fixed-rate mortgages rises at reset for both cohorts, with a larger increase among households resetting in the low-rate environment. This pattern accords with Proposition 1, as interest-rate insurance is cheaper when rates are low.

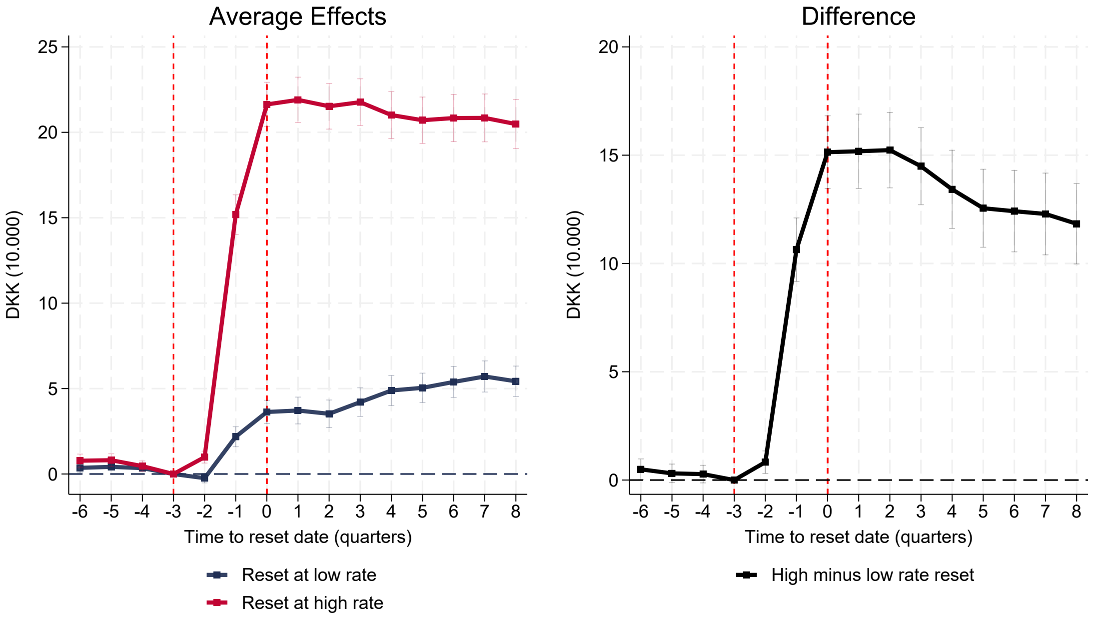
Appendix Table A.2 shows that these findings are robust to a range of alternative specifications. The baseline coefficient is largely unchanged when adding controls for household composition at $t-3$, non-parametric controls for asset deciles, and non-parametric controls for loan maturity groups, all measured in $t-3$. Further, Figure A.4 shows that the estimates are robust to controlling for regional consumption inflation from Danmarks Statistik, addressing the concern that aggregate macroeconomic conditions may confound the comparison across reset cohorts.

Taken together, these results support Proposition 1. When households face a materially higher reset rate and steeper expected path of future rates, they respond by economising on rate insurance. The model thus captures how the composition of reset-time re-optimisation changes with the rate environment, over and above the baseline reallocation that occurs at any scheduled reset.

These shifts in fixation choices also affect the average interest rates households pay. In our setting, shorter-fixation mortgages typically carry lower current coupons than longer-fixation contracts, so moving out of ARM5 into shorter fixation attenuates the immediate increase in borrowing costs relative to remaining in ARM5. Consistent with this mechanism, Appendix Figure A.6 shows that households resetting in the high-rate environment pay higher average interest rates on their total outstanding debt than those resetting when rates are low. However, the increase is smaller than the rise in ARM5 rates shown in Figure 2, indicating that substitution toward alternative, typically cheaper, contract structures partially dampens the pass-through of higher reset rates into current borrowing costs.

Interest-rate exposure. A shift toward shorter fixation matters economically because it changes households' exposure to future repricing risk. We therefore next consider an outcome that aggregates the implications of contract choice for future payment sensitivity. This measure is closely related to the cash-flow channel of monetary policy, (see e.g., Auclert, 2019), but our focus here is on how reset-time restructuring changes households' vulnerability to future interest-rate shocks. We

Figure 4: **Interest Rate Exposure** Notes: The figure shows the development in interest rate exposure around rate reset in a high and a low interest rate environment. Interest rate exposure is defined as the amount of debt with an interest rate fixation of 12 months or less. The left panel presents the sample-average predicted values for the 2021 (reset at low rate) and 2022 cohorts (reset at high rate), obtained from the estimation of Model (15), relative to three quarter before their scheduled reset. The right panel shows the differences between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate), corresponding to the estimates of the β_j in Model (15). The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.



define interest-rate exposure as the amount of outstanding mortgage debt with an interest-fixation period of twelve months or less, and estimate the same event-study specification. Figure 4 reports the corresponding estimates.

The pattern closely mirrors the fixation results. In the pre-reset period, differences in the development of interest-rate exposure are small. Around the reset, exposure rises for both cohorts. As above, we interpret the increase among borrowers resetting in a low-rate environment as reflecting generic reset-time re-optimisation into shorter fixation periods, which mechanically raises the volume of debt repricing within a year. The key result is that exposure rises much more for households resetting when rates are high. Quantitatively, the amount of average debt held in short-fixation contracts is approximately DKK 150,000 larger for the 2022 cohort than for the 2021 cohort. Benchmarking this against the cohort's average pre-reset baseline exposure implies that interest-rate exposure almost doubles for the high-reset cohort relative to the low-reset cohort.

This result is the stock implication of the contract-choice response documented above. Households facing high reset rates do not merely pay more today; they also leave the reset with substantially more debt that will reprice within the next year. The evidence therefore supports the central prediction of Proposition 1: higher reset rates induce households to preserve current consumption by selecting contracts with less rate insurance, thereby trading off lower payments today against greater exposure to future rate increases. We next show that the same consumption-smoothing motive also operates through the amortization margin, as borrowers ease current cash-flow pressure by slowing principal repayment.

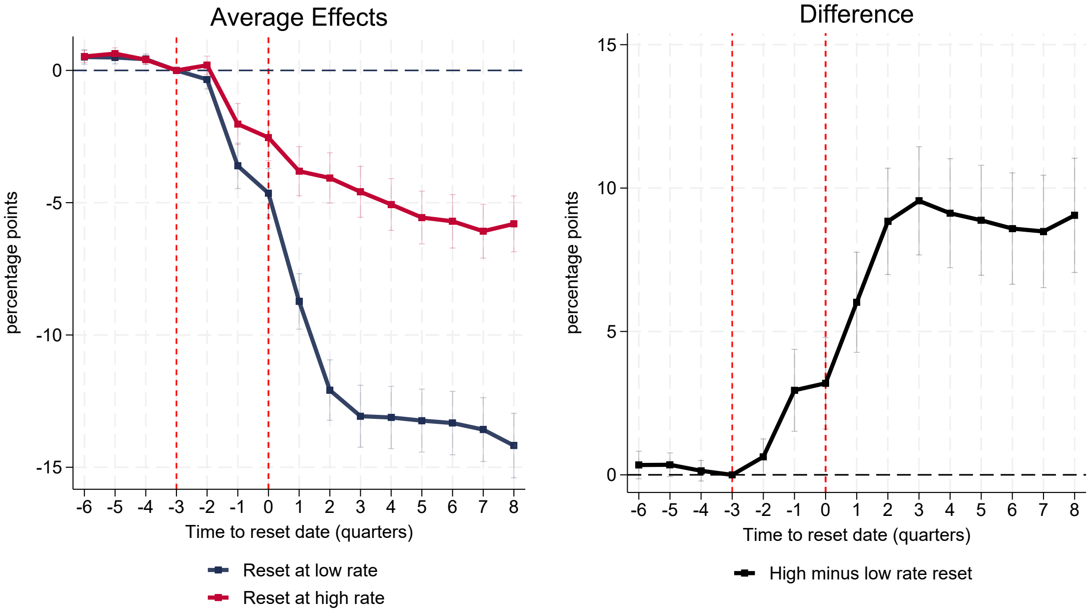
5.2 Mortgage restructuring on the amortization margin

We next turn to the *amortization margin* of mortgage restructuring. The model of Section 2 allows households to respond to higher reset rates not only by reducing interest-rate insurance, but also by lowering current amortization. This margin is particularly relevant when higher reset rates tighten near-term affordability: shifting into an interest-only (IO) mortgage reduces current debt-service payments by postponing principal repayment, at the cost of slower balance-sheet repair and greater vulnerability to future shocks. The model therefore predicts that, when reset rates rise, some households will respond by making greater use of IO contracts.

Figure 5 reports the estimated differences in the share of borrowers holding at least one IO mortgage. Prior to reset, treated and control households exhibit parallel trends in IO participation. Following the reset, however, individuals exposed to higher rates become about 3 percentage points more likely to hold an IO loan compared with those in the control group (right panel of Figure 5). This gap continues to widen, reaching nearly 10 percentage points three quarters after reset. Unlike the fixation result in the previous subsection, which captures the insurance margin, this pattern speaks directly to the role of amortization in the model: when current borrowing costs rise sharply, households also respond by backloading repayment.

The left panel of Figure 5 clarifies the underlying dynamics. Around the reset,

Figure 5: **Share of Individuals With an Interest-Only Loan** Notes: The figure shows the development in the share of individuals with an interest-only loan around rate reset in a high and a low interest rate environment. Individuals count as having an interest-only loan if the individual has any loan without current amortizations. It does not include loans with the option to pause amortizations that is not currently in use. The left panel presents the sample-average predicted values for the 2021 (reset at low rate) and 2022 cohorts (reset at high rate), obtained from the estimation of Model (15), relative to three quarter before their scheduled reset. The right panel shows the differences between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate), corresponding to the estimates of the β_j in Model (15). Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.



the share of households with an IO loan declines in both cohorts, but the decline is substantially smaller for households resetting in the high-rate environment. This common downward drift is not surprising. IO eligibility is granted for a fixed number of years, so even absent any behavioral response the share of households holding an IO loan will tend to decline over time as previously granted IO periods are used up. Importantly, our estimation sample includes only those individuals who, if they hold an IO loan before the scheduled reset, still have more than three quarters of granted IO eligibility remaining at $t = -3$. This rules out a mechanical expiration of IO eligibility exactly at the reset date. The differential pattern in Figure 5 therefore reflects active contract choice in response to the higher-rate environment, rather than a compositional artifact of expiring IO periods.

In complementary results reported in Appendix Figure A.7, we show that the volume of outstanding IO debt follows a similar pattern. Households resetting in the high-rate environment therefore do not merely become more likely to use IO contracts; they also hold a larger stock of debt on IO terms after the reset. Furthermore, Online Appendix Figure A.8 shows that even among individuals without any IO loan three quarters before reset, the amount of IO debt rises more for the 2022 reset cohort than for the 2021 cohort. This indicates that the response reflects not only the continuation of pre-existing IO arrangements, but also new take-up of IO borrowing at reset.

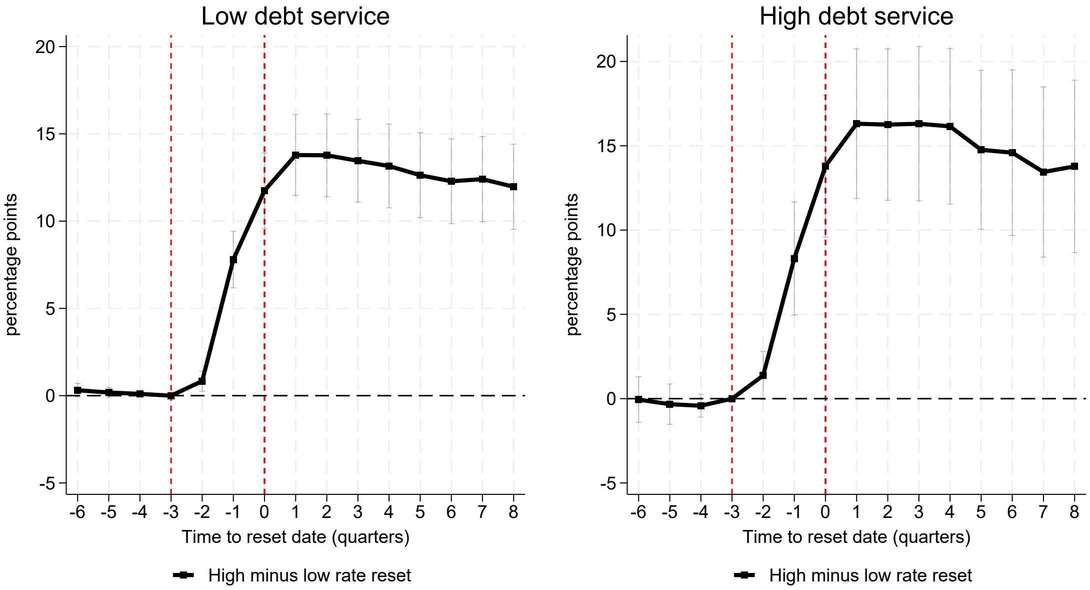
These findings provide direct support for the amortization mechanism in the model. Higher reset rates lead households not only to economize on interest-rate insurance by shortening fixation, but also to lower current debt-service obligations by backloading repayment through IO contracts. The joint evidence from fixation and IO borrowing therefore shows that mortgage restructuring in response to higher reset rates is two-dimensional: households adjust both the insurance profile and the repayment profile of their liabilities. The next section examines what drives adjustment along these two margins and whether alternative omitted mechanisms can account for the patterns in the data.

5.3 Debt-service heterogeneity and the cash-flow channel

Corollary 1 delivers a sharp heterogeneity prediction. When rates rise, the decline in the attractiveness of payment insurance should be stronger for households with tighter cash-flow positions and larger inherited payment burdens. Households that already devote a large share of income to debt service should therefore have the strongest incentive to adjust mortgage structure in ways that relieve current payments at reset, even if doing so increases exposure to future shocks. By contrast, households with more slack should adjust less aggressively. Heterogeneity by pre-reset debt service therefore provides a direct test of the cash-flow channel emphasized by the model.

We implement this test by splitting households according to their pre-reset debt-service-to-income ratio. For each reset cohort, we measure interest expenses and income in the year before the reset (2020 for the 2021 cohort and 2021 for the 2022 cohort) and define debt-service-to-income as interest expenses divided by income at the household level. We classify households above the 75th percentile of this ratio (within the relevant cohort-year and estimation sample) as “high debt service” and

Figure 6: **Share of Loans with Interest Fixation Below Five Years: Low and High Debt-service** Notes: The Figure shows the differences in the share of individuals with a mortgage with interest rate fixation below 5 years between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate), corresponding to the estimates of the β_j in Model (15) estimated on the part of our estimation sample with low debt service (left panel) and high debt service (right panel). High debt service refers to having interest expenses relative to gross income above the 75th percentile within our sample of individuals measured three quarters before scheduled rate reset. Low debt service refers to having interest expenses relative to gross income below the 25th percentile within our sample of individuals measured three quarters before scheduled rate reset. The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.



households below the 25th percentile as “low debt service.” We then re-estimate the event-study specification in equation (15) separately for these two groups and examine how the response of contract choice to the higher 2022 reset rate varies with initial debt-service burdens.

Figure 6 reports the results for the fixation margin. Panel (a) plots the treated–

control difference in the share of mortgages with an interest-fixation period below five years for households with low debt service, while panel (b) shows the corresponding difference for households with high debt service. In both groups, the coefficients are close to zero well before the reset, consistent with parallel pre-trends. Following the reset, the shift toward shorter fixation is somewhat larger for households with high debt service than for households with low debt service, but the difference is economically modest and statistically imprecise.

The heterogeneity is clearer when we turn from the broad extensive margin of switching to the stock of debt exposed to repricing. Appendix Figure A.9 shows that interest-rate exposure—defined as outstanding debt with an interest-fixation period of one year or less—increases substantially more for high-debt-service households than for low-debt-service households when resets occur in a high-rate rather than a low-rate environment. Thus, even though the difference in the share of households moving below five-year fixation is modest, households under tighter cash-flow pressure still emerge from the reset with materially greater repricing risk. This suggests that heterogeneity is more pronounced in the intensity of adjustment than in the broad extensive margin: conditional on adjusting, high-debt-service households reallocate more aggressively toward very short-fix debt.

This pattern is consistent with Corollary 1 once one accounts for the institutional constraints governing mortgage choice in Denmark. Under the "*God skik*" regulation, borrowers with a debt-to-income ratio above four and a loan-to-value ratio above 60 percent can only be granted fixed-rate loans (with or without amortization) and variable-rate loans with amortization and a fixation period of at least five years. For many high-debt-service households, this restricts the scope for the most aggressive shift into very short-fix products.[19] As a result, the heterogeneity predicted by the model is muted in the extensive-margin indicator of moving below five-year fixation, but still shows up clearly in the amount of debt exposed to rapid repricing. Within the set of permissible products, the contractual margin that most directly lowers current payments is therefore often the amortization margin rather than the fixation margin.

The picture is indeed different for the amortization margin. Figure 7 reports the same estimated β_q's when the outcome is an indicator for holding any interest-only

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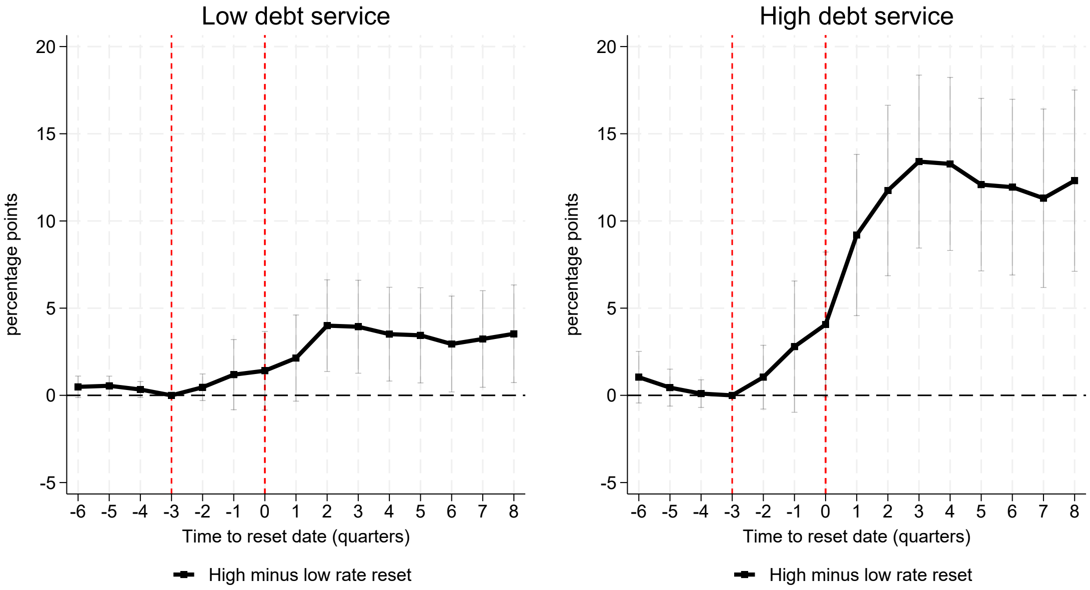
[19] Loan-to-value restrictions are less likely to bind at reset, since many borrowers have already paid down part of their debt and house prices increased between loan origination in 2016–2017 and reset in 2021–2022.

Figure 7: **Difference in the Share of Individuals with an Interest-only Loan** Notes: The Figure shows the difference in the share of individuals with an interest-only-loans between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate). We define interest exposure as the amount of outstanding debt with an interest rate fixation of 12 months or less. The points in the figure corresponds to the estimates of the β_j in Model (15) estimated on the part of our estimation sample with low debt service (left panel) and high debt service (right panel). High debt service refers to having interest expenses relative to gross income above the 75th percentile within our sample of individuals measured three quarters before scheduled rate reset. Low debt service refers to having interest expenses relative to gross income below the 25th percentile within our sample of individuals measured three quarters before scheduled rate reset. The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.



mortgage. Among low-debt-service households (left panel), the development in IO participation is similar between treated and control cohorts in the pre-reset period, and the post-reset response peaks at about 4 percentage points. Among high-debt-service households (right panel), by contrast, the response is substantially stronger, peaking at around 14 percentage points. This indicates that the shift toward IO borrowing is disproportionately concentrated among households with tighter cash-flow positions. In complementary results reported in Online Appendix Figure A.10, we show that the volume of IO debt in kroner displays an analogous pattern.

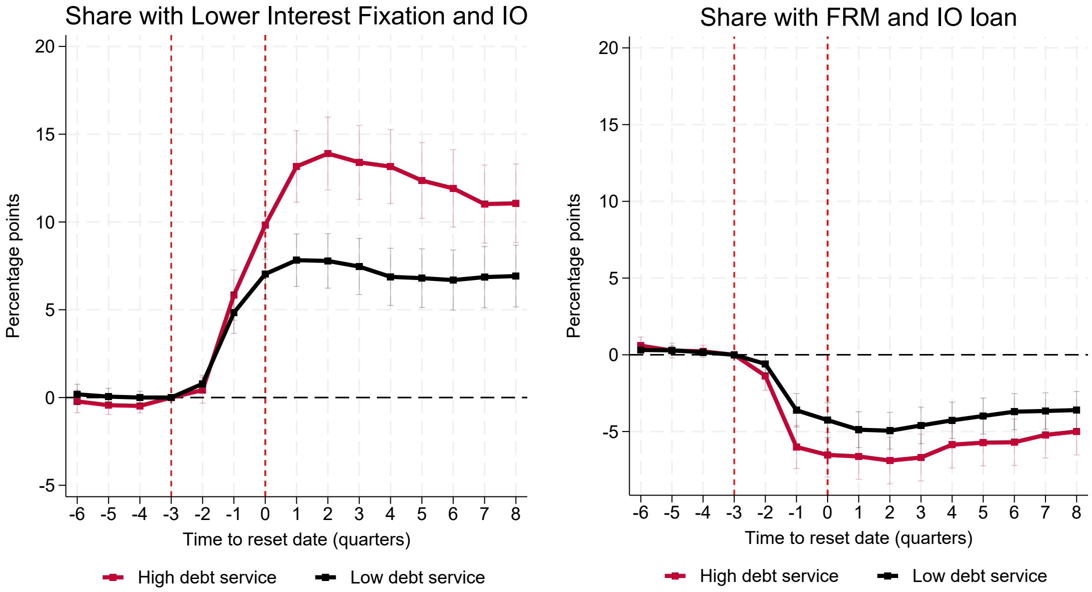
Finally, Figure 8 examines the joint choice of fixation period and IO among borrowers who have IO loans at reset, conditioning on pre-reset debt-service-to-income. The left panel shows that, among those choosing a short fixation period, high debt-service borrowers respond substantially more than low debt-service borrowers following a rate reset. By contrast, the right panel shows that uptake of the FRM-IO combination is largely insensitive to debt-service burden. This asymmetry suggests that the short-fixation option is specifically attractive to borrowers with high debt service, as combining IO with short fixation delivers the largest relief available within the Danish mortgage menu following the rate increase.

Taken together, the evidence in Figures 6 and 7 provides a sharp test of the model's mechanism once institutional constraints are taken into account. Borrowers facing tighter cash-flow pressure do not respond disproportionately by moving into very short fixation, because regulation limits that adjustment margin for many of them. Instead, the strongest heterogeneity appears on the amortization margin: households with high pre-reset debt service are much more likely than households with low pre-reset debt service to shift into IO contracts when reset rates are high. This comparison shows that the demand for current-payment relief rises sharply with pre-existing cash-flow pressure. Moreover, Figure 8 shows that this pattern extends within the IO margin: conditional on shifting into an IO contract, high-debt-service households are also more likely to select shorter fixation periods, combining payment relief on both amortizations and interest rates. The heterogeneity evidence therefore points directly to the repayment-side cash-flow channel emphasized by the model.

5.4 Balance-sheet dynamics and self-insurance margins

We next examine whether households offset the greater risk embedded in their mortgage contracts by adjusting other margins of self-insurance outside the contract itself. This is important for interpreting the economic significance of the restructuring results above. A shift toward shorter fixation or greater use of interest-only borrowing only implies a meaningful buildup in vulnerability if it is not simultaneously neu-

Figure 8: **Rate Fixation Choice Within Interest-only Loans** Notes: The Figure shows the difference in the share of individuals with an interest only loan at reset between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate) in combination with either a rate fixation period below 5 years (left panel) or fixed rate mortgage (right panel). The points in each figure corresponds to the estimates of the β_j in Model (15) estimated on the part of our estimation sample with low debt service (blue lines) and high debt service (red lines). High debt service refers to having interest expenses relative to gross income above the 75th percentile within our sample of individuals measured three quarters before scheduled rate reset. Low debt service refers to having interest expenses relative to gross income below the 25th percentile within our sample of individuals measured three quarters before scheduled rate reset. The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.



tralized by aggressive deleveraging or by the accumulation of large liquid buffers. If households were to respond to higher reset rates by paying down debt rapidly or by building precautionary savings, risk-taking through contract choice would be partly offset at the balance-sheet level. If instead higher reset rates are associated with weaker deleveraging and little evidence of buffer accumulation, then the contract response translates more directly into a net increase in household exposure to future aggregate or idiosyncratic shocks.

Debt dynamics. We next examine how household indebtedness evolves around the reset. Our main outcome is the book value of *total outstanding debt* as measured in the credit registry, defined as the sum of all credit obligations rather than mortgage debt alone.[20] Focusing on total debt allows us to assess whether higher reset rates are associated with faster balance-sheet repair through deleveraging or instead leave households with persistently higher overall indebtedness.

The left panel of Figure 9 plots average total outstanding debt, normalized to three quarters before the reset, separately for households whose mortgages reset in 2022 (the high-rate cohort) and in 2021 (the low-rate cohort). The right panel reports the corresponding event-study estimates from equation (15). Before the reset, the estimated differential is small and statistically insignificant, consistent with the identifying assumption. Around the reset, however, a clear divergence emerges. For the 2021 cohort, whose mortgages reset in a low-rate environment, outstanding debt declines over time, consistent with ongoing deleveraging. By contrast, for the 2022 cohort, whose reset coincides with a sharp increase in interest rates, outstanding debt rises around the reset and remains persistently above that of the 2021 cohort.

This pattern is fully consistent with tighter cash-flow conditions limiting households' ability to reduce debt when rates reset at much higher levels. It also aligns closely with the increased use of interest-only borrowing documented above: if households respond to higher reset rates by lowering current amortization, one would expect slower deleveraging and, as a result, a persistently higher path of debt outstanding after reset. At the same time, total outstanding debt is broader than mortgage debt alone, and the increase around the reset may partly reflect accounting and valuation effects associated with refinancing in addition to behavioral responses.[21]

The main message of Figure 9 is thus clear. Households exposed to higher re-

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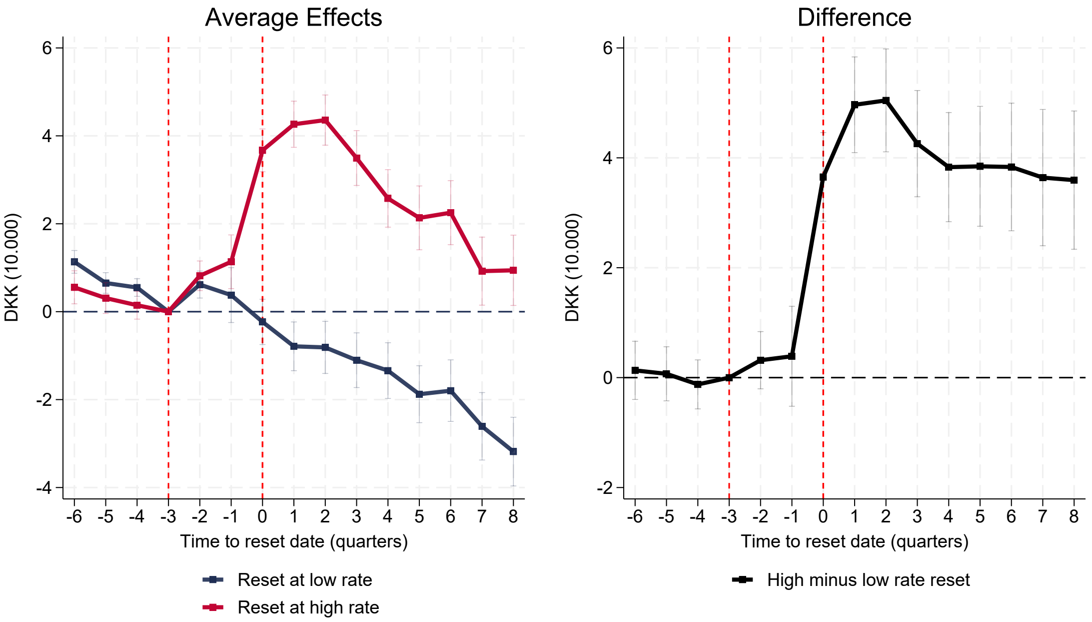
[20] This includes all debt with Danish banks or large subsidiaries of foreign banks operating as creditors, but does not include debt within family, foreign debt, or other types of debt.

[21] The increase in debt around the rate reset may partly reflect differences between the nominal value of the maturing bond and the newly issued bond at reset, as discussed in Section 3.3.1. The data do not allow us to cleanly separate this price effect from behavioral responses. However, note that bank debt, where there is no capital losses associated with rate reset, shown in Appendix Figure A.3 also shows an increase at the time of the rate reset.

Figure 9: **Total Outstanding Debt** Notes: The figure shows the evolution of total outstanding debt (mortgage and bank debt) around the rate reset in a high- and a low-interest-rate environment. The left panel presents the sample-average predicted values for the 2021 cohort (reset at low rates) and the 2022 cohort (reset at high rates), obtained from the estimation of Model (15), relative to three quarters before the scheduled reset. The right panel shows the differences between individuals with a reset in 2022 and in 2021, corresponding to the estimates of the β_j in Model (15). The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.



set rates do not offset the move toward riskier mortgage structures through faster deleveraging. If anything, debt remains persistently higher after reset. This is consistent with the broader mechanism emphasized in the paper: when reset rates rise, households alleviate near-term payment pressure primarily through mortgage restructuring rather than through rapid balance-sheet repair. In the next subsection, we ask whether they instead offset this increased exposure by building liquid financial buffers.

Liquid wealth. We next turn to the asset side of the household balance sheet. The debt results above show that households exposed to higher reset rates do not respond through faster deleveraging, but this does not by itself rule out offsetting adjustment through precautionary saving. In particular, even if debt remains high—

or rises mechanically because of refinancing-related valuation effects—households may still partly self-insure by accumulating liquid assets. This is the most natural self-insurance margin outside the mortgage contract. If households that shorten fixation or shift into interest-only borrowing simultaneously build liquid buffers, the increase in contractual risk need not translate into a comparable increase in net vulnerability.

Figure 10: **Liquid wealth**Note: The figure shows the development in deposits (left panel) and financial assets (right panel). Financial assets include deposits, listed shares and investment fund shares as well as bond holdings. Both panels show the differences between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate), corresponding to the estimates of the β_j in Model (15). Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.

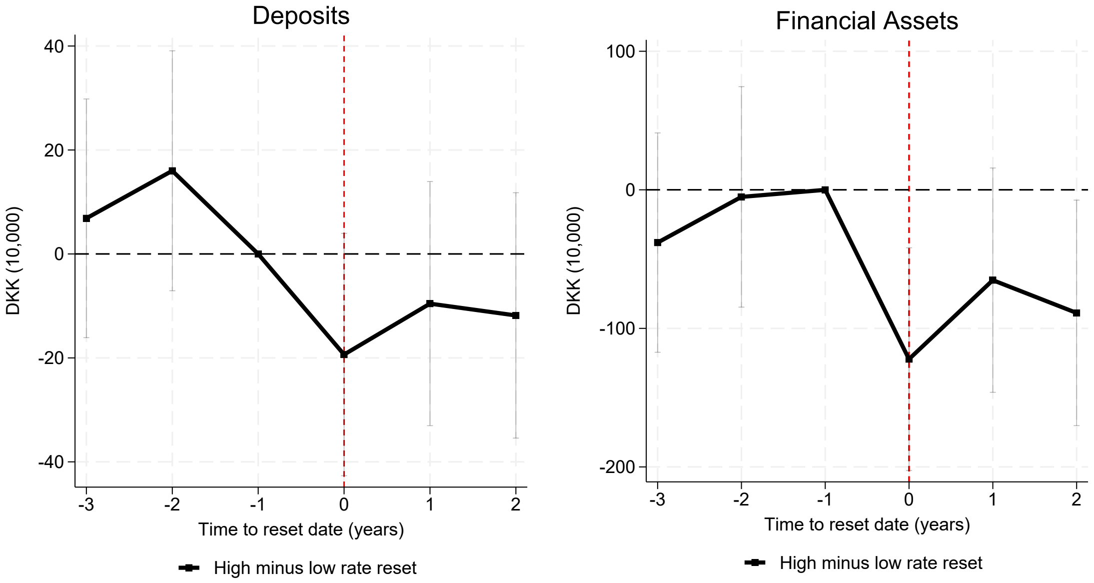


Figure 10 reports the corresponding event-study estimates for total liquid wealth. We find no evidence that households resetting in the high-rate environment accumulate larger liquid buffers than households resetting in the low-rate environment. If anything, the point estimates turn negative after reset, suggesting somewhat lower liquid wealth for the high-rate cohort, although the estimates are not precise enough to support a strong claim of active decumulation.

Taken together with the debt results, this evidence suggests that households exposed to higher reset rates do not offset riskier mortgage structures either by faster balance-sheet repair on the liability side or by building larger precautionary buffers on the asset side. We therefore interpret the contract responses documented above as translating into a genuine increase in exposure to future aggregate and idiosyncratic shocks, rather than being neutralized elsewhere on the household balance sheet.[22]

5.5 Liquidity and post-reset mortgage composition

We next examine how post-reset mortgage choices vary with households' liquid asset positions. This decomposition is useful for sharpening the mechanism behind the contract responses documented above. Throughout, we continue to study the same reset sample as in the rest of the paper: households whose five-year reset mortgage reaches its scheduled repricing date. We then ask how the higher-rate environment changes the probability that these households end up, after reset, in one of four broad contract categories: adjustable-rate mortgages (ARM) with and without IO, and fixed-rate mortgages (FRM) with and without IO.

To study heterogeneity by liquidity, we split borrowers according to their pre-reset liquid wealth. We classify borrowers with deposit balances below one month of annual disposable income as having low liquidity, and borrowers with deposit balances above annual disposable income as having high liquidity. To ease comparison of the liquidity gradient across borrower groups, we replace the full event-time specification with a triple-difference (DDD) estimator and do not consider the dynamics of the response. Concretely, we construct a post-reset indicator equal to 1 in quarters $t = 0$ to $t + 3$ and 0 in the pre-reset periods $t - 6$ to $t - 3$, and substitute this for the event-time indicators in (15), fully interacting the resulting specification with the liquidity indicator.[23] The coefficient of interest, is the estimate on $\mathbf{1}[\text{high rate}] \times \mathbf{1}[\text{post reset}] \times \mathbf{1}[\text{low liquid wealth}]$, that captures the additional effect of a high rate reset on low-liquidity borrowers, over and above any effect the impact of a high rate reset shared with high-liquidity borrowers. In other words, the triple-difference thus isolates the additional effect of a high rate reset for borrowers with low liquid wealth. Figure 11 presents the resulting estimates.

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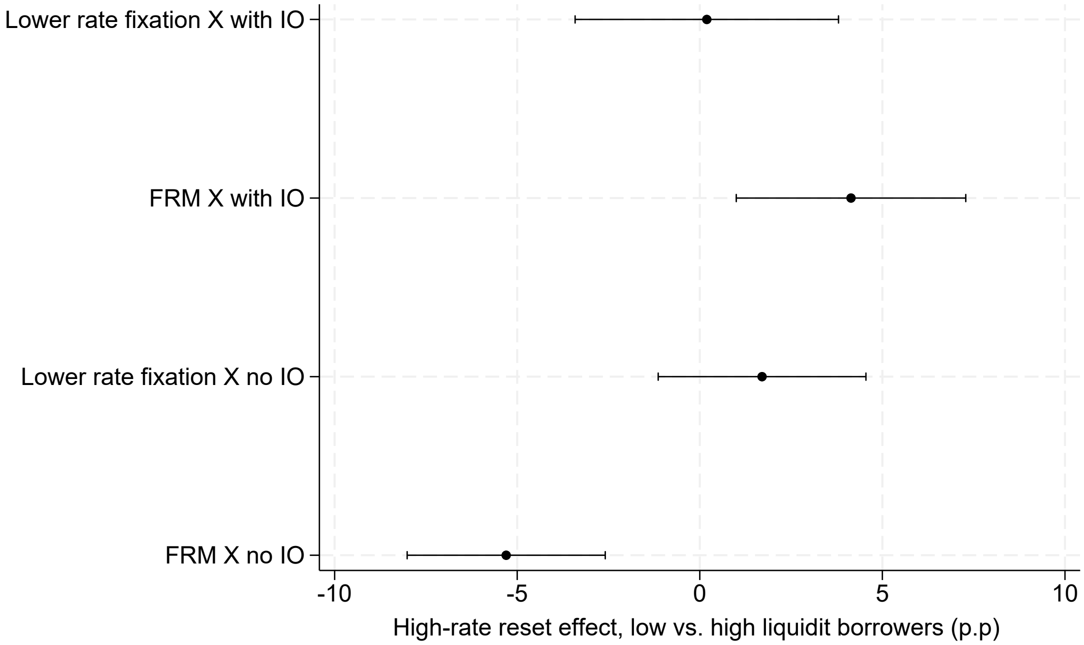
[22] Higher reset rates may also raise returns on deposit holdings. Appendix Figure A.11 shows that net interest income nonetheless falls following the rate increase, indicating that the rise in mortgage payments dominates any gain on the deposit side.

[23] We restrict attention to t through $t + 3$ since our primary interest is in the immediate restructuring of mortgages at reset. We exclude $t - 2$ and $t - 1$ from the estimation window because, as discussed above, these periods may partly reflect early borrower adjustments and partly reflect banks reporting rate changes ahead of their effective date.

Figure 11: **Mortgage choice among liqudity constraint borrowers** The figure shows the triple-difference (DDD) estimate of the additional effect of resetting at a high rate on low-liquidity borrowers relative to high-liquidity borrowers, before versus after reset. Low-liquidity borrowers are defined as those with deposits below one month of annual income in the pre-reset period. The estimates correspond to the coefficient on $\mathbf{1}[\text{high rate}] \times \mathbf{1}[\text{post reset}] \times \mathbf{1}[\text{low liquid wealth}]$ from a fully interacted version of (15). Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.



Broad mortgage-type composition by liquidity. A first result is that liquidity does not generate a strong differential response in the broad fixation categories. The increase in the probability of ending up in an adjustable-rate mortgage after reset, whether with IO or without IO, is not markedly larger for low-liquidity households than for high-liquidity households. Thus, we do not find strong evidence that low-liquidity households respond to higher reset rates by disproportionately reducing rate insurance. This pattern is consistent with the modeling choice in Section 2: the fixation decision is treated primarily as an insurance trade-off, rather than as a margin on which the reduced-form affordability constraint binds.

By contrast, liquidity differences are more visible on the amortization margin. Among FRM contracts without IO, high-liquidity households are relatively more likely to end up in these contracts after reset than low-liquidity households. Conversely, among FRM contracts with IO, low-liquidity households are relatively more likely to end up in these contracts after reset than high-liquidity households. Thus, the clearest liquidity gradient in the data appears in whether households continue to amortize within fixed-rate borrowing. This is consistent with the model's assumption that liquidity and affordability constraints matter most for the repayment profile, where choosing IO provides direct current-payment relief.

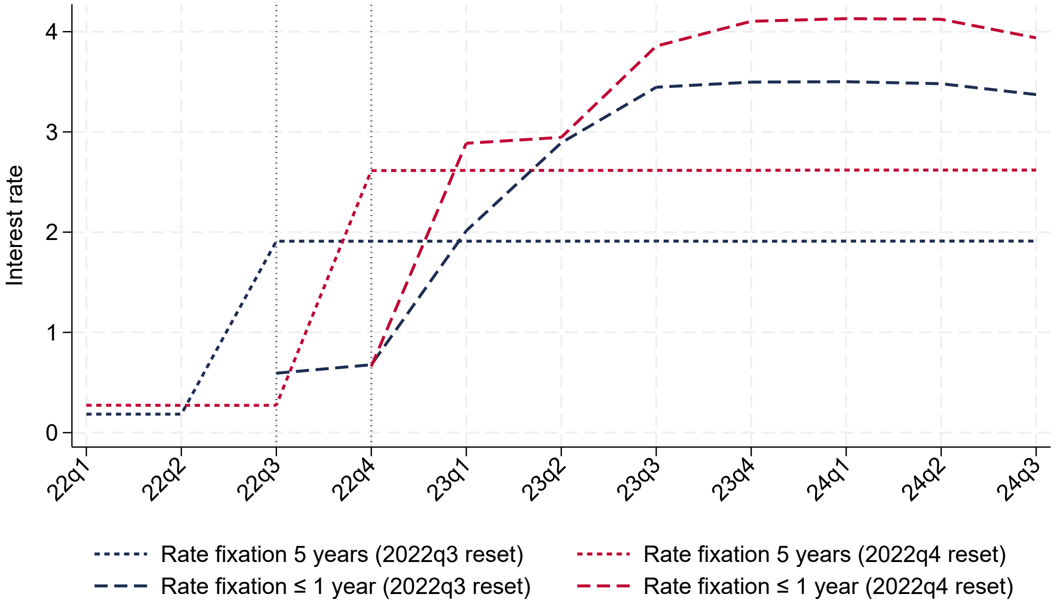
We interpret this pattern cautiously. In the model, tighter liquidity increases the value of reducing current payments through IO regardless of the chosen fixation period. In the data, however, households do not choose from an unrestricted set of contracts. Danish lending rules and bank underwriting make it harder for financially stretched households to combine very low rate insurance with no amortization. The desire for payment relief therefore need not appear as a stronger low-liquidity response in the broad ARM categories. Instead, it shows up where adjustment remains feasible: within fixed-rate borrowing, through a higher propensity to choose IO rather than continue amortizing.

5.6 Financial distress

We now turn from the creation of balance-sheet risk at reset to its subsequent materialization. The evidence so far shows that households exposed to higher reset rates restructure their mortgages in ways that increase future interest-rate exposure. What remains to be shown is whether this additional exposure translated into financial distress, or whether households were able to absorb the higher payment burdens without falling into repayment problems.

Figure 12 shows that, within our sample, this risk was not merely latent: it subsequently materialized in the form of higher borrowing costs for borrowers who shortened fixation. Borrowers who retained a five-year fixation at reset effectively locked in the reset rate. By contrast, borrowers who switched to fixation periods of one year or less remained exposed to the subsequent path of short rates. For example, borrowers resetting in 2022Q4 (2022Q3) could have locked in a five-year rate of roughly 2.7% (1.9%), while the rate on one-year-or-shorter fixation loans rose to about 4.1% (3.5%) over the following two years. This realized divergence in borrowing costs allows us to examine whether the exposure created at reset translated into financial distress, and whether distress is concentrated among the borrowers whose

Figure 12: **Mortgage interest rates following resets** Notes: The dotted lines show the average interest rate on five-year adjustable-rate mortgages (ARM5) for loans scheduled to reset in either 2022Q3 (blue) or 2022Q4 (red), before and after the reset, assuming borrowers keep their ARM5 contract. The dashed lines show the interest rates borrowers face if, at reset, they instead choose a one-year or shorter rate fixation (ARM1 or shorter). The figure reports average interest rates across all ARM5 loans and all ARM1-or-shorter loans with scheduled resets in the respective quarters.



balance sheets became most exposed to subsequent rate increases.

To interpret this heterogeneity, we first examine the timing of financial distress. If higher reset rates had pushed borrowers into repayment problems immediately at reset, the observed shift toward shorter fixation and greater use of IO loans could reflect emergency refinancing by borrowers already at the edge of delinquency, rather than active adjustment of mortgage risk and amortization in response to tighter payment burdens. If, instead, distress rises only later, after borrowers who shortened fixation are exposed to further rate increases, the evidence is more consistent with households initially managing the reset shock by taking on greater future exposure, which subsequently materializes.

To examine this possibility, we estimate the same event-study specification as in equation (15) using our indicator of financial distress as the outcome. Figure 13 reports the resulting estimates for the full sample and for subsamples defined by pre-reset vulnerability and post-reset exposure choices.

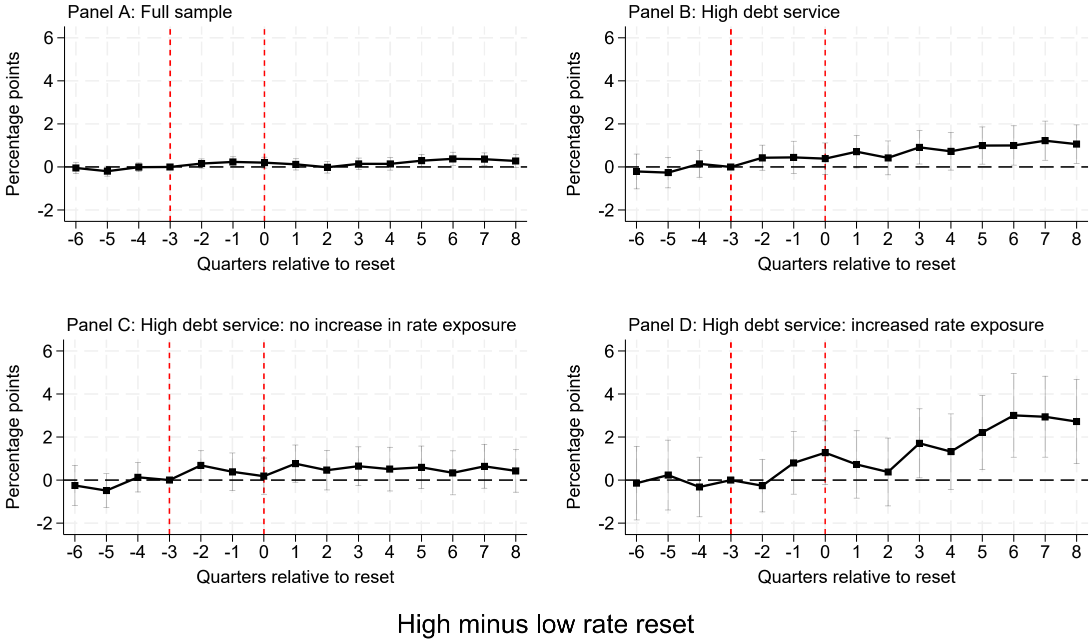


Figure 13: **Financial Distress Around Mortgage Reset** Notes: The figure shows difference estimates of financial distress around scheduled mortgage resets in a low- and high-interest-rate environment. All panels report estimates of the coefficients β_j from Model (15), comparing borrowers resetting in 2022 (high-rate environment) to borrowers resetting in 2021 (low-rate environment), normalized relative to three quarters before the scheduled reset. Panel A shows the full sample. Panel B restricts the sample to borrowers with high pre-reset debt-service-to-income ratios, defined as the top quartile of the distribution one year before reset. Panels C and D further split this high-debt-service group by post-reset exposure choice: borrowers whose interest-rate exposure does not increase (Panel C) and borrowers whose exposure increases (Panel D). The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.

Panel A shows that financial distress increases following resets in the high-rate environment, but not immediately. At the time of reset, the estimates are small and statistically insignificant. The increase becomes visible only several quarters later: five to seven quarters after reset, financial distress rises significantly. Although the baseline rate of financial distress is only 0.91 percent three quarters before reset, the estimated effect at $t + 7$ of 0.36 percentage points implies that the difference in financial distress between the high- and low-rate cohorts amounts to approximately 40 percent of the pre-reset baseline distress rate.

This average pattern masks substantial heterogeneity across borrowers. Panel B shows that the post-reset increase in financial distress is stronger and more persistent among borrowers with high pre-reset debt-service-to-income ratios. This indicates that the effects of higher reset rates are concentrated among borrowers whose debt-service burdens were already high before reset.[24]

Within the high pre-reset debt-service group, the increase in financial distress is concentrated among borrowers who reduce rate insurance at reset. Panel D shows a markedly larger rise in distress for borrowers whose interest-rate exposure increases than Panel C does for borrowers whose exposure does not rise. This pattern indicates that elevated post-reset vulnerability is concentrated among borrowers who combine high initial debt-service burdens with greater exposure to subsequent rate movements.

The timing reinforces this interpretation. Distress does not rise sharply at reset itself, but increases later in the post-reset period for the group that became more exposed to short-term rates. We do not interpret this split as identifying a causal effect of the rate-insurance choice itself: borrowers who choose shorter fixation may differ from those who do not in ways that also affect subsequent distress. Nevertheless, the timing is consistent with the mechanism emphasized in this paper. Borrowers who shortened fixation initially reduced current payments, but remained exposed to the additional rate increases that followed, as shown in Figure 12. Quantitatively, the increase is substantial. At $t + 7$, the difference in financial distress between the high- and low-rate cohorts amounts to 2.94 percentage points, equivalent to approximately 150 percent of the pre-reset baseline distress rate of 1.98 percent.

6 Conclusion

This paper studies how a sharp and persistent increase in interest rates affects household mortgage choices when borrowers reach scheduled reset dates. Using the predetermined timing of five-year adjustable-rate mortgage (ARM) resets in Denmark, we compare otherwise similar cohorts whose first reset occurs just before versus just after the end of the low-for-long regime. The design isolates quasi-exogenous variation in reset rates within the same mortgage product and allows us to trace households' responses with comprehensive administrative data.

Our central finding is that higher reset rates induce households to restructure

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[24] Consistent with this interpretation, borrowers with low pre-reset debt service do not exhibit a significant increase in financial distress at or following reset across cohorts.

their mortgages along two distinct contractual margins. First, they reduce rate insurance by shifting toward shorter fixation and thereby leave the reset with substantially greater debt repricing within the next year. Second, they reduce current debt-service obligations by making greater use of interest-only contracts and thus backload principal repayment. Higher rates therefore do not simply raise current payments mechanically. They also change the composition of mortgage contracts in ways that increase households' sensitivity to future shocks.

The heterogeneity patterns help pin down the mechanism behind these responses. Households with tighter pre-reset debt-service positions react more strongly, particularly on the amortization margin. Additional evidence based on liquid wealth shows that liquidity differences matter more for whether households continue to amortize than for the broad choice between fixed- and adjustable-rate borrowing. Taken together, these results point to near-term affordability pressure as a central force shaping mortgage restructuring at reset.

We also show that these contractual adjustments are not offset elsewhere on the household balance sheet. Households exposed to higher reset rates do not deleverage more aggressively and do not build larger liquid buffers. While financial distress does not rise sharply at the time of reset, it increases significantly in the post-reset period and is concentrated among more vulnerable borrowers. The picture that emerges is therefore one of forward-looking adjustment under tighter payment pressure: households reshape mortgage contracts to manage higher payments and remain current in the short run, but in some cases at the cost of increased vulnerability to subsequent rate increases or other adverse shocks. In a less favorable macroeconomic environment, these effects could potentially be substantially larger.

These findings have implications for how monetary policy interacts with household risk-taking and financial stability. Conventional intuition suggests that higher rates should reduce risk. Our evidence shows that the opposite can occur. When higher rates make payment insurance more expensive and tighten current affordability, households may optimally choose less insurance and lower amortization, increasing exposure to subsequent aggregate and idiosyncratic shocks. Mortgage contract composition is therefore not a passive state variable during a tightening cycle; it is an endogenous margin through which higher rates can amplify future transmission.

A natural next step is to quantify how these endogenous shifts in fixation and amortization affect the aggregate and distributional consequences of subsequent interest-rate shocks, and how borrower-based regulation shapes the extent to which households can smooth current payments by taking on future risk.

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A Additional Figures and Tables

Figure A.1: **Timeline of reset** Notes: The figure shows the timing of the notification from the bank of an upcoming reset, time of auction and interest rate reset around a scheduled rate reset in quarters relative to the reset (event). The scheduled reset takes place at time $t = 0$

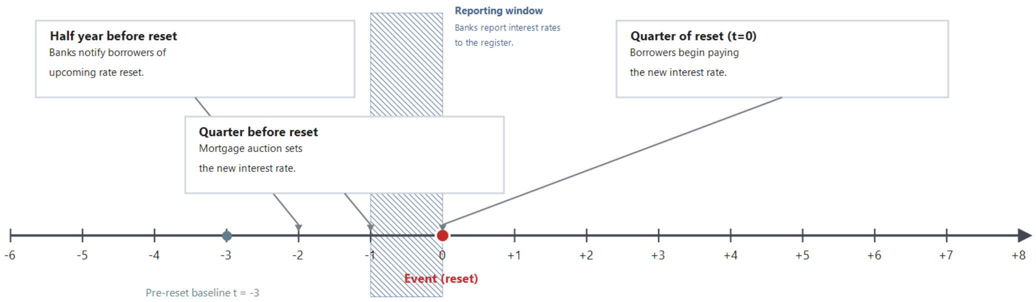


Figure A.2: **Labor Market Outcomes** The figure shows the development in labor market hours worked (left panel) and salary income (right panel) in calender times in 2021q3 and 2022q3. The figure shows the differences between individuals with a reset in 2022q3 (reset at high rate) and in 2021q3 (reset at low rate), corresponding to the estimates of the β_j in Model (15) relative to their difference in 2021q4. The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.

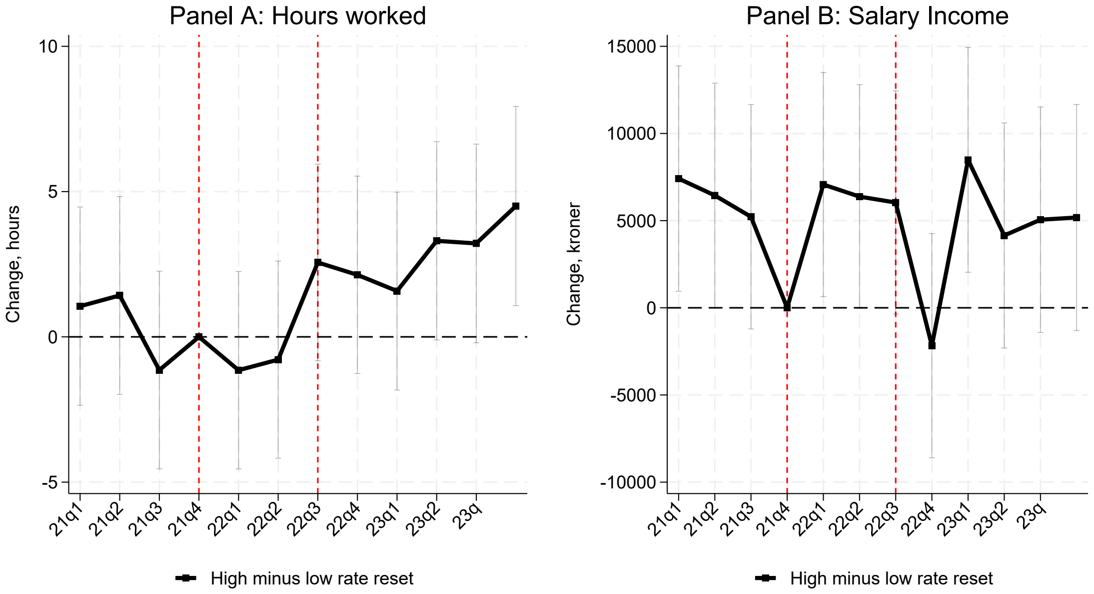


Figure A.3: **Total outstanding bank debt** The figure shows the development in total bank debt in a high and a low interest rate environment. Bank debt refers to all loans issued by Danish banks excluding mortgage credit loans originated through the Danish mortgage credit system. The left panel presents the sample-average predicted values for the 2021 (reset at low rate) and 2022 cohorts (reset at high rate), obtained from the estimation of Model (15), relative to three quarter before their scheduled reset. The right panel shows the differences between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate), corresponding to the estimates of the β_j in Model (15). The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.

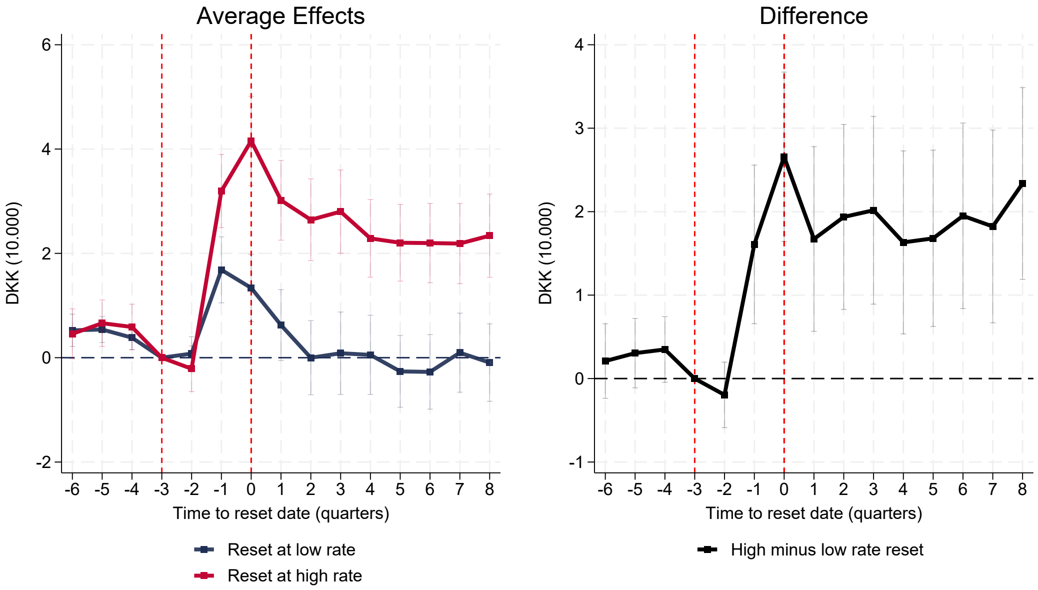


Table A.1: **Share of individuals with lower interest rate fixation across 2021 cohorts** Notes: The table reports OLS estimates of the effect of being post-reset on the share of individuals with an interest rate fixation below five years, considering all mortgages relative to three quarters before. Each column corresponds to a different 2021 reset quarter. The post-reset indicator is equal to one for event-time quarters zero through three and zero for event-time quarters below minus three. Standard errors are clustered at the household level.

	(1) (1)	(2) (2)	(3) (3)	(4) (4)
Post reset	0.0364^{***}	0.0178^{***}	0.0596^{***}	0.0131^{**}
	(12.02)	(6.09)	(13.54)	(2.32)
Quarter	21q1	21q2	21q3	21q4
Baseline Controls	Yes	Yes	Yes	Yes
N	130,493	157,438	80,261	32,630

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.2: **Alternative controls** Notes: The table reports post-reset estimates from a simple dif-in-dif specification of model (15) without dynamics to ease of comparison. The dependent variable is an indicator for holding a mortgage with an interest-rate fixation period below five years. The coefficient *Reset at High Rate* × *Post* measures the average difference in this outcome between the high- and low-rate reset cohorts in quarters $t = 0$ to $t + 3$, relative to the pre-reset period $t - 6$ to $t - 3$. *Fixed HH* indicates a control for household composition measured at $t - 3$. *Asset Decile* and *Maturity Controls* are included both uninteracted and interacted with event time. *Asset Decile* indicates non-parametric controls for pre-reset asset decile. *Maturity Controls* indicates non-parametric controls for borrowers' average outstanding loan maturity, weighted by outstanding debt and grouped into one-year bins. All pre-reset controls are measured at $t - 3$. Standard errors are clustered at the household level.

	Baseline	(1)	(2)	(3)	(4)	(5)
Reset at High Rate X Post	0.141^{***}	0.153^{***}	0.134^{***}	0.129^{***}	0.139^{***}	0.146^{***}
	(24.79)	(31.41)	(72.54)	(66.21)	(26.04)	(45.18)
Baseline Controls	Yes	Yes	Yes	Yes	Yes	No
Fixed HH	No	Yes	No	No	Yes	No
Asset Decile	No	No	Yes	No	Yes	No
Maturity Groups	No	No	No	Yes	Yes	No
N	237,998	237,845	237,991	237,998	237,838	238,069

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure A.4: **Share of Individuals With a Mortgage with Interest Fixation Below 5 Years: Regional Inflation Controls** Notes: The figure replicates the right panel of Figure 3, adding non-parametric controls for regional consumption inflation measured at the calendar quarter corresponding to event time t for each individual. Regional inflation is measured by the Consumption Survey collected by Danmarks Statistik (table FU18). The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.

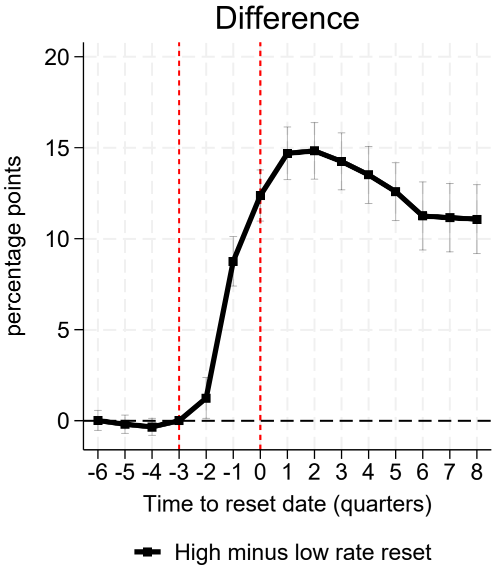


Figure A.5: **Share of Individuals with a Loan With Fixed Rate Mortgages**
The figure shows the development in the share individuals with a fixed-rate mortgage in a high and a low interest rate environment. The left panel presents the sample-average predicted values for the 2021 (reset at low rate) and 2022 cohorts (reset at high rate), obtained from the estimation of Model (15), relative to three quarter before their scheduled reset. The right panel shows the differences between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate), corresponding to the estimates of the β_j in Model (15). The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.

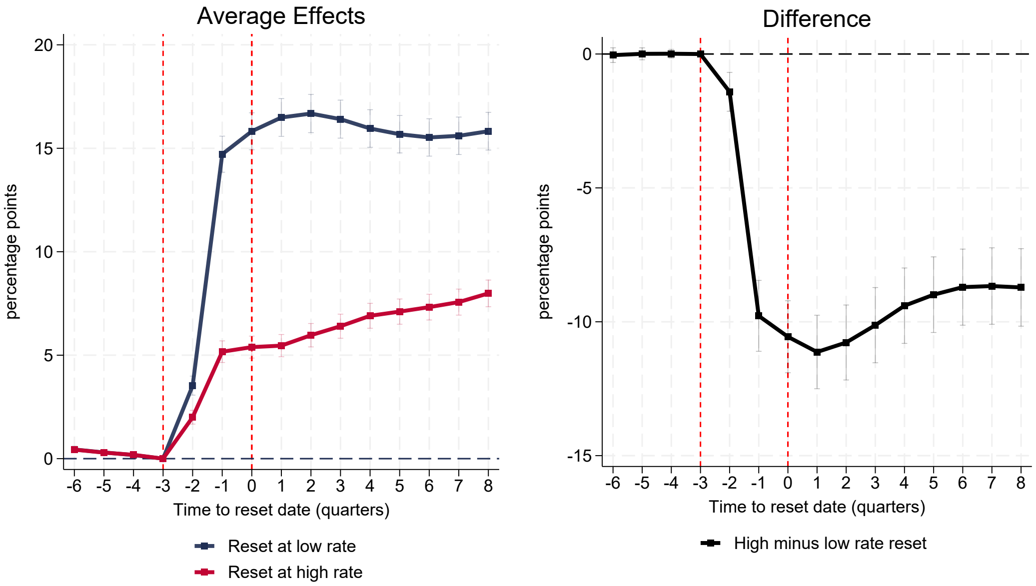


Figure A.6: **Average Interest Rate on Outstanding Debt** Notes: The figure shows the development in the average interest rate on outstanding debt around rate reset in a high and a low interest rate environment. The average interest rate refers to the average interest rate on all debt, weighted by the amount of outstanding debt for each loan. The left panel presents the sample-average predicted values for the 2021 (reset at low rate) and 2022 cohorts (reset at high rate), obtained from the estimation of Model (15), relative to three quarter before their scheduled reset. The right panel shows the differences between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate), corresponding to the estimates of the β_j in Model (15). The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.

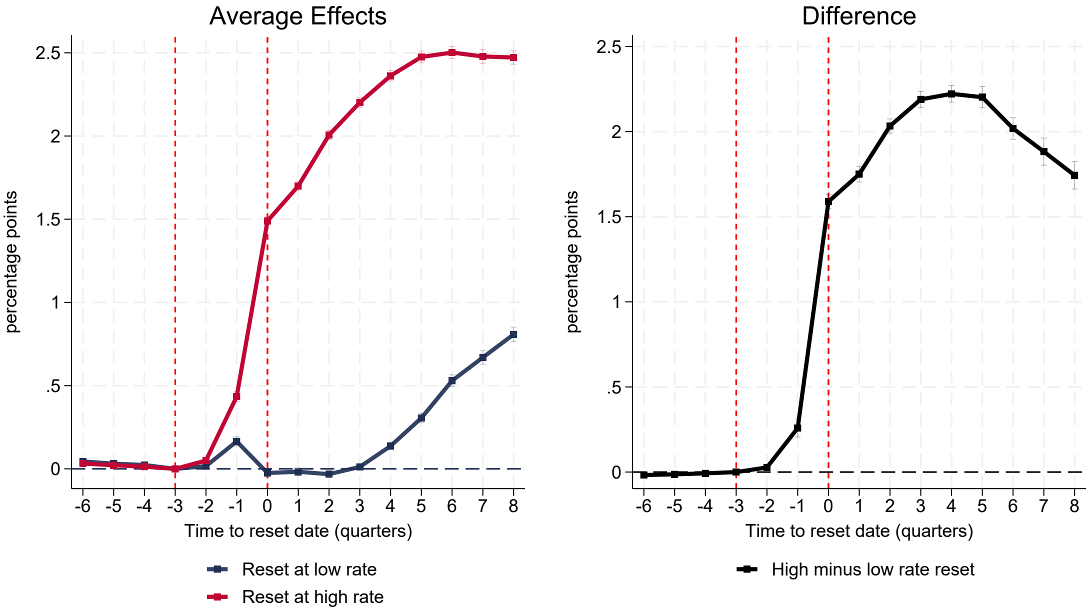


Figure A.7: **Outstanding Debt in Interest-Only Loans** Notes: The figure shows the development in the amount of outstanding debt on interest-only loans around rate reset in a high and a low interest rate environment. The left panel presents the sample-average predicted values for the 2021 (reset at low rate) and 2022 cohorts (reset at high rate), obtained from the estimation of Model (15), relative to three quarter before their scheduled reset. The right panel shows the differences between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate), corresponding to the estimates of the β_j in Model (15). The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.

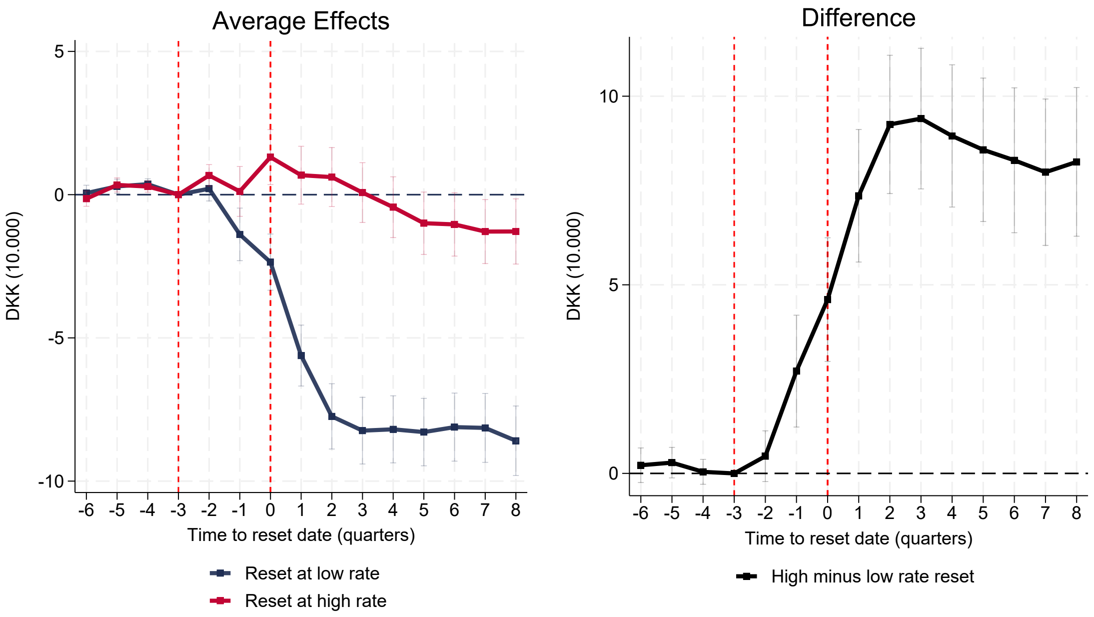


Figure A.8: **Extensive margin: Outstanding Debt on Interest-Only Loan**
Notes: The figure shows the development in outstanding debt on interest-only loans for households with no interest-only loan prior to their rate reset around rate reset in a high and a low interest rate environment. From the estimation sample, we exclude individuals with an interest-only three quarters before rate reset. Individuals count as having an interest-only loan if the individual has any loan without current amortizations. The left panel presents the sample-average predicted values for the 2021 (reset at low rate) and 2022 cohorts (reset at high rate), obtained from the estimation of Model (15), relative to three quarter before their scheduled reset. The right panel shows the differences between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate), corresponding to the estimates of the β_j in Model (15). The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.

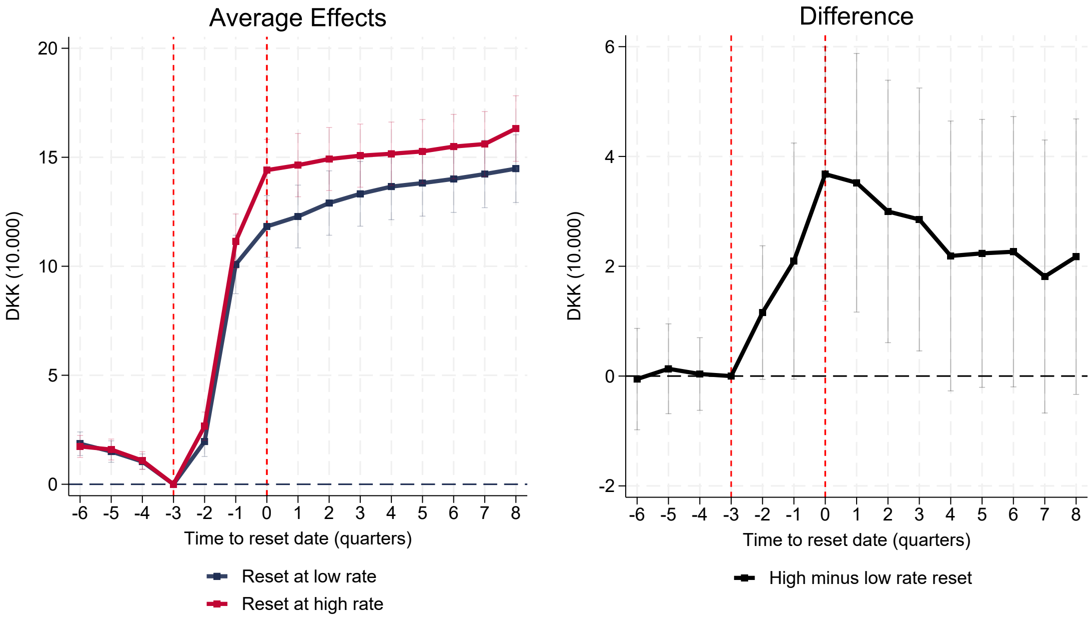


Figure A.9: **Interest Exposure: Low and High Debt-service** Notes: The Figure shows the difference in interest exposure between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate). We define interest exposure as the amount of outstanding debt with an interest rate fixation of 12 months or less. The points in the figure corresponds to the estimates of the β_j in Model (15) estimated on the part of our estimation sample with low debt service (left panel) and high debt service (right panel). High debt service refers to having interest expenses relative to gross income above the 75th percentile within our sample of individuals measured three quarters before scheduled rate reset. Low debt service refers to having interest expenses relative to gross income below the 25th percentile within our sample of individuals measured three quarters before scheduled rate reset. The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.

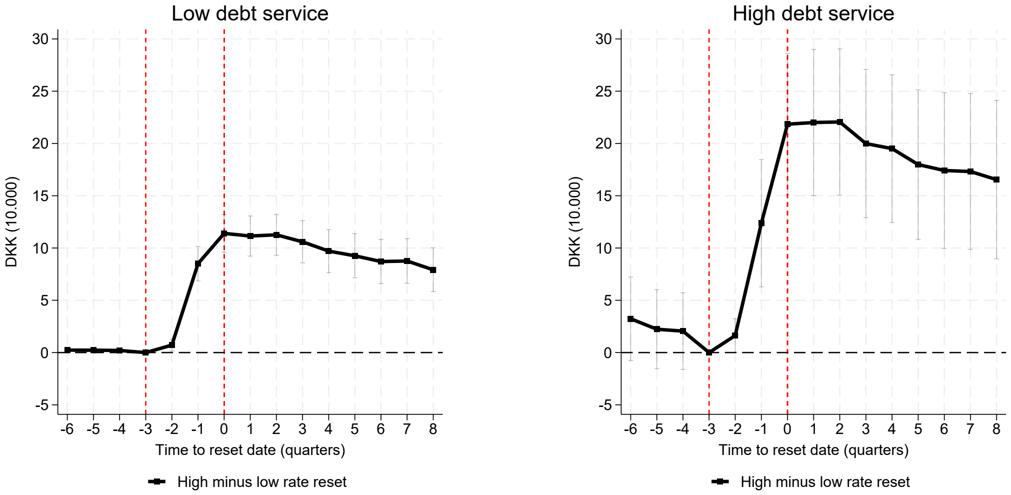


Figure A.10: **Outstanding debt on interest-only-loans: Low and High Debt-service** Notes: The Figure shows the difference in the amount of outstanding debt on interest-only-loans between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate). We define interest exposure as the amount of outstanding debt with an interest rate fixation of 12 months or less. The points in the figure corresponds to the estimates of the β_j in Model (15) estimated on the part of our estimation sample with low debt service (left panel) and high debt service (right panel). High debt service refers to having interest expenses relative to gross income above the 75th percentile within our sample of individuals measured three quarters before scheduled rate reset. Low debt service refers to having interest expenses relative to gross income below the 25th percentile within our sample of individuals measured three quarters before scheduled rate reset. The dotted vertical red lines indicate the event window within which borrowers are notified of their upcoming reset and must decide on any restructuring, from up to six months before the reset date to the auction approximately two months prior, as described in Section 3 and illustrated in Appendix Figure A.1. Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.

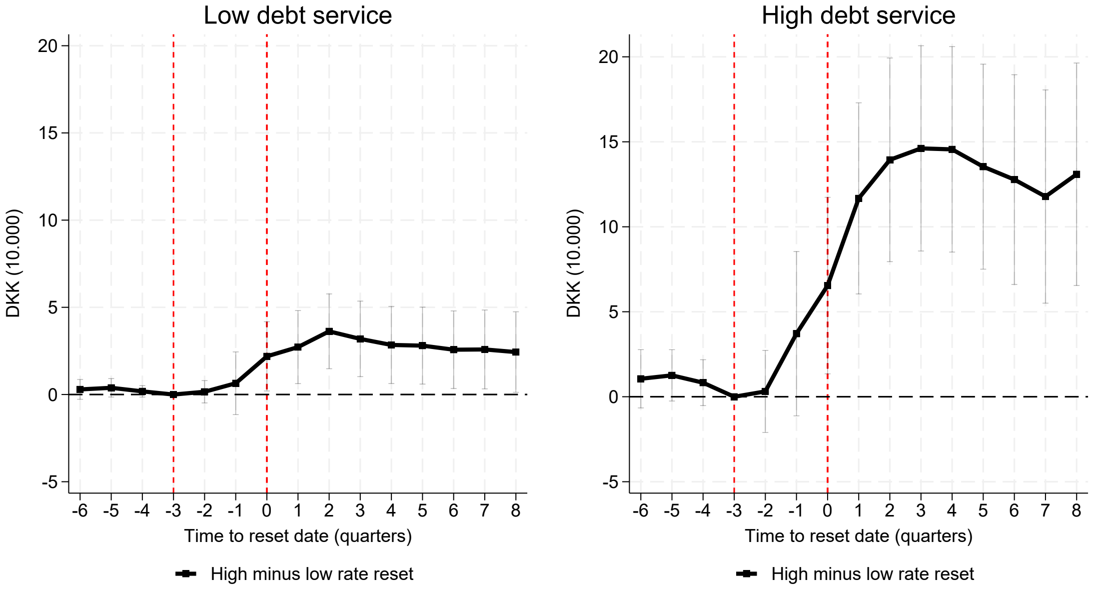
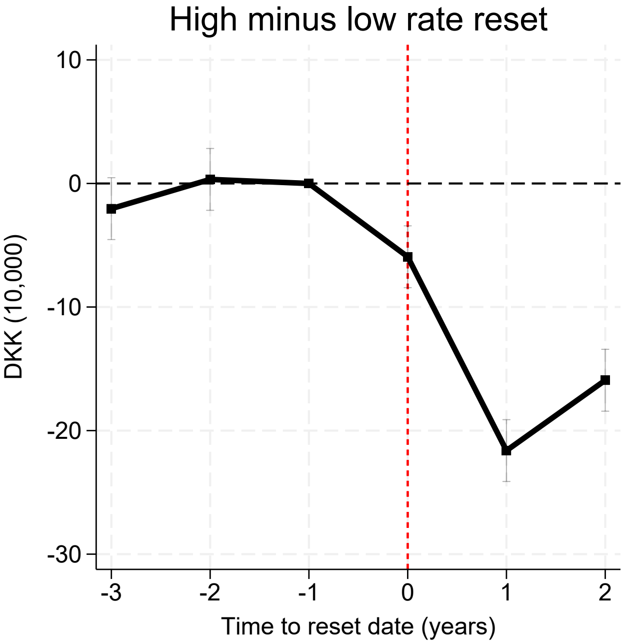


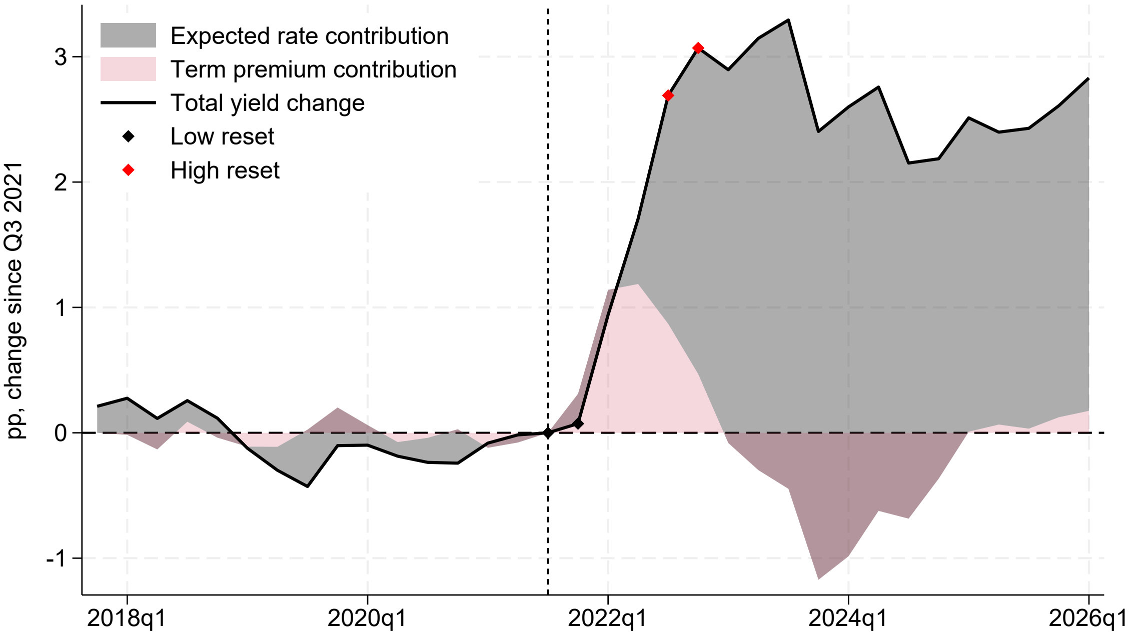
Figure A.11: **Net interest income** Notes: The figure shows the development in net interest income (interest income net of interest expenses). The coefficients show the differences between individuals with a reset in 2022 (reset at high rate) and in 2021 (reset at low rate), corresponding to the estimates of the β_j in Model (15). Vertical bars indicate 95% confidence intervals. Standard errors are clustered at the household level.



B Decomposition of interest rate spread changes

Since a direct decomposition of mortgage rates is unavailable, we exploit a decomposition of yields on comparable Danish government bonds, whose yields are highly correlated with mortgage rates. Figure B.1 decomposes the change in the yield of a Danish 5-year government bond, relative to 2021Q3, into changes in the term premium (red area) and changes in contemporaneous and expected short-term interest rates (gray area), using end-of-quarter values. For the high-rate reset period (red dots), both components contribute positively to the rise in 5-year yields. However, the contribution of expected short-term rates clearly dominates: it accounts for 85% of the total rate increase in 2022Q4 and 66% in 2022Q3.

Figure B.1: **Government Bonds: Decomposition into short term rates and term premia** Notes: The Figure shows changes in the end of quarter yield of Danish 5 year government bonds (black line), relative to 2021Q3. The change is decomposed into movements in the contemporaneous and expected short term interest rate (gray area) and changes in the term premium (red area).



The rise in the term premium coincides with — and likely reflects — heightened uncertainty about the future path of interest rates, as evidenced by a marked widening of interest rate forecast intervals published by Danske Bank in 2021 and 2022. Such uncertainty would have been communicated to mortgage customers. For a risk-averse household, greater interest rate uncertainty creates an incentive to lock in a fixed rate today; but a simultaneously higher term premium — the price of fixing — creates a countervailing incentive to choose shorter fixation periods. The net theoretical prediction is therefore ambiguous, which limits the scope for the term premium to provide a clean alternative explanation.

C Proofs

C.1 Proof of Proposition 1

Fix (y, B, φ, β) and a rate level κ in the interior of the admissible set, so that consumption is strictly positive under both contracts and for all shocks when σ is sufficiently small. Write $\Delta U(\kappa; \sigma^2)$ and $\mathbb{E}_\sigma[\cdot]$ to emphasise dependence on the dispersion parameter σ^2. Define

$$m_0(\kappa) \equiv c_0^V(\kappa) = y - \kappa B, \qquad m_1(\kappa) \equiv c_1^V(\kappa, 0) = y - (1+\kappa)B,$$

so that

$$c_0^F(\kappa) = m_0(\kappa) - \varphi B, \qquad c_1^F(\kappa) = m_1(\kappa) - \varphi B, \qquad c_1^V(\kappa, \varepsilon_\sigma) = m_1(\kappa) - \varepsilon_\sigma B.$$

Using (8), we can write

$$\Delta U'(\kappa; \sigma^2) = -B\Big[u'\big(m_0(\kappa) - \varphi B\big) - u'\big(m_0(\kappa)\big) + \beta\Big\{u'\big(m_1(\kappa) - \varphi B\big) - \mathbb{E}_\sigma u'\big(m_1(\kappa) - \varepsilon_\sigma B\big)\Big\}\Big]. \tag{16}$$

Let $g(x) \equiv u'(x)$. Under the assumption that g is twice continuously differentiable on $(0, \infty)$ with

$$g'(x) = u''(x) < 0, \qquad g''(x) = u'''(x) \geq 0.$$

For σ small enough, $m_1(\kappa) - \varepsilon_\sigma B$ lies in a compact subset of $(0, \infty)$ for all realisations of ε_σ. A second-order Taylor expansion of $g(m_1(\kappa) - \varepsilon_\sigma B)$ around $m_1(\kappa)$ then yields

$$g\big(m_1(\kappa) - \varepsilon_\sigma B\big) = g\big(m_1(\kappa)\big) + g'\big(m_1(\kappa)\big)(-\varepsilon_\sigma B) + \frac{1}{2}g''\big(m_1(\kappa)\big)(\varepsilon_\sigma B)^2 + \rho(\kappa, \varepsilon_\sigma, \sigma), \tag{17}$$

where the remainder $\rho(\kappa, \varepsilon_\sigma, \sigma)$ satisfies $\rho(\kappa, \varepsilon_\sigma, \sigma) = o(\varepsilon_\sigma^2)$ uniformly in ε_σ as $\sigma \downarrow 0$. Taking expectations and using $\mathbb{E}_\sigma[\varepsilon_\sigma] = 0$ and $\mathbb{E}_\sigma[\varepsilon_\sigma^2] = \sigma^2$ gives

$$\begin{aligned}\mathbb{E}_\sigma\big[u'\big(m_1(\kappa) - \varepsilon_\sigma B\big)\big] &= g\big(m_1(\kappa)\big) + \frac{1}{2}g''\big(m_1(\kappa)\big)B^2\mathbb{E}_\sigma[\varepsilon_\sigma^2] + R(\kappa, \sigma^2) \\ &= u'\big(m_1(\kappa)\big) + \frac{1}{2}u'''\big(m_1(\kappa)\big)B^2\sigma^2 + R(\kappa, \sigma^2),\end{aligned} \tag{18}$$

where

$$R(\kappa, \sigma^2) \equiv \mathbb{E}_\sigma[\rho(\kappa, \varepsilon_\sigma, \sigma)]$$

satisfies $R(\kappa, \sigma^2) = o(\sigma^2)$ as $\sigma^2 \downarrow 0$.

Substituting (18) into (16) yields

$$\begin{aligned}
\Delta U'(\kappa; \sigma^2) = -B\Big[&u'\big(m_0(\kappa) - \varphi B\big) - u'\big(m_0(\kappa)\big) \\
&+ \beta\Big\{u'\big(m_1(\kappa) - \varphi B\big) - \Big(u'\big(m_1(\kappa)\big) + \tfrac{1}{2}u'''\big(m_1(\kappa)\big)B^2\sigma^2 + R(\kappa, \sigma^2)\Big)\Big\}\Big] \\
= -B\Big[&u'\big(m_0(\kappa) - \varphi B\big) - u'\big(m_0(\kappa)\big) \\
&+ \beta\big(u'\big(m_1(\kappa) - \varphi B\big) - u'\big(m_1(\kappa)\big)\big) \\
&- \tfrac{1}{2}\beta u'''\big(m_1(\kappa)\big)B^2\sigma^2 - \beta R(\kappa, \sigma^2)\Big]. \qquad (19)
\end{aligned}$$

Define

$$A(\kappa) \equiv u'\big(m_0(\kappa) - \varphi B\big) - u'\big(m_0(\kappa)\big) + \beta\big(u'\big(m_1(\kappa) - \varphi B\big) - u'\big(m_1(\kappa)\big)\big), \qquad C(\kappa) \equiv \frac{1}{2}\beta u'''\big(m_1(\kappa)\big)B^2.$$

By strict concavity of u, u' is strictly decreasing, and therefore $A(\kappa) > 0$ for all admissible κ: the fixed contract lowers consumption by φB relative to the deterministic flexible benchmark in both periods. By the maintained prudence condition, $u'''(\cdot) \geq 0$, so $C(\kappa) \geq 0$. Equation (19) can then be written as

$$\Delta U'(\kappa; \sigma^2) = -B\Big\{A(\kappa) - C(\kappa)\sigma^2 + r(\kappa, \sigma^2)\Big\},$$

where $r(\kappa, \sigma^2) \equiv -\beta R(\kappa, \sigma^2)$ satisfies $r(\kappa, \sigma^2) = o(\sigma^2)$ as $\sigma^2 \downarrow 0$.

Since $A(\kappa) > 0$ is fixed at the given κ and $C(\kappa) \geq 0$ is finite, there exists $\bar{\sigma}(\kappa) > 0$ such that, for all $\sigma \in (0, \bar{\sigma}(\kappa))$,

$$C(\kappa)\sigma^2 + \big|r(\kappa, \sigma^2)\big| < \frac{1}{2}A(\kappa).$$

For such σ,

$$A(\kappa) - C(\kappa)\sigma^2 + r(\kappa, \sigma^2) \;\geq\; A(\kappa) - C(\kappa)\sigma^2 - \big|r(\kappa, \sigma^2)\big| \;>\; \frac{1}{2}A(\kappa) \;>\; 0.$$

Hence the bracket in (19) is strictly positive for all $\sigma \in (0, \bar{\sigma}(\kappa))$, implying

$$\Delta U'(\kappa; \sigma^2) < 0 \quad \text{for all } \sigma \in (0, \bar{\sigma}(\kappa)).$$

This proves the proposition. ■

C.2 Proof of Corollary 1

Proof. Fix a debt level $B > 0$ and a rate level $\kappa > 0$ such that consumption is strictly positive under both contracts and for all shocks for all sufficiently small σ. Write

$$m_0(\kappa, B) = y - \kappa B, \qquad m_1(\kappa, B) = y - (1 + \kappa)B,$$

as in the proof of Proposition 1. To simplify notation below, write $m_0 = m_0(\kappa, B)$ and $m_1 = m_1(\kappa, B)$. Define

$$S(B, \sigma) \equiv u'\big(m_0 - \varphi B\big) - u'\big(m_0\big) + \beta\left[u'\big(m_1 - \varphi B\big) - \mathbb{E}_\sigma\big[u'\big(m_1 - \varepsilon_\sigma B\big)\big]\right].$$

Equation (16) implies

$$\Delta U'(\kappa; \sigma^2) \;=\; -B\, S(B, \sigma).$$

Under the assumptions of Proposition 1, there exists $\bar{\sigma}_1(\kappa, B) > 0$ such that for all $\sigma \in (0, \bar{\sigma}_1(\kappa, B))$ we have $\Delta U'(\kappa; \sigma^2) < 0$. Since $B > 0$, it follows that

$$S(B, \sigma) > 0 \qquad \text{for all } \sigma \in (0, \bar{\sigma}_1(\kappa, B)). \tag{20}$$

Differentiate $S(B, \sigma)$ with respect to B. Using $\frac{d}{dB}u'(y - aB) = -a\, u''(y - aB)$ and the definitions above yields

$$\begin{aligned} S_B(B, \sigma) = &-(\kappa + \varphi)u''\big(m_0 - \varphi B\big) + \kappa u''\big(m_0\big) \\ &+ \beta\left[-(1 + \kappa + \varphi)u''\big(m_1 - \varphi B\big) + \mathbb{E}_\sigma\big[(1 + \kappa + \varepsilon_\sigma)u''\big(m_1 - \varepsilon_\sigma B\big)\big]\right]. \end{aligned}$$

Rewrite the expectation term as

$$\begin{aligned} &\mathbb{E}_\sigma[(1 + \kappa + \varepsilon_\sigma)u''(m_1 - \varepsilon_\sigma B)] \\ &\quad = (1 + \kappa)\,\mathbb{E}_\sigma[u''(m_1 - \varepsilon_\sigma B)] + \mathbb{E}_\sigma[\varepsilon_\sigma u''(m_1 - \varepsilon_\sigma B)]\,. \end{aligned}$$

Hence,

$$\begin{aligned} S_B(B,\sigma) = &\Big\{ -(\kappa+\varphi)u''(m_0-\varphi B) + \kappa u''(m_0) \Big\} \\ &+ \beta \Big\{ -(1+\kappa+\varphi)u''(m_1-\varphi B) + (1+\kappa)u''(m_1) \Big\} \\ &+ \beta(1+\kappa)\Big\{ \mathbb{E}_\sigma[u''(m_1-\varepsilon_\sigma B)] - u''(m_1) \Big\} \\ &+ \beta\, \mathbb{E}_\sigma[\varepsilon_\sigma u''(m_1-\varepsilon_\sigma B)]. \end{aligned} \tag{21}$$

Consider the two deterministic bracketed terms,

$$D_0(B) \equiv -(\kappa+\varphi)u''(m_0-\varphi B) + \kappa u''(m_0),$$

and

$$D_1(B) \equiv -(1+\kappa+\varphi)u''(m_1-\varphi B) + (1+\kappa)u''(m_1).$$

Since $u'' < 0$ and $\varphi > 0$, we have

$$\begin{aligned} D_0(B) &= (\kappa+\varphi)(-u''(m_0-\varphi B)) - \kappa(-u''(m_0)) \\ &\geq (\kappa+\varphi)(-u''(m_0)) - \kappa(-u''(m_0)) \\ &= \varphi(-u''(m_0)) > 0, \end{aligned}$$

where the inequality uses prudence $u''' \geq 0$, which implies $u''(\cdot)$ is increasing and hence $-u''(m_0-\varphi B) \geq -u''(m_0)$. Similarly,

$$\begin{aligned} D_1(B) &= (1+\kappa+\varphi)(-u''(m_1-\varphi B)) - (1+\kappa)(-u''(m_1)) \\ &\geq (1+\kappa+\varphi)(-u''(m_1)) - (1+\kappa)(-u''(m_1)) \\ &= \varphi(-u''(m_1)) > 0. \end{aligned}$$

Therefore $D_0(B) + \beta D_1(B) > 0$.

It remains to control the two terms on the last two lines of (21). Because ε_σ is bounded in $[-K\sigma, K\sigma]$ and, for σ small, $m_1 - \varepsilon_\sigma B$ lies in a compact subset of $(0,\infty)$, u'' is bounded on the relevant domain. Moreover, $m_1 - \varepsilon_\sigma B \to m_1$ uniformly as $\sigma \downarrow 0$, so by continuity of u'',

$$\mathbb{E}_\sigma[u''(m_1-\varepsilon_\sigma B)] \to u''(m_1) \quad \text{and} \quad \mathbb{E}_\sigma[\varepsilon_\sigma u''(m_1-\varepsilon_\sigma B)] \to 0 \qquad \text{as } \sigma \downarrow 0.$$

Therefore there exists $\bar{\sigma}_2(\kappa, B) > 0$ such that for all $\sigma \in (0, \bar{\sigma}_2(\kappa, B))$,

$$\begin{aligned}&\Big|\beta(1+\kappa)\{\mathbb{E}_\sigma[u''(m_1 - \varepsilon_\sigma B)] - u''(m_1)\} + \beta\,\mathbb{E}_\sigma[\varepsilon_\sigma u''(m_1 - \varepsilon_\sigma B)]\Big| \\ &\qquad\qquad < \frac{1}{2}\big(D_0(B) + \beta D_1(B)\big).\end{aligned}$$

Combining this bound with (21) gives

$$S_B(B, \sigma) > \frac{1}{2}\big(D_0(B) + \beta D_1(B)\big) > 0$$

for all $\sigma \in (0, \bar{\sigma}_2(\kappa, B))$.

Finally, differentiate $\Delta U'(\kappa; \sigma^2) = -B\,S(B, \sigma)$:

$$\frac{\partial}{\partial B}\Delta U'(\kappa; \sigma^2) = -S(B, \sigma) - B\,S_B(B, \sigma).$$

Let $\bar{\sigma}(\kappa, B) = \min\{\bar{\sigma}_1(\kappa, B), \bar{\sigma}_2(\kappa, B)\}$. For all $\sigma \in (0, \bar{\sigma}(\kappa, B))$, we have $S(B, \sigma) > 0$ by (20) and $S_B(B, \sigma) > 0$ by the previous argument, hence

$$\frac{\partial}{\partial B}\Delta U'(\kappa; \sigma^2) < 0.$$

This proves the corollary. ■