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**Research Report**

## Refinancing behaviour by homeowners in Denmark when mortgage rates rise

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# DANMARKS NATIONALBANK

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## Refinancing behaviour by homeowners in Denmark when mortgage rates rise

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## Refinancing behaviour by homeowners in Denmark when mortgage rates rise

### Abstract

Rising mortgage rates have led to one in five Danish fixed-rate mortgages to be refinanced during the first three quarters of 2022. The unique Danish match-funding principle has allowed fixed rate mortgage borrowers to buy back their existing mortgages at a 18 per cent discount, on average.

62 per cent of the realised net wealth gain has been used to reduce mortgage and bank debt, while 38 per cent was cashed out. The cash-out share is higher for borrowers with lower levels of wealth, indicating that cash outs may be used to support consumption now or as precautionary savings.

Four in ten refinancers switched from fixed to adjustable-rate mortgages. When combined with cashing out, homeowners become more sensitive to adverse developments in interest rates and house prices. Nonetheless, most refinancers remain robust even in severe scenarios.

### Introduction

The Danish 30-year fixed-rate mortgage rate has increased by approx. 4 percentage points during 2022. This represents the largest rate surge in 40 years and a strong contrast to the general decline in yields following the global financial crisis, cf. chart 1 (left). These developments are expected to reduce home prices and economic activity, but particular features of the Danish mortgage system may attenuate the contractionary effects of higher interest rates on private consumption and housing investments in Denmark.

The Danish mortgage framework resembles the US by having a large share of fixed-rate callable mortgages. However, fixed-rate mortgages in Denmark are also issued under the match-funding principle, implying that the market value of the individual loan is directly linked to the market value of the underlying fixed-rate mortgage bond. Consequently, net wealth of existing fixed-rate mortgage borrowers increases as mortgage rates rise.

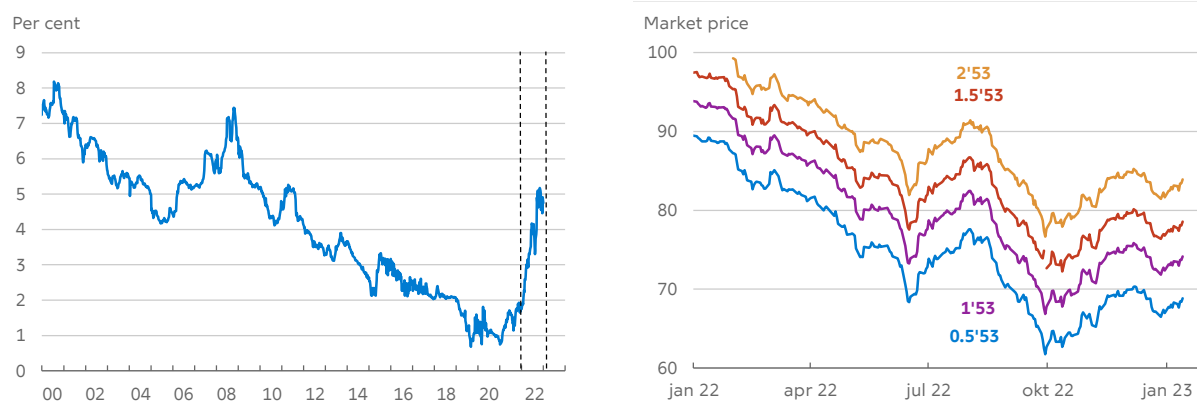
To realise this net wealth gain, fixed-rate mortgage borrowers can prepay their mortgage at market value at any point in time prior to maturity. By the end of 2022, some Danish mortgage bonds traded below a price of 70, cf. chart 1 (right), meaning that these particular borrowers could cut their outstanding mortgage debt by more than 30 per cent by refinancing their fixed-rate mortgage.<sup>1</sup> For the rest of this memo, we refer to this realised net wealth gain simply as the 'net wealth gain'.

<sup>1</sup> Refinancing into a new fixed-rate mortgage implies that the borrower pays a higher interest rate on a now lower outstanding mortgage debt. This higher interest rate includes a sizeable premium for a call option that can be exercised by the borrower should the market rates fall in

the future. Calling the option means that the borrower prepays the mortgage at par to lock in a lower interest rate on a new mortgage, while the outstanding debt remains almost unchanged when abstracting from transaction costs.

### Higher interest rates drive down bond prices on long-term fixed-rate mortgage bonds

Chart 1



Note: Average effective 30-year mortgage rate (left) and bond prices on Nykredit fixed-rate mortgage bonds with different coupon rates. Vertical dashed lines on the left-hand panel marks the time period shown for the right-hand panel.  
Source: Finans Danmark, Refinitiv Eikon and own calculations.

This study uses micro-level data to describe the refinancing behaviour of Danish households who refinanced their fixed-rate mortgage during the first three quarters of 2022, a period of rapid rate increases. In addition, we point to possible motives behind mortgage refinancing when mortgage rates rise and quantify their relative importance.

From January to September 2022, Danish homeowners have refinanced 30-year fixed-rate mortgages by an amount that corresponds to about 21 per cent of all outstanding fixed-rate mortgages in Denmark and 10 per cent of all outstanding mortgages. This high refinancing activity follows a period where many homeowners have obtained low coupon mortgages with high duration. Rising rates have led to an average bond buyback price of kr. 82 per kr. 100 of notional debt, resulting in a net wealth gain that corresponds to 18 per cent of their existing mortgage debt. The realised net wealth gain was, however, smaller because of transaction costs and fees. In total, our data shows that existing fixed-rate mortgage borrowers have realised a net wealth gain by kr. 28 billion in connection to the buybacks in this period.

Our empirical analysis indicates that 41.6 per cent of the net wealth generated through refinancing was

used to reduce mortgage debt, 20.5 per cent was used to reduce debt in commercial banks, while the remaining 37.9 per cent was extracted as cash to be used for consumption or savings. The share of the net wealth gain extracted as cash is larger among homeowners with limited liquid wealth prior to refinancing. This may indicate that the cash extractors are already liquidity constrained or expect to be so in the near future, and cash extraction can therefore support their consumption over the coming years.

Moreover, we find that four out of ten refinancers used the buyback as an opportunity to switch from fixed to adjustable-rate mortgages. Households refinancing early in 2022 faced relatively low short-term rates, e.g. floating, three, and five years, which could have served to make adjustable-rate mortgages more attractive. On average, households switching to adjustable-rate saw their interest rate initially decline by 0.25 percentage points. However, as the short-term rates started to increase later in 2022, most refinancing households now face higher debt service costs.

Households who extracted their net wealth gain as cash faced, on average, higher loan-to-value (LTV)

and debt-service-to-income (DSTI) ratios after refinancing. However, our results indicate that the average household is robust to adverse developments. In fact, some households will likely fare better in a stress scenario because of lower leverage and more favourable debt composition after refinancing. The share of refinanced loans characterised as vulnerable (LTV > 100 and DSTI > 40) is well below five per cent even when we expose them to a scenario of increased interest rates and falling house prices. At-risk debt among refinancing households amount to about kr. 3 billion in our most severe scenario. Our interpretation is that risks associated with the high-levels of refinancing activity in 2022 are relatively contained.

The rest of the memo is structured in the following way: Part 1 provides an overview of mortgage refinancing in Denmark in 2022. Part 2 examines the various types of refinancers in terms of how their realised net wealth gains are allocated between debt reduction and liquidity extraction, and discusses possible motives for households' refinancing choices. Part 3 evaluates the impact of refinancing for households' financial resilience to adverse economic developments.

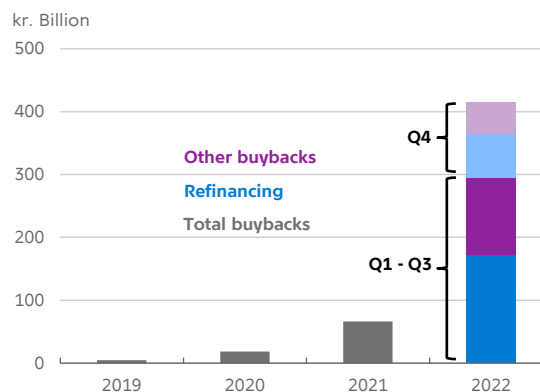
## Refinancing behaviour in the Danish housing market

### Significant increase in buybacks following sudden rise in mortgage rates during 2022

The sudden increase in long-term interest rates during 2022 has reduced the market value of outstanding mortgages and subsequently given rise to high bond buyback activity in Denmark, cf. chart 2. Between the 1st and 3rd quarters of 2022, households refinanced long-term fixed-rate mortgages for a nominal value of kr. 173 billion, corresponding to about one in five of all outstanding fixed-rate mortgages. Over the past ten years, Danish mortgage borrowers have multiple times exercised

**Buybacks of callable mortgage bonds have increased significantly**

Chart 2



Note: The chart displays the total notional value of bought back mortgage bonds. In this memo, we focus on household mortgages that were refinanced during the 1st to 3rd quarter of 2022 (blue bar). Data from the 4th quarter is preliminary. 'Other buybacks' include firm refinancing and prepayments due to home transactions, extraordinary amortisations etc.

Source: Scanrate Rio and Nationalbanken.

their contractual right to prepay their mortgages at par, allowing them to lock in a lower fixed-rate on their mortgage.<sup>2</sup>

### Access to credit register data enables analysis

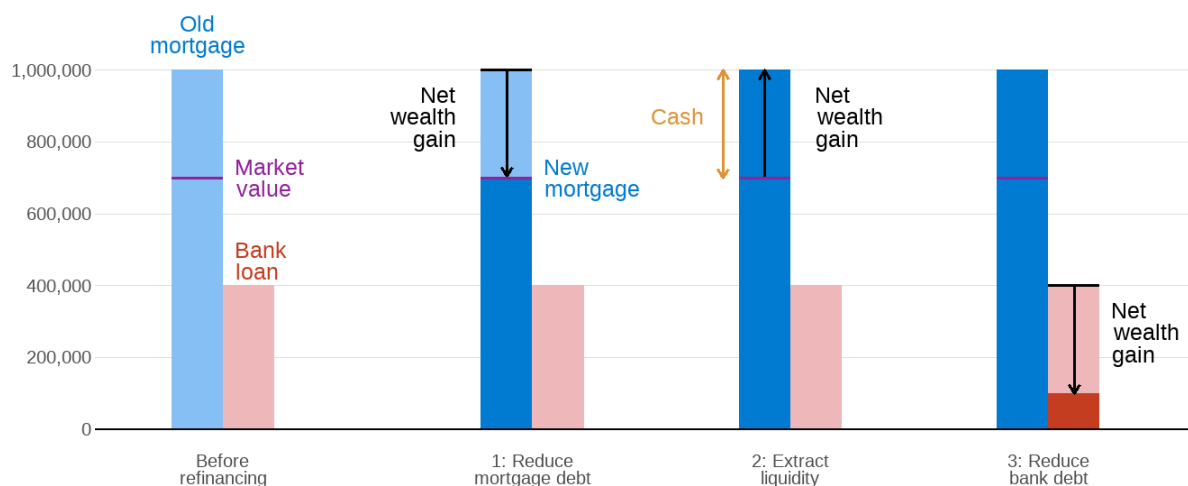
Loan level quarterly data from the Danish credit register that covers the first three quarters of 2022 allows us to observe all refinancing activity in Denmark. This provides a unique view into refinancing behaviour of the individual households. Appendix 1 provides detailed information on how fixed-rate mortgage refinancing is identified in our data as well as our sample restrictions.

The decision to refinance during rising interest rates is complex and subject to expectations about the future as well as household circumstances. In appendix 2, we present a model for predicting refinancing and which observable characteristics best explain a household decision to refinance. However,

<sup>2</sup> See for example Mortgage refinancing supports private consumption, Danmarks Nationalbank Analyse, No. 17, September, 2019.

Illustration of changes to household liabilities under different refinancing allocations

Chart 3



Note: The chart is an illustration that shows three possible uses of net wealth gains from refinancing. In this simplified example, the household has a nominal mortgage debt of kr. 1,000,000 and a bank loan of kr. 400,000. Due to rising interest rates, the market value of the underlying mortgage bond has fallen to 700,000, leaving the household with a potential capital gain from refinancing of kr. 300,000.

our main analysis focuses on the set of households that did refinance in 2022.

Chart 3 illustrates stylised accounts of three possible ways to use the net wealth gain from refinancing that we can identify using micro data. As we will show, need not strictly adhere to either of the three, but are free to combine different uses.

In the first scenario, households refinance in order to reduce their nominal mortgage debt. The decline in the market value of their current mortgage allows them to buy back the underlying mortgage bond at a discount financed by taking out a new mortgage. The principal debt on the new mortgage is lower (as it is equivalent to the market value of the old loan), but it carries a higher interest rate. In this scenario, the mortgage refinancing has no effect on liquidity for the borrower.

In the second scenario, the household chooses to take up a new mortgage with a principal that is larger than the market value of the old mortgage. The difference comes in the form of cash extraction which can be used for consumption or savings.

The third scenario is similar in spirit to the second scenario in that homeowners take out a new mortgage that is larger than the market value of their existing mortgage. However, they use the proceeds to pay down non-mortgage debt. This debt includes both collateralised loans, e.g. secondary mortgage debt, as well as uncollateralised bank debt. The change in total debt is identical in the first and third scenario, but the resulting composition between debt to mortgage banks and debt to commercial banks is different. As bank debt typically carries a higher interest rate, the household can potentially lower their debt service bill.

#### Net wealth gains are primarily used to reduce debt

The net wealth generated from refinancing fixed-rate mortgages during the first three quarters in 2022 amounted to kr. 28 billion, cf. chart 4. From this gain, 62 per cent was subsequently used to reduce total debt. More specifically, the net reduction in mortgage debt amounted to kr. 11.6 billion and another kr. 5.7 billion was used to reduce debt to commercial banks. The remaining kr. 10.6 billion was

used for immediate consumption or they were saved in savings accounts.

Precautionary savings motives may play a role for household behaviour during 2022. House prices have started to decline over the course of the year and consumer sentiments hit record lows in late 2022. The immediate stimulating effect of mortgage refinancing on private consumption will inherently be weaker if the precautionary savings motive is stronger. Specifically, refinancing homeowners can store the extracted liquidity on deposit accounts to support spending in the near-term future or invest in financial asset or pension accounts to support spending in the longer term.

Some of the mortgage refinancing in our data may also have taken place even without the rise in mortgage rates, as Danish households had ample home equity available, particularly following the rise in house prices during the covid-19 pandemic. In case many households in our sample were planning to extract home equity even before they learned that mortgage rates increased, a part of the kr. 10.6 billion extracted cash that we find would have stimulated the economy no matter how mortgage rates developed during this period. However, we impose sample restrictions that aim to exclude refinancings that would have occurred regardless of interest rate developments from our main sample (see appendix 1).

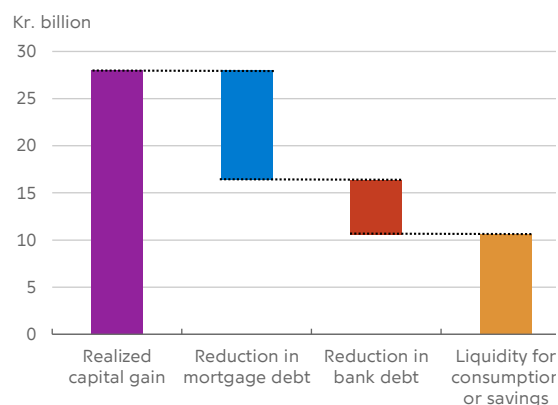
### Significant differences in households' debt changes

There is significant heterogeneity across homeowners in terms of how their debt changes when refinancing. Some households extract large amounts of liquidity, while others obtain a new mortgage at more or less the same size as the market value of their original mortgage, thus not extracting any home equity. Finally, a few pay down their debt extraordinarily using already accumulated assets.

The blue histogram in chart 5 (left) displays the change in total debt of all households in the sample, including both mortgage and bank debt. More than eight out of ten homeowners reduce their

### Buybacks may support private consumption opportunities through home equity extractions

Chart 4



Note: The chart shows the usage of realized capital gains net fees from refinancing split into debt reduction and liquidity extraction purposes.

Source: Danmarks Nationalbank.

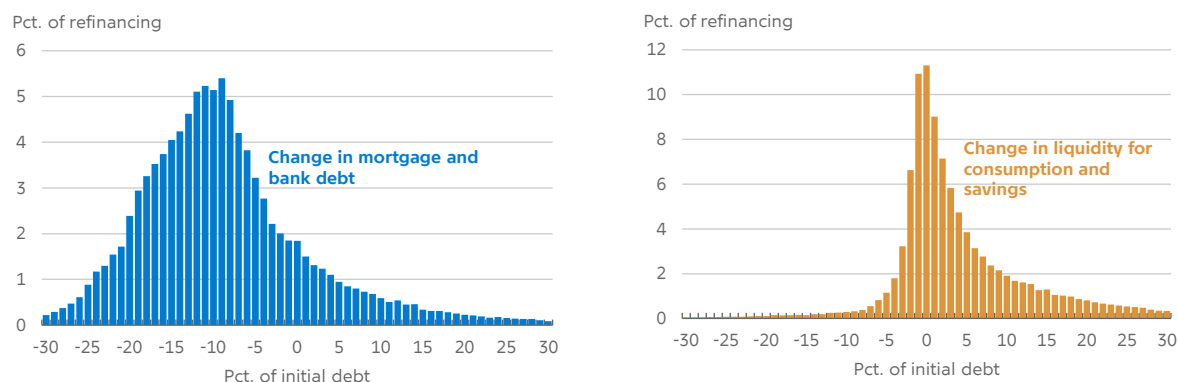
outstanding notional debt when refinancing. The median debt reduction was 10 per cent of the initial debt. This also implies that less than one in five refinancing households increased their notional debt (blue area > 0 per cent).

### Most households do not extract liquidity

As refinancing households could both reduce debt and extract home equity at the same time, we turn to measuring how much liquidity is generated. Specifically, we take the net wealth gain realised by each borrower who refinances their mortgage and subtract the change in their total debt. The resulting number is their equity extraction, and the yellow histogram in chart 5 (right) shows the distribution of this measure.

### Refinancing has generally contributed to lower debt for the majority of households, but a significant fraction has extracted liquidity

Chart 5



Note: The left panel shows the distribution of changes in the total nominal value of debt following refinancing as a per cent of initial debt. The right panel shows the corresponding distribution of liquidity extraction for consumption and savings.  
Source: Danmarks Nationalbank.

Slightly more than 60 per cent of the sample lies within a five-percentage-point interval around zero, meaning that they essentially just replace their existing fixed-rate mortgage with a new mortgage of similar size  $\pm 5$  per cent. One third of the sample did, however, extract home equity. The extracted amounts varied substantially, in some cases up to 30 per cent of the initial debt. Negative values indicate that borrowers repaid additional debt on top of what can be explained by the net wealth gain that was realised by mortgage refinancing. This implies that these borrowers must have drawn down bank deposits or other sources of savings to repay additional debt. Around 5 per cent of refinancing households did this.

#### Four in ten refinancers switched from fixed to adjustable-rate mortgages

Homeowners can switch to an adjustable-rate mortgage when refinancing if they are eligible according to applicable lending policies. About 40 per cent of refinancers switched to a new mortgage

with adjustable rate, while 60 per cent took out a new fixed-rate mortgage.<sup>3</sup>

Chart 6 (left) shows the change in effective interest rates, excl. administrative fees, following refinancing. The purple distribution depicts homeowners who decided to take out a new fixed-rate mortgage and the blue distribution shows homeowners who switched to an adjustable-rate mortgage. For the majority of homeowners who opted for a fixed-rate mortgage, the distribution tends to bunch around integers and half-integers consistent with the coupon rates that fixed-rate mortgage bonds are typically issued with in Denmark. For homeowners that switch to adjustable-rate mortgages there is an average initial reduction in interest rate of 25 basis points. This distribution of effective interest rate changes for people switching to adjustable-rate mortgages is quite wide as it depends on the interest rate fixation period chosen by the household. These are typically between six months and five years.

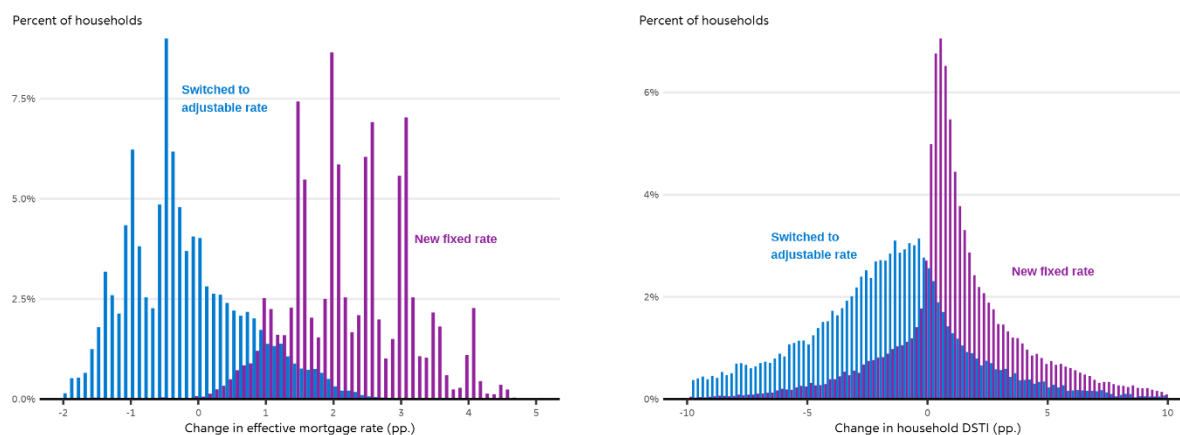
<sup>3</sup> The choice of variable rate mortgage is in Denmark tightly linked to the slope of the yield curve. During the first quarters of 2022, an especially steep yield curve has incentivised many homeowners to exchange their fixed rate to an adjustable-rate mortgage in connection to the buyback. See *Stigende renter og priser kan udfordre bankernes kunder*, Danmarks Nationalbank Analyse (2022). A number of households in our

sample have also chosen adjustable-rate mortgages with deferred amortisation. This loan type is considered particularly risky for financial stability, see Det Systemiske Risikoråd, *Øget udbredelse af lån med variabel rente og afdragsfrihed bidrager til risikopbygning*, Observation, 27. september 2022.



## Interest rates on the new mortgage impact household budgets

Chart 6



Note: The left panel shows the distribution of changes to the effective mortgage interest rate for refinancing households before and after refinancing. The right panel shows the distribution of changes to household DSTI before and after refinancing.

Source: Danmarks Nationalbank.

In order to capture the impact of changing debt service payments on household budgets, we compute the DSTI ratio for each borrower before and after refinancing. Borrowers who remained in fixed-rate mortgages incurred a higher interest rate as shown in chart 6 (right), but the change in their DSTI was limited. This is because the higher rate is in many cases offset by a smaller mortgage principal after refinancing. The wide distribution of DSTI changes also implies that heterogeneity in household behaviour is likely causing large differences in how mortgage refinancing affects households budgets. The next part of the memo aims to map out this heterogeneity.

## Heterogeneous use of refinancing gains among households

### Exploring heterogeneity in behaviour is important to understand motives for refinancing

Until now, we have shown that 62 per cent of the net wealth gain from refinancing was used to repay debt, while the rest was extracted as liquidity (see chart 4). As we will show in this part of the memo, most households focused on either mortgage debt

reduction, bank debt reduction or liquidity extraction over opting for a mixed allocation.

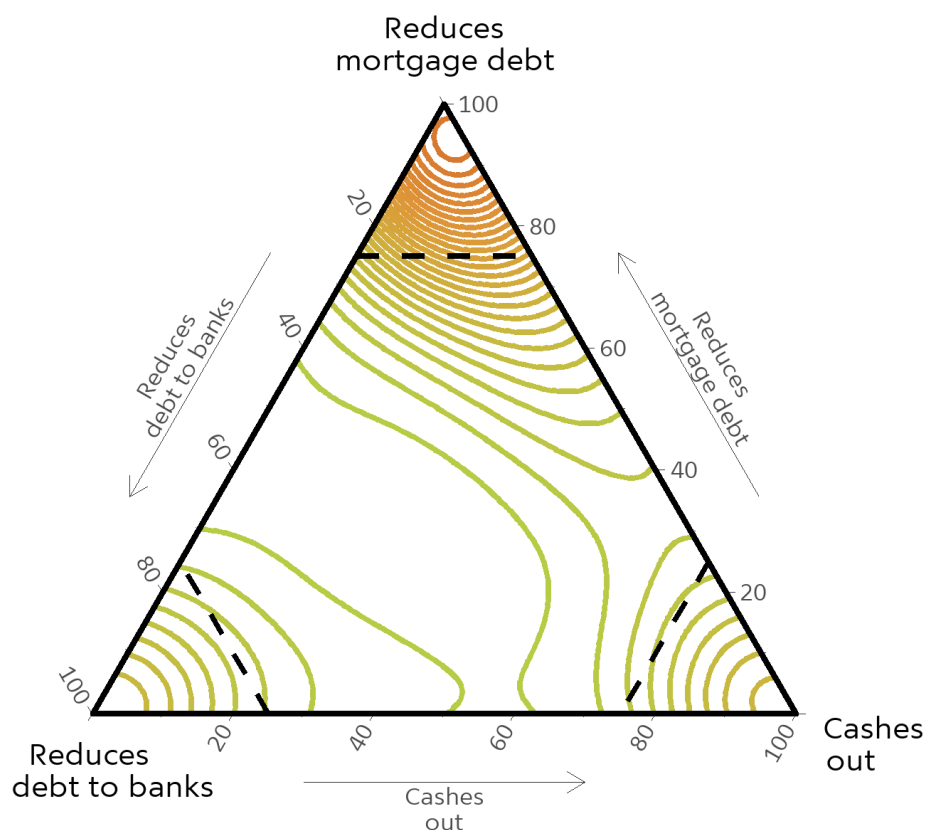
We implement an allocation measure for how each borrower predominantly used the realised net wealth gain. This will help us understand their motives for refinancing and assess the financial risk exposure connected to their financial situation after refinancing.

### The use of buyback liquidity can be well described by dividing households into three categories

The first step is to categorise each refinancing borrower based on their predominant use of the net wealth gained from refinancing. We use the same categories as illustrated in chart 3. These are (i) a reduction in mortgage debt, (ii) extraction of home equity and (iii) reduced debt to non-mortgage banks. Obviously, a household may opt for a mix of the three scenarios.

Distribution of borrowers based on how they use the net wealth gained from refinancing

Chart 7



Note: The chart shows the probability distribution of how households allocate their realised capital gain. Points along the same line have the same probability density. A red shade signifies a higher probability and a green shade signifies a lower probability.

Source: Danmarks Nationalbank.

Chart 7 shows the distribution of the three uses of the net wealth gain. Each household is placed in either of the three corners if they allocated the entire capital gain to reducing mortgage debt (top), cashed out through home equity extraction (bottom right) or reduced debt to banks (bottom left). The contour lines describe the probability distribution density over the three different uses of capital, with red (green) indicating a higher (lower) density of households. The distribution shows that households do in fact tend to favour one of the three uses over a mixed allocation of funds, with reduced mortgage debt being the most popular choice.

In order to categorise each borrower based on their main use of capital, we first determine whether any single use receives 75 per cent or more of their

realised net wealth gain. This means that, for example, borrowers who allocate 75 per cent or more of the net wealth gained from refinancing to mortgage debt reduction are categorised as primarily reducing mortgage debt. If no single use receives 75 per cent, the household is categorised as mixed. Using this simple classification rule, we find that 46 per cent of the sample primarily reduced mortgage debt, while 17 and 16 per cent extracted cash and reduced debt to banks, respectively. For the remaining 22 per cent of households, no single use clears the 75 per cent threshold. These are categorised as mixed use. To focus on the three distinct uses of realised wealth gain, we do not analyse the mixed-use group specifically.

### **Mortgage debt reducers and cash-outs were similar in terms of indebtedness prior to refinancing**

Table 1 shows descriptive characteristics for the three refinancing categories. Strikingly, mortgage debt reducers and cash-outs had very similar LTV, DTI, and DSTI ratios prior to refinancing. In fact, their LTV ratios were identical at 68 per cent on average. Bank debt reducers, on the other hand, were more indebted by all measures, potentially also reflecting that they are typically younger. Their average LTV ratio was 82 per cent prior to refinancing.

Households who primarily reduced mortgage debt realised the largest capital gain, on average, compared to the two other groups, which is likely related to the fact that they own the most valuable homes and are on average older. The group reducing bank debt realised the smallest amount of capital gains relative to the other groups, indicating that this group also lived in the least expensive houses with the smallest mortgages in the sample.

### **Probability to opt for interest-only mortgages vary**

Among the group that extracted cash, the share of households taking up an interest only mortgage increased by 11 percentage points. This indicates that the cash extraction group generally has a high preference for liquidity and use all available sources to acquire more cash on hand. The propensity to take out an interest only mortgage increased by 5 percentage points for the mortgage debt reducers, while dropping 10 percentage points for the bank debt reducers. The behaviour of the latter group should be seen in the context that they may have repaid all their bank debt when refinancing. For this reason, they may have more space in their private budget and thus be more inclined to begin amortisation on their mortgage.

### **We propose three motives for refinancing fixed-rate mortgages when mortgage rates rise**

In order to understand the driving forces behind the buybacks, we propose motivations for each of the three scenarios presented above. Naturally, each borrower may not fully fall within one of the three, as multiple circumstances and incentives may drive their

refinancing decisions. We also fully recognise that additional motives for refinancing exist.

#### *The portfolio optimiser motive*

We first focus on refinancers that primarily spend their realised net wealth gain to reduce mortgage debt. We propose that this group may be driven by the *portfolio optimiser motive*. Based on individual beliefs about future interest rate developments and how long they expect to remain in their current home, borrowers may find it optimal to refinance their existing fixed-rate mortgage. Their outstanding debt declines while they incur higher interest rates, which together leaves their total debt service payments (borrowing costs and repayments) at the time of refinancing almost unchanged. However, they may be expecting mortgage rates to decline again in near future. If this happens, they can refinance to lock in a lower rate. Because of the borrower's contractual right to always prepay mortgages at par, their outstanding debt will not change when refinancing to lock in a lower rate. Together, this two-step strategy likely lowers the total borrowing costs over the loan lifetime.

This strategy may reduce total borrowing cost if mortgage rates actually do decline again in the near future as this motive dictates. For illustration purposes, we model interest rate dynamics based on certain expectations in appendix 3.

## Characteristics across the three borrower categories

Table 1

Variable	Reduces mortgage debt	Cashes out	Reduces debt to banks
<b>Before refinancing</b>			
LTV (%)	68	68	82
DTI	2.56	2.39	2.66
DSTI (%)	12	11	15
Age of oldest household member	45.34	43.77	39.96
Home value (kr. 1,000)	3,795	3,522	2,803
Mortgage debt (kr. 1,000)	2,451	2,148	1,889
Debt to banks (kr. 1,000)	112	111	442
Bank deposits (kr. 1,000)	335	244	166
Financial wealth (kr. 1,000)	492	351	206
IO mortgage share (%)	24	30	34
Mortgage interest rate (%)	1.09	1.12	1.18
Bank loan interest rate (%)	4.62	5.09	4.41
Combined interest rate (%)	1.20	1.27	1.81
Mortgage fees (%)	0.72	0.75	0.81
<b>After refinancing</b>			
Net wealth gain (kr. 1,000)	336	267	241
Change in mortgage debt (kr. 1,000)	-360	195	225
Change in bank debt (kr. 1,000)	2	13	-315
Cash out (kr. 1,000)	-18	482	142
Share switching from fixed to adjustable rate (%)	39	43	36
IO mortgage share (%)	29	41	24
Combined interest rate (%)	2.42	2.37	2.50
Mortgage fees (%)	0.63	0.77	0.80
Combined interest rate, 24-month forecast (%)	3.33	3.12	3.14
<b>Number of households</b>	<b>38,963</b>	<b>14,298</b>	<b>13,380</b>

Note: Columns show truncated means (the top and bottom 1 per cent of observations are removed). Household income and financial wealth is observed in 2020 (end of year).

Source: Danmarks Nationalbank.

Based on the expectation that mortgage rates will decline from the current level of about 4 per cent to a long-run level of 1 per cent, the model suggests a 40 per cent probability that current refinancers will be able to lock in this lower fixed-rate of 1 per cent within five years. The probability increases to 80 per cent by taking a 10-year perspective. These probabilities are model simulations and cannot be interpreted as the view of Danmarks Nationalbank.

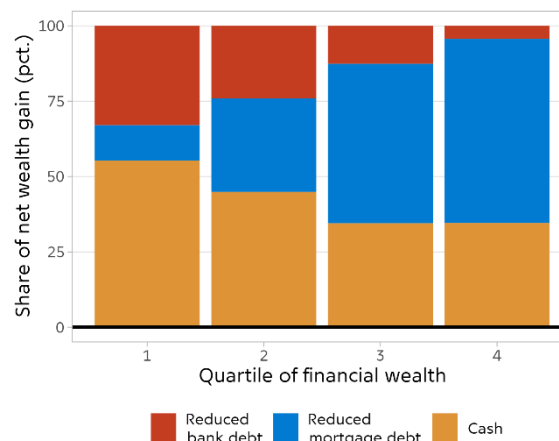
The expectation of interest rates to converge back to a lower level (1 per cent in the example) may be motivated by the widely acknowledged fact that the natural real interest rate has declined over the past decades. Several factors still point to a low natural real rate in the near future.<sup>4</sup> If mortgage rates do not decline before the loan matures, the total payments from the borrower to the lender over the loan life-time will be larger compared to a situation where the borrower did not refinance to a higher fixed-rate mortgage. We explain the importance of interest rate expectations for the portfolio motive in appendix 3.

Refinancing from a low-coupon to a higher-coupon fixed-rate mortgage comes with a cost. The new higher-coupon mortgage has an embedded call option where borrowers can prepay the mortgage at par at any point in time. This is particularly valuable for the borrower if the mortgage rates are likely to fall in the near future. The investor requires a premium for the risk of prepayment, implying that the overall interest rate on the new fixed-rate mortgage may be well above the risk-free interest rate. When market participants perceive the probability of falling mortgage rates to be substantial (resulting in a substantial risk of prepayment), the fixed-rate mortgage rate incurred by the refinancing borrower is also substantially higher compared to, e.g., a risk-free rate of similar maturity or a short-term mortgage rate.

The decision to refinance when mortgage rates rise depends to a large extent on subjective expectations by each borrower. In this memo we focus solely on

**Allocation of net wealth gains across financial wealth quartiles**

Chart 8



Note: The mean allocation of refinancing gains across households, split by quartiles of the financial wealth distribution in 2020.

Source: Danmarks Nationalbank.

borrowers who do refinance their mortgage. However, we should keep in mind that a set of existing fixed-rate mortgage borrowers have not refinanced their mortgages in 2022 despite also having experienced a net wealth gain when mortgage rates increased. The net wealth increase may induce them to increase spending without refinancing, simply in order to smooth consumption over their lifetime. In theory, this requires, however, that they believe that the net wealth gain is permanent, i.e., that mortgage rates remain elevated until their mortgage matures.

One example is refinancers who expect to move within a few years. If they believe that mortgage rates might come down before the expected time of selling their property, they may want to realise the net wealth gain by refinancing today. When they eventually sell their property, and mortgage rates may have come down again, they will realise more home equity compared to a situation where they did not refinance when mortgage rates were high.

<sup>4</sup> Realrenter i lyset af inflation og højere offentlig gæld. Danmarks Nationalbank, Forthcoming.

Finally, mortgage borrowers do not necessarily pay attention to changes in mortgage rates, meaning that they do not realise their net wealth rising. Inattention is found to play a significant role for refinancing behaviour when mortgage rates decline.<sup>5</sup> Inattention may play an equally important role when mortgage rates rise.

#### *The liquidity motive*

Limited access to liquid wealth or an inability to take out any more credit may prevent households from spending as much as they believe is optimal. Borrowers can lift this liquidity constraint by refinancing their mortgage when mortgage rates rise to extract the net wealth gain. We term this the *liquidity motive*. Similar patterns would be consistent with an alternative explanation, namely that consumers are myopic by nature.<sup>6</sup> Here, borrowers value near-term spending disproportionately highly, which may induce them to refinance and cash out the newly gained net wealth.

The liquidity motive is likely to dominate among homeowners who had relatively few liquid assets prior to refinancing. Chart 8 shows exactly this by dividing all borrowers into quartiles of financial wealth prior to refinancing. The group to the left, with the smallest amounts of wealth, cashed out a substantially larger part of their net wealth gain when refinancing compared to households in the top quartile. For the same reason, it is likely that cash-outs have higher marginal propensities to consume compared to the refinancers who reduced debt.

The median household in the two higher quartiles had less than kr. 10,000 in bank debt prior to refinancing, explaining why they on average spend little on repaying debt to banks. The lowest quartiles, who may have relatively high marginal propensities to consume, also have more debt in the form of bank loans. As they refinance their mortgage, they may

face conflicting objectives: a desire to consume out of their home equity and paying down bank debt.

#### *The consolidation motive*

Mortgage refinancers who primarily use realised net wealth gains to reduce bank debt are likely driven by the *consolidation motive*. For homeowners in this group, DSTI can be reduced by repayment of more expensive supplementary debt in commercial banks via the realised net wealth gain from refinancing the mortgage debt.

The intuition is that homeowners who had additional loans on top of their mortgage, either as part of their home financing or consumer credit, face relatively high borrowing costs. Table 1 shows that bank debt reducers had substantially more bank debt prior to refinancing and that bank debt interest rates are significantly larger, on average, than mortgage rates. Home equity extractions made possible through refinancing allowed these households to repay the most expensive loans in their liability portfolios and thereby optimise and consolidate the composition of their liabilities.

## Refinancing affects homeowners' financial robustness

Refinancing during rising interest rates can come at the cost of higher sensitivity to financial stress. Homeowners who use their realised net wealth gain for consumption will have higher LTV and DSTI ratios compared to homeowners who use the buyback opportunity to reduce debt. Moreover, shifts from fixed to adjustable-rate mortgages expose borrowers to the risk of higher debt service costs in the future, than if they had kept their fixed-rate mortgage. This risk is most salient for households who opt for a short interest rate fixation period, cf. chart 9, which

<sup>5</sup> Andersen, Steffen, John Y. Campbell, Kasper Meisner Nielsen, and Tarun Ramadorai. 2020. Sources of Inaction in Household Finance: Evidence from the Danish Mortgage Market. *American Economic Review*, 110 (10), pp 3184–3230.

<sup>6</sup> See for example Strotz, R. H. 1955. Myopia and Inconsistency in Dynamic Utility Maximization. *The Review of Economic Studies*, 23(3), pp 165–180 and Laibson, David. 1997. Golden eggs and hyperbolic discounting. *Quarterly Journal of Economics*, 112(2), pp 443–477.

constitute more than half of mortgages that were refinanced to an adjustable rate.

These concerns are particularly relevant under the current macroeconomic outlook. Rising interest rates not only reduce the market value of mortgage bonds, they also put downward pressure on real estate valuations, likely for years to come. This increases the risk of negative home equity for highly leveraged households.

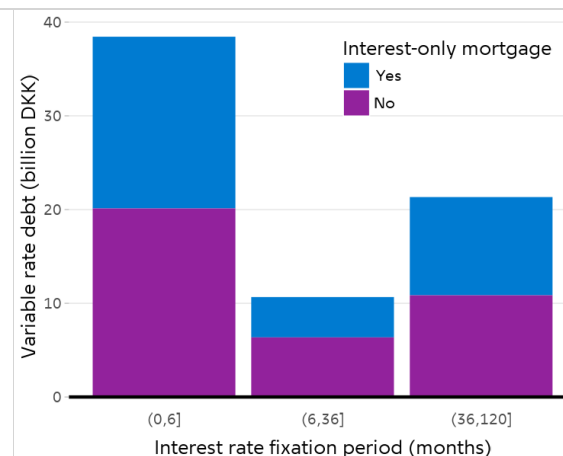
### Some households will face higher debt-service costs

To assess these risks, we examine the LTV and DSTI distributions of refinancing households in all three groups. The distributions are shown in chart 10.<sup>7</sup> The panels on the left show the end-of-quarter distributions before and after refinancing. The right-side panels contain our two-year forecast of the distributions. Within the 24 months following refinancing, many adjustable-rate mortgages will reset to higher interest rates, and house prices will likely fall due to rising rates. See the note in chart 10 for a description of our forecast scenario. In yellow, we show our estimate of the counterfactual distribution in absence of refinancing. Here, we use the same scenario for interest rates and house prices but we assume that households kept their original fixed-rate mortgages (but still face higher rates on any other variable rate debt they might have).

We forecast a slight increase in the share of stressed households (DSTI > 40 per cent) in all three groups, rising from near zero (left, blue) to between 1 and 3 per cent (right, red).<sup>8</sup> However, the refinancing decision affects the groups differently based on their use of the realised net wealth gain. Compared to the counterfactual of not refinancing (right, in yellow) rising interest rates will increase the risk of high DSTI for the cash extractors only (from 1.2 to 2.7 per cent). For the two groups that reduced debt when refinancing, the risk of facing a high DSTI is almost

Fixation periods for households refinancing to adjustable-rate mortgages

Chart 9



Note: Outstanding loan amounts after refinancing for new adjustable-rate mortgages by interest rate fixation period.

Source: Danmarks Nationalbank.

unchanged or declines slightly when compared to the counterfactual.

### Cash extractors take on more risk when refinancing

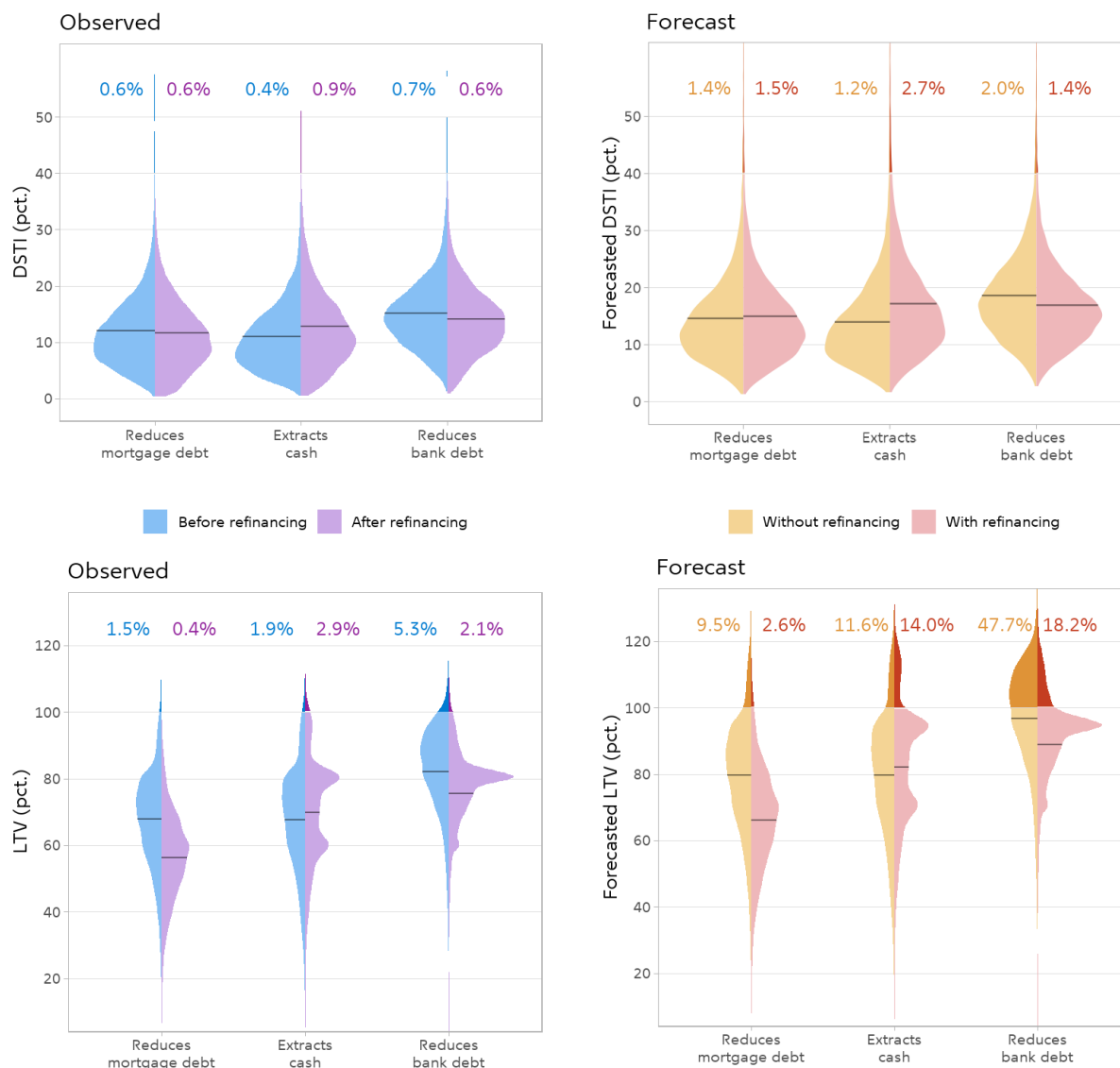
The post-refinancing LTV distributions show how households that cashed out increased their leverage when refinancing (see the bottom left panel in chart 10). Conversely, the group that opts to reduce mortgage debt see a large overall drop in LTV ratios, with some signs of clustering around 60 per cent.

<sup>7</sup> For data on LTV, we use loan amounts and property valuations reported by banks and mortgage banks in the Danish credit register. Our LTV measure accounts for all loans where the refinanced property is used as collateral. For DSTI, we estimate annual debt service payments at the household level using data on loan amortisation

schedule, effective interest rate, time to maturity and outstanding loan amount. For income, we use household disposable income in 2020.  
<sup>8</sup> While Denmark has no formal DSTI limit, several EU countries targeting DSTI as part of macroprudential policy have set their limit to around 40. (European Systemic Risk Board. 2021. A Review of Macroprudential Policy in the EU in 2020.)

**Adverse scenarios of rising interest rates and declining house prices affect borrowers differently, depending on their use of net wealth gains from refinancing**

Chart 10



Note: Top left: The household DSTI distribution density for mortgages that were refinanced between 1st and 3rd quarter of 2022 before and after refinancing. Top right: Forecasted DSTI in 2024 based on the assumption that adjustable mortgage rates remain at January 2023 levels (320-340 bps). For adjustable-rate bank loans, we forecast an increase of 200 bps over 2022 levels. The percentages shown at the top indicate the share of stressed households (DSTI > 40) within each group. The horizontal lines represent means. Bottom left: The household LTV distribution density before and after refinancing. Bottom right: Forecasted LTV where house prices are assumed to fall by 15 per cent between 2022 and 2024. The percentages shown at the top indicate the share of underwater households (LTV > 100) within each group.

Source: Danmarks Nationalbank.

This level is used as a guideline above which banks should be restrictive when issuing interest-only adjustable-rate mortgages. 60 per cent also marks a cut off where mortgage banks charge reduced administrative fees.

Banks provide subordinated mortgages designed to cover the difference between the 80 per cent LTV limit for mortgages issued by mortgage banks and the regulatory 95 overall LTV limit. After refinancing, households paying down bank debt cluster tightly



around 80 per cent LTV, the limit for mortgages. This suggests that many households tend to refinance their homes up to the LTV limit and use the wealth gain to pay down bank debt, with the remainder extracted as cash.

When incorporating our baseline forecast of a 15 per cent drop in home values by 2024 (right, red) and comparing against the counterfactual LTV distribution (right, yellow), we see that refinancing can have a large impact on the likelihood of technical insolvency ( $LTV > 100$ ). In particular, the group that reduces their bank debt as part of refinancing see a substantial decrease in their vulnerability to lower house prices. The households that cash out and reduce their mortgage debt initially have similar LTV ratios (cf. table 1). However, because of how they allocate their realised wealth gain, the cash-outs find themselves more exposed in our LTV forecast. Ultimately, the latter group's financial robustness depends on how they use their refinancing gains. If they invest in their homes or use the cash to boost their savings accounts, they will be in a better position than if they increase consumption.

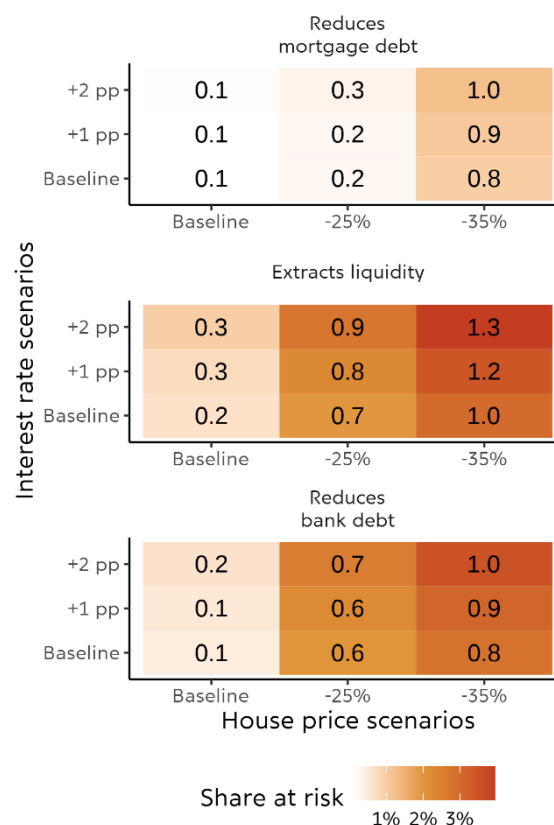
### MFI exposure to vulnerable refinancers is limited

In order to assess implications for banks and mortgage banks in adverse scenarios, we examine the joint DSTI-LTV distribution given our baseline forecast for interest rates and home values (cf. chart 10). In chart 11, we present the total amount of outstanding debt of borrowers with  $LTV > 100$  and  $DSTI > 40$ . We show this for our baseline forecast as well as more severe scenarios.

The top panel shows that mortgage debt reducers are expected to fare well even in our most severe scenario, with only about kr. 1 billion worth of loans in the risky segment. Households who primarily extract cash see similar levels of exposed debt. However, as the group is smaller, the relative risk rate is substantially higher as up to 4 per cent of loans fall into the risky segment in our most severe scenario. Refinancers who primarily reduce bank debt see relative risk rates to the cash extracting

**MFI exposure to refinancing households remain limited even in adverse scenarios**

Chart 11



Note: The charts show the total amount of outstanding loans (in kr. billions) for refinancing households that would be vulnerable ( $LTV > 100$  and  $DSTI > 40$ ) in different stress scenarios. For house prices, we test drops of 15 per cent by 2024 (baseline), 25 per cent and 35 per cent. The interest are scenarios for adjustable-rate mortgages are current market rates (baseline), +1 pp and +2 pp. The shading illustrates the share of debt at risk in each scenario.

Source: Danmarks Nationalbank.

group. However, this can be attributed to their higher initial levels of indebtedness.

In total, we estimate that refinanced mortgages of around kr. 3 billion fall in the risky segment in our most severe scenario. To put this number into context, our sample covers refinanced loans totalling kr. 173 billion. The total nominal mortgage debt of Danish households amounted to about kr. 1,500 billion at the time when we conducted this study.

To conclude, the impact of refinancing under rising interest rates can serve to both weaken and strengthen the financial robustness of households,

depending on how the realised net wealth gain is allocated between debt reduction and cash extraction. While some households who primarily cash out their wealth gain will find themselves more vulnerable in an adverse scenario because of refinancing, the effects are small and will depend on whether they use the cash for consumption, savings, or housing investment. As a final word of caution, we would like to emphasise that we do not stress household income in this study. A recession along with a negative employment shock could cause dramatic shifts in the DSTI distribution, pushing many more households into unsustainably high levels of debt service.

## Appendix 1: Quantifying realised capital gains from refinancing fixed-rate mortgages

The analysis builds on data from the Danish credit register containing reported quarterly observations covering the full population of outstanding mortgages and bank loans in Denmark. We focus on the recent impact of rising interest rates and consequently limit the reference period to between the 1st and 3rd quarters of 2022.

Importantly, we characterise a mortgage refinancing as a full prepayment of a fixed-rate mortgage financed by a new mortgage backed by the same underlying collateral asset, without changes in the borrower base or any housing market activity.

Capital gains from refinancing are not directly reported to the credit register. We therefore estimate a realised capital gain for each individual refinancing transaction the loan-borrower level. The realised capital gain in the simplest case of a sole debtor refinancing a single fixed-rate mortgage is calculated as the change in the market value of mortgage debt net transaction costs:

$$\begin{aligned} \text{Realised capital gain}_i &= p_i^{\text{New loan}} \times N_i^{\text{New loan}} \\ &\quad - p_i^{\text{Buyback}} \times N_i^{\text{Buyback}} - FC \end{aligned}$$

Where  $N$  denotes the notional mortgage debt,  $p$  represents the corresponding bond price and  $FC$  captures the (fixed) transaction costs of refinancing. Consequently, the liquidity extraction is calculated as the residual capital gain net of total changes in outstanding debt commitments  $D$ .

For each buyback bond price,  $p$ , we use the daily market price of the underlying mortgage bond two bank days before the initiation date of the substituting loan. The bond price of the substituting mortgage is assumed to be 98.5 for fixed-rate

mortgages and par for adjustable-rate mortgages. Fixed transaction fees are set to kr. 25,000.

$$\text{Liquidity extraction}_i = \text{Realised capital gain}_i - \Delta D_i$$

Some households may have chosen to refinance a fixed-rate mortgage even in the absence of the sudden 2022 mortgage rate rise. Such motives include the desire to extract home equity that was available even before the rate increase, e.g., for home renovations or spending. Other motives may be adjustments of borrowing terms such as starting or ending interest-only features, or adjustments of the mortgage duration. We therefore restrict the full population of refinancers to cases where a capital gains argument is justifiable, given the size of a potential gain and the assumed transaction fees. This aims to limit the extent of alternative and potentially competing household circumstances in our refinancing sample.

We therefore abstract from 7 per cent of the total amount of mortgage refinancing which plausibly is not connected to the increase in mortgage rates. These excluded refinancers are identified by buyback-prices being relatively high or mortgage debt being comparably low. Both restrictions are set to ensure that the market value of these mortgages is not sufficiently affected by lower bond prices and consequently imply that these households are not responding to recent rate increases.<sup>9</sup>

These sampling restrictions mainly affect the amount of refinancing early in the 1st quarter of 2022 before bond prices began to fall materially. The excluded sample during the 2nd and 3rd quarters of 2022 is mainly caused by imposing the minimum debt level restriction, resulting in only 3 per cent of refinancings being excluded after the 1st quarter.

<sup>9</sup> We set the cut-off bond price to 92 and the minimum debt limit to kr. 500,000, meaning that all buybacks at or above a price of kr. 92 per kr. 100 notional mortgage debt are excluded in the analysis. These price

and debt level restrictions are in line with the general rule-of-thumb guidelines that the Danish mortgage credit institutions utilise when advising households on refinancing decisions.

### Refinancing characteristics using our sample restrictions

Table A

Variable averages at the individual borrower level

Full sample (N=155,740)    Restricted sample (N=139,957)    Excluded sample (N=15,783)

Bond buyback price	83.0	<b>81.9</b>	94.7
Refinancing amount (kr. 1,000)	1,198	<b>1,240</b>	827
Total debt before refinancing (kr. 1,000)	1,493	<b>1,527</b>	1,192
Capital gain net fees (kr. 1,000)	182	<b>200</b>	16
Change in total debt (kr. 1,000)	-100	<b>-124</b>	117
Liquidity extraction (kr. 1,000)	81	<b>76</b>	126

Note: The table presents means for our full, restricted and residual (excluded) sample. The data is observed at the individual borrower level.  
Source: Nationalbanken.

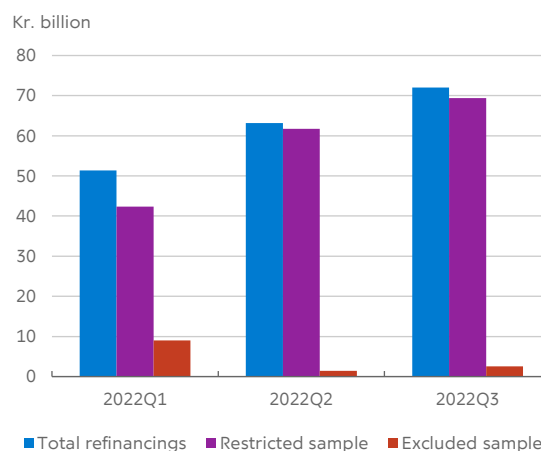
Table A contains descriptive statistics for the average refinancing in each of the three samples, the full, the restricted and the excluded sample. The average bond price of all refinancings in our preferred (restricted) sample is 81.9, with an average notional mortgage debt of kr. 1.2 million. This corresponds to an average capital gain of kr. 200,000 per individual transaction, net of fees. The majority of the capital gain is used for debt reductions, while 38 per cent, on average, is extracted for spending or savings. For our main analysis, borrower-level data is aggregated to the household level. As many households have two or more adults co-signing a mortgage, this aggregation reduces the number of observations (cf. table 1).

This picture changes significantly in the excluded sample in which the average buyback price is 94.7. In combination with a lower refinancing amount, realised capital gains are much smaller at kr. 16,000 per borrower. Oppositely, we observe an outsized liquidity extraction, resulting from an increase in outstanding debt. This significant difference between the two samples highlights the importance of the excluded sample in the pursuit of isolating the effects from rising rates. Lastly, given the similarities

between the full and restricted sample averages, all our aggregate findings are robust to this sample selection.

### The refinancing sample population

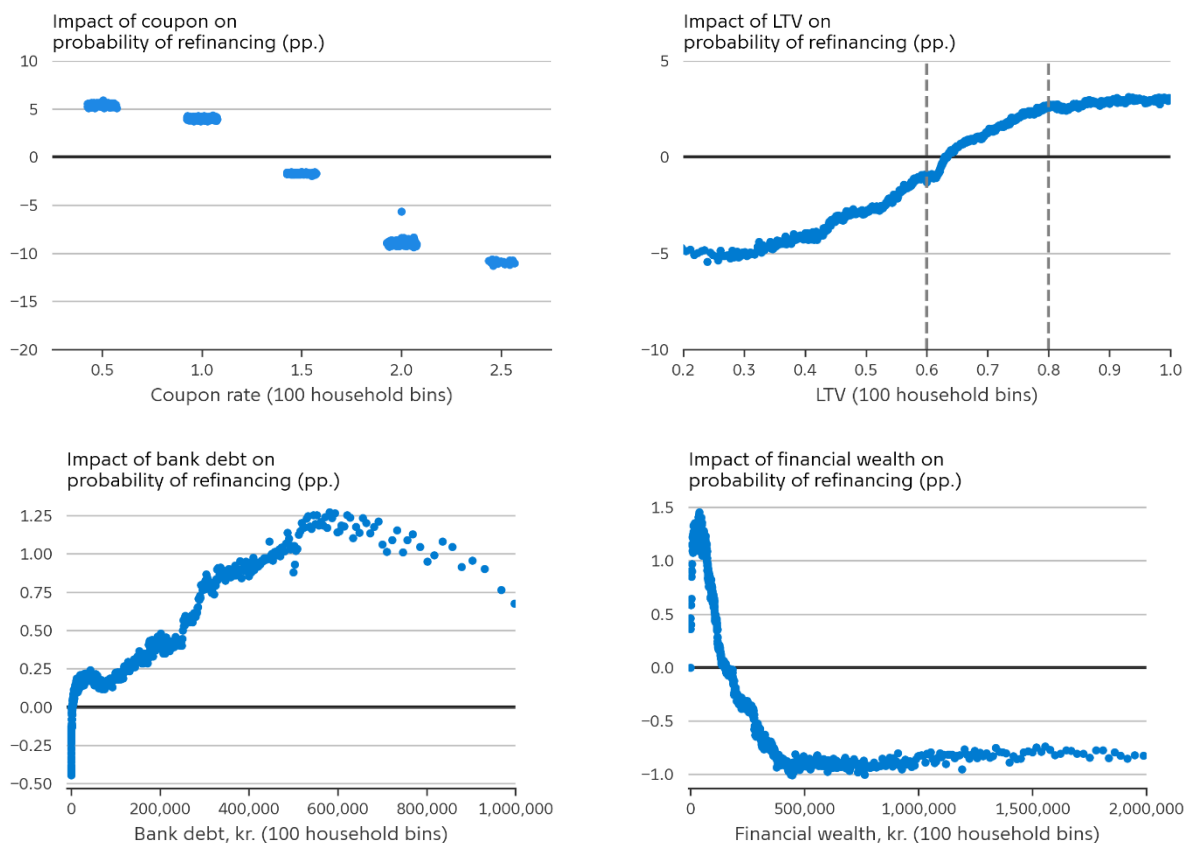
Chart A



Note: Refinancing population sizes across sample restrictions.  
Source: Nationalbanken.

### The impact of LTV and coupon rate on the estimated probability of refinancing.

Chart A



Note: The figure shows the marginal impact on the probability of refinancing relative to the mean refinancing rate of 17 percent for different values of coupon rate prior to refinancing (top left), LTV (top left), bank debt (bottom left) and financial wealth (bottom right). Each dot represents the mean of 100 households. In the top left graph, the variation along the x-axis within each discrete coupon is jitter added for illustrative purposes.

Source: Danmarks Nationalbank.

### Appendix 2: Who refinances during rising interest rates?

To learn which predetermined household and loan characteristics best explain the decision to refinance during 2022, we collect data on the universe of Danish borrowers with a 30-year fixed-rate mortgage of at least kr. 500,000 at the end of 2021. Our sample consists of 426,000 households, 17 per cent of which refinanced in the 1st to 3rd quarters of 2022.

We then estimate a prediction model that attempts to predict whether or not a household refinanced during this period using a range of characteristics observed in the 4th quarter of 2021.<sup>10</sup> To account for potential interaction effects and non-linearities, we estimate a gradient boosted tree model (XGboost) and use Shapley values<sup>11</sup> to examine the marginal impact of each variable on model predictions. To avoid overfitting, we evaluate the model on 25 per cent test sample that was not used to train the model.

<sup>10</sup> The variables are LTV, mortgage debt, bank debt, DSTI, DTI, household income, municipality, home value, age of the oldest household member, financial wealth, coupon rate, mortgage fee rate, change in home value between 2019 and 2021, interest-only status and indicators for current mortgage bank.

<sup>11</sup> Lundberg, Scott M. et al. 2020. From local explanations to global understanding with explainable AI for trees. *Nature Machine Intelligence*, 2, pp 56–67.

Unobservable household characteristics, such as expectations, play an important role in the refinancing decision. Therefore, our set of explanatory variables are likely insufficient for fully explaining refinancing behaviour. Indeed, while the model performs significantly better than random guessing, the performance is far from perfect. Table A summarizes model predictions on the out-of-training-sample test data. In particular, the model overestimates the number of households that refines. Only 31 per cent of all positive predictions are actually true (*precision*).

Nevertheless, we can draw some conclusions on how mortgage and household characteristics correlate with the decision to refinance. The most important predictors all relate to the size of the wealth gain that can be realized through refinancing. In particular, the coupon rate on the household's current mortgage is found to be the most important predictor. Having a coupon rate of 0.5 or 1 per cent increases the likelihood of refinancing by about 5 percentage points, cf. chart A, top left. Households holding low-coupon mortgages therefore stand to realise the largest net wealth gains by refinancing their fixed-rate mortgage. Another potential mechanism is that households with a low coupon secured this rate by refinancing in the recent past, when interest rates were at record lows. Households that have refinanced in the past could face lower information costs when faced with the decision to refinance again.

Another important predictor is Loan-to-value (LTV) ratios. Here, our model predicts that LTV ratios above 65 per cent are associated with a higher likelihood of refinancing, cf. chart A, top right. This is consistent with a consolidation motive as some household may target an LTV ratio of 60 per cent in order to qualify for adjustable-rate and interest-only mortgages as well as lower fees. In support of a liquidity and portfolio optimising motive, we find that both low financial wealth and high levels of bank debt are associated with a higher likelihood of refinancing, although both matter much less than LTV and coupon rate, cf. chart A, bottom.

Model performance matrix

Table A

	Predicted refinance	Predicted no refinance	
Refinance	14,403	3,850	True positive rate: 79%
No refinance	32,391	56,058	False positive rate: 37%
Precision: 31%		False omission rate: 6%	

Note: The table presents the performance of our prediction model on the test dataset. The numbers capture the number of observations by their actual refinancing status (rows) and their predicted status (columns).

Source: Danmarks Nationalbank.

### Appendix 3: Rationalising refinancing behaviour when mortgage rates increase

The Danish mortgage system allows borrowers to refinance both in case of falling and rising mortgage rates. While mortgage refinancing is easily rationalised when mortgage rates decline<sup>12</sup>, the optimal refinancing decision is more complex when mortgage rates increase.<sup>13</sup> This appendix explains the main factors that may rationalise mortgage refinancing in case of rising mortgage rates through the portfolio optimisation motive.

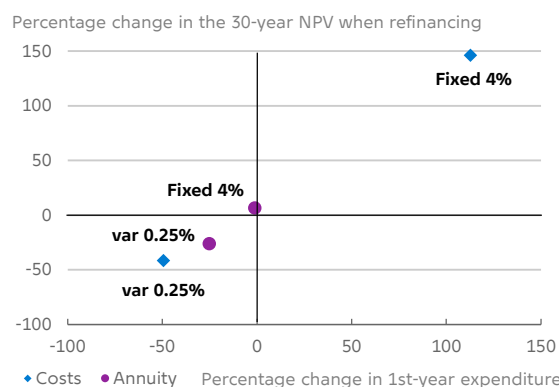
#### Household borrowing costs and liquidity

From an accounting perspective, the refinancing decision is considered profitable insofar that the net present value (NPV) of the after-tax interest payments (incl. administration fee) associated with the new loan are lower than that of the existing mortgage. In addition to the cost of borrowing, the mortgage is typically amortised over a 30-year period. This implies that the cashflow constitutes both interest payments and capital repayments. The latter is not considered to be costs of borrowing but is rather a form of savings vehicle in the sense that the borrower effectively owns an increasing share of the property for each mortgage repayment. Nonetheless, mortgage repayments impact borrowers' budgets directly and may for that reason play an important role for the refinancing decision. In the following, we focus both on the change in the NPV of after-tax borrowing costs as well as the change in the NPV of the total annuity payments (after-tax borrowing costs and repayments).

Consider an existing mortgage borrower with a 30-year kr. 1 million 1% fixed-rate mortgage. As fixed mortgage rates increase to, say, 4% the borrower can buy back the existing mortgage at a reduced price, say kr. 82 for each kr. 100 owed. The buyback is financed by a new mortgage of kr. 820,000 at a 4% 30-year fixed rate.

#### Change in payments when refinancing depends on the type of the new loan

Chart A



Note: In these examples, we consider a situation where a fixed-rate 1% mortgage is refinanced and the entire net wealth gain is used to reduce mortgage debt. Based on bond prices on 23 June 2022 where market prices of bonds were at a local minimum. We assume that the homeowner keeps the new mortgage until maturity (calculation horizon is 30 years). Discounting rate of 2.5 per cent.

Source: Refinitiv Eikon and own calculations.

In this case, the interest payments have risen from 1% on a kr. 1 million loan to 4% on a kr. 820,000 loan. This is an immediate increase of 110 per cent in the 1<sup>st</sup>-year expenditures and over the full lifetime of the loan, the NPV of all cash flows increase by 146 per cent (after tax). This is illustrated by the blue dot in chart A. However, as the size of the mortgage has declined substantially, capital repayments are substantially lower on the new mortgage compared to the old one. In fact, the NPV and 1<sup>st</sup>-year expenditures remain almost unchanged when considering the sum of changes to borrowing costs and capital repayments. This is illustrated by the purple dot in chart A. In absent of interest rate tax deductions, the 1<sup>st</sup>-year payments would increase by 10 percentage-points, rather than decreasing 1 percentage-point as shown in chart A. This illustrates the importance of current tax rules on the refinancing decisions in households.

<sup>12</sup> See for example Andersen, Steffen, John Y. Campbell, Kasper Meisner Nielsen, and Tarun Ramadorai. 2020. Sources of Inaction in Household Finance: Evidence from the Danish Mortgage Market. *American Economic Review*, 110 (10), pp 3184–3230.

<sup>13</sup> See for example Jensen, Bjarne Astrup and Jensen, Michael Møller Jensen and Møller. 2022. Den misforståede gevinst ved opkonvertering.

Moreover, the chart illustrates the impact of refinancing from the fixed rate 1% mortgage to an adjustable-rate mortgage, which entails substantially lower interest payments, say 0.25%. This comes, however, at the expense of an increased exposure to future changes in interest rates.

### The portfolio optimiser motive: Subjective expectations about future rates are key

Refinancing to a higher coupon fixed-rate mortgage implies higher borrowing costs and lower capital repayments as shown in chart A. In isolation, such refinancing activity does not seem profitable. However, such activity may work as a first step of a two-step refinancing strategy with the final aim of returning to a lower fixed-rate coupon again in the near-term future. By doing so, the borrower would return to a lower fixed interest rate as well as obtaining a reduced mortgage size.

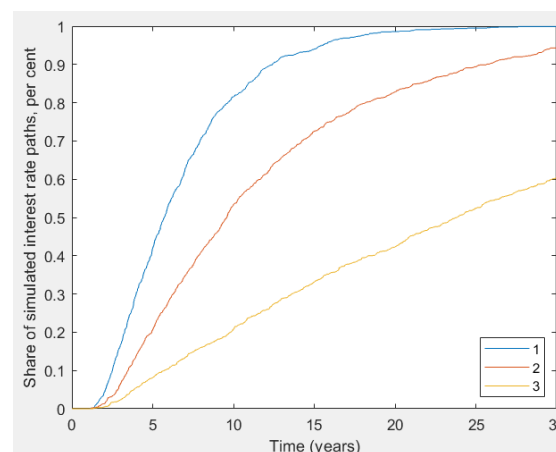
The incentives of homeowners to conduct such a speculative strategy depends crucially on their subjective expectations to the future path of interest rates on the long-term fixed-rate mortgage bonds. According to the Vasicek model<sup>14</sup>, the evolution of interest rates ( $r_t$ ) depends on the long-term (steady state) mean level of the interest rate ( $b$ ), the speed of adjustment to this level ( $a$ ) and the volatility in the interest rate path ( $\sigma$ ), cf. equation below.  $W_t$  denotes a process of shocks to the system.

$$dr_t = a(b - r_t)dt + \sigma W_t$$

The model provides a framework for assessing the probability of returning to a lower rate given certain expectations. The probability is higher if the homeowners expect i) a steady state long-term rate lower than the prevailing market rate, ii) a relatively quick transition and iii) a relatively high volatility in interest rates. Given such expectations, homeowners have stronger incentives, all else being equal, to speculate in an up-down refinancing strategy.

**Model-based probabilities of refinancing back to a 1% mortgage conditional long-term interest rate expectations**

Chart B



Source: Own calculations.

Simulation on the model illustrates the importance of expectations of the long-term rate. Conditional on an initial level of interest rates of 4% (as in June 2022) and expecting a long-term interest level of 1%, homeowners should be able to refinance back down to a 1% mortgage in less than five years with a 40 per cent probability and within 10 years with a 80 per cent probability, cf. chart B.

Though this illustration is simplified, it showcases the incentives and factors at play in such a two-step refinancing strategy.

Chart C shows that the two-step refinancing strategy has breakeven points at 5 and 8 years for fixed-rate mortgages with and without a 10-year interest-only feature, respectively. Specifically, after refinancing to a higher coupon fixed-rate mortgage, refinancing back down to a lower coupon fixed-rate mortgage should take place before 5 or 8 years depending on the mortgage typology. Otherwise, the NPV of total payments (borrowing costs and capital repayments) will increase compared to the situation where the borrower had kept their original mortgage.

<sup>14</sup> Vasicek, Oldrich. 1977. An equilibrium characterization of the term structure. *Journal of Financial Economics*, 5(2), pp 177–188.



### Expected length of homeownership is important

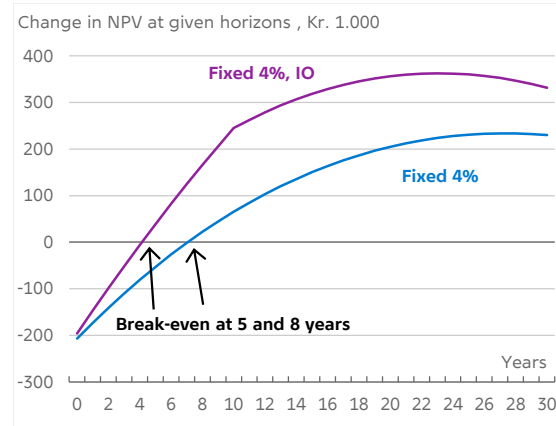
The relevant horizon for evaluating the NPV of refinancing is significantly shorter than 30 years. For Danish homeowners, who sold a home between 2010-2020, the median period of living in the same home was 13 years, cf. chart D. As shown in the chart, a large share of homeowners remain less than 10 years in their homes. This implies that the probability of crossing the breakeven, illustrated in chart C, may be low for many Danish homeowners.

The optimal refinancing decision also depends on the interest rate expectations. For example, if the homeowner expects to move in 5 years and (correctly) expects interest rates to fall to 1% within 1–5 years' time, then it will be optimal to refinance into a higher rate mortgage immediately. The NPV would fall for the relevant horizons.

However, say the homeowner expects the market rate to stay at 4% for at least 5 years, then it would be optimal not to refinance. The homeowner would still get the reduction in mortgage debt when buying back her mortgage when moving while not having to pay higher interest rates (4% vs 1%) over the course of the period between refinancing and selling the property.

### NPVs of opting for a higher-rate loan and prepaying this at different horizons

Chart C

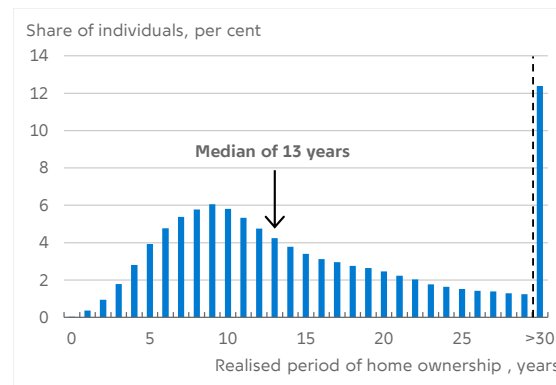


Note: Example with an initial mortgage of kr. 1 million being refinanced, where the entire net wealth gain is spent on a reduction in mortgage debt. The change in NPV is the accumulated change in borrowing costs in each year following the refinancing minus the change in the realised net wealth gain. At break-even the net wealth gain equals the accumulated increase in borrowing costs.

Source: Own calculations.

### Length of home ownership co-determines the relevant horizon for assessing the refinancing decision

Chart D



Note: The sample is comprised by homeowners that sold a house between 2010-2020.

Source: Own calculations based on register data from Statistics Denmark.

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