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Mortgage Choice and Expenditure over the Lifecycle: Evidence from Expiring Interest-Only Loans

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Abstract

We study how homeowners' consumption responds to a negative and anticipated disposable income shock: the beginning of the amortisation period on interest-only mortgages. We identify spending behavior through an event study approach, by matching loan-level data that covers the universe of Danish mortgages to detailed administrative registries on borrowers. In response to an average increase in installments worth 9 percent of income, consumption drops by 3 percent of income, in the year when amortisation begins. The reduction in expenditure is persistent. Borrowers who fail to smooth consumption are highly leveraged, hand-to-mouth consumers, likely to be unable to obtain a new interest-only loan.

Resume

Vi undersøger, hvordan boligejernes forbrug reagerer på et negativt og fuldt ud forventet stød til den disponible indkomst, nemlig udløb af den afdragsfrie periode på deres afdragsfrie realkreditlån. Ved at samkøre lånedata, der dækker alle realkreditlån i Danmark, med administrative registre for alle låntagere kan vi identificere ændringer i husholdningernes forbrug via et eventstudie. Som følge af en gennemsnitlig stigning i afdragene på 9 pct. af den årlige indkomst falder forbruget med 3 pct. af indkomsten i det år, hvor afdragsfriheden slipper op. Denne nedgang i privatforbruget varer i flere år. Låntagere, som ikke kan udjævne deres forbrug, fremstår låne- og likviditetsbegrænsede, og de har sandsynligvis ikke mulighed for at opnå en ny afdragsfri periode.

Key words
Interest-only, Mortgages, Consumption

JEL classification
D15; E21; G51

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December 13, 2019

Abstract

We study how homeowners' consumption responds to a negative and anticipated disposable income shock: the beginning of the amortisation period on interest-only mortgages. We identify spending behavior through an event study approach, by matching loan-level data that covers the universe of Danish mortgages to detailed administrative registries on borrowers. In response to an average increase in installments worth 9 percent of income, consumption drops by 3 percent of income, in the year when amortisation begins. The reduction in expenditure is persistent. Borrowers who fail to smooth consumption are highly leveraged, hand-to-mouth consumers, likely to be unable to obtain a new interest-only loan.

JEL Classification: D15; E21; G51
Keywords: Interest-Only; Mortgages; Consumption; Hand-to-Mouth

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1 Introduction

Non-traditional mortgages, such as interest-only and negative amortisation loans, became very popular in the run-up to the 2007-2008 financial crisis (Dokko et al., 2019). These products were associated with an increased risk of default during the Great Recession, among prime US borrowers (Amromin et al., 2018). As several developed economies are witnessing a new boom in interest-only mortgage originations, there are rising concerns about the degree to which borrowers will be prepared to service these loans, in the medium-run.[1]

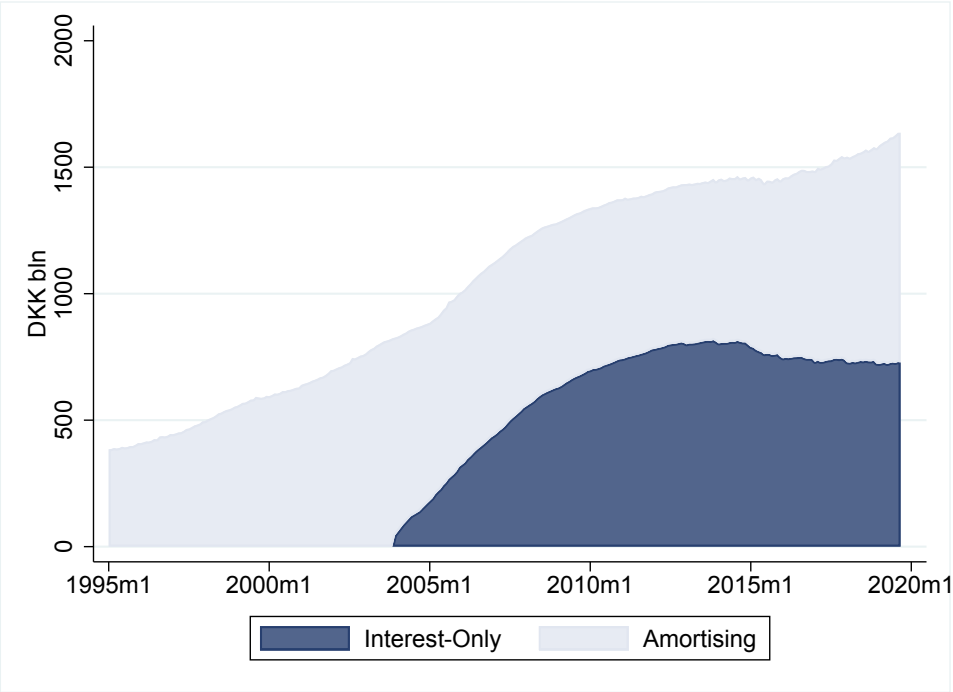
Interest-only loans allow borrowers to defer amortization for a variable period of time, thus initially reducing debt servicing costs. These loans are nevertheless based on the premise that borrowers will eventually begin repaying the principal on their mortgages. When amortization begins and installments rise, consumers are faced with a significant decline in their discretionary income. As this change in mortgage repayments is fully anticipated, a permanent income model predicts that borrowers will smooth consumption over the loan lifecycle, in order to be able to afford the rising installments. One key implication of this theory is that household expenditure should not display a discrete drop, when amortisation starts.

To test this prediction, we combine loan-level data reported by Danish credit institutions with a panel dataset that includes information on income, saving and expenditure patterns of the entire population of Danish mortgagors. Interest-only loans were first introduced to Denmark in October 2003, and quickly became very popular, making up about half of the outstanding mortgage volumes already by the end of 2006 (Figure 1). The widespread use of this loan typology in Denmark, combined with the availability of detailed administrative data on individual borrowers and their expenditure, provides us with the ideal setting to study behavior around the beginning of the amortisation period.

Under Danish law, the interest-only option can be used for a maximum of ten years from the day of origination, while mortgage length remains capped at thirty years. When the tenth year expires, borrowers are thus required to start repaying the full extent of the principal over a period of 20 years, unless a new interest-only loan is requested and granted. Our analysis is based on mortgages originated between 2003 and 2007, which begin amortising between 2013 and 2017. We focus on borrowers who do not refinance into another loan upon expiration, roughly 65% of our sample. Using an event study approach that exploits variation in the mortgage expiration date, we find that around the tenth year of the loan interest-only borrowers are faced with an average increase in installments worth about 9 percent of income. In response, they reduce consumption by 3 percent of income, on average, implying an MPC of 33%. The expenditure cut persists for at least three years after expiration, indicating that

[1] See press coverage for the United States; the United Kingdom; or Australia.

Figure 1: Evolution of oustanding mortgage volumes



Source: Danmarks Nationalbank, based on reporting from credit institutions.

these borrowers do not fully internalize the consumption smoothing mechanism implied in their loans. The remaining adjustment comes through a reduction on liquid savings or an increase in non-mortgage debt. Detailed information on individuals and their families allows us to rule out that this response may be driven by potential confounders, such as changes in income, house prices, family composition or lifecycle dynamics. Individual fixed-effects allow us to control for time-invariant characteristics of borrowers, such as their degree of financial literacy.

Traditionally, excess sensitivity to predictable income changes has been explained on the basis of two models of consumer behavior: rational agents bound by liquidity constraints, or behavioral models featuring some form of present bias (Jappelli and Pistaferri, 2010; Fuchs-Schuendeln and Hassan, 2015; Baugh et al., 2018). In our case, the drop in consumption at the end of the amortisation period is driven entirely by borrowers with high loan-to-value ratios. Consumers with lower leverage who begin amortising do not display any significant change in their expenditure patterns. This evidence suggests that unanticipated borrowing constraints may be playing a major role in these results. After the Great Recession, Danish banks were put under stricter supervision with respect to their loan portfolio with deferred amortisation, in an attempt to limit the share of high-leverage lending and to improve debt

servicing ratios for new borrowers. This change in guidelines is likely to have affected the consumers whose loans came to term between 2013 and 2017, especially those who had high leverage at origination. Possibly, some borrowers expected to be able to obtain another loan with deferred amortization after ten years, but were denied the extension by their banks. Borrowers who hold simultaneously high leverage and low levels of liquid savings at the time of expiration respond by cutting spending by 5 percent of income, on average, implying an MPC of 55%.

This evidence points to a rational model with borrowing constraints as the main explanation for the drop in consumption that follows the expiration of IO loans. However, it also indicates an important behavioral mechanism underpinning the functioning of interest-only lending. A large subset of borrowers (roughly 25 percent in our sample) appear to treat the non-amortising option as a permanent state. They maintain high expenditure levels throughout the loan lifespan and if denied the option to refinance into another IO mortgage, they must adjust to the new regime through a significant drop in spending, to avoid selling their property.[2] This suggests that a large fraction of mortgage borrowers do not fully internalize the consumption-smoothing mechanism implied in IO mortgages. These consumers are very vulnerable to reductions in their refinancing capacity, as those stemming from changes in regulation, or a significant decline in house prices.

Our contribution to the literature is twofold. First, while many studies document the consumption response to expected positive income changes, episodes of predictable negative income changes are rare.[3] These cases are, however, interesting because, as discussed in Ganong and Noel (2019), the excess response cannot be easily explained by borrowing constraints: individuals only need access to a current account to be able to save. Consistently with a rational model with liquidity constraints, Baugh et al. (2018) find that anticipated tax refunds lead to an increase in expenditure, while planned tax payments do not affect spending patterns. Other studies document instead a significant consumption drop in response to predictable and large declines in income, such as the expiration of unemployment benefits (Ganong and Noel, 2019) or retirement (Olafsson and Pagel, 2018). With respect to these studies, we contribute by showing that the excess sensitivity of consumption affects a relatively large cross-section of the population, spanning the income and age distribution. More importantly, the richness of our data also allows us to study the mechanism driving this

[2]Full-recourse legislation makes mortgage defaults very rare, in Denmark (Leth-Petersen et al., 2019). The mechanism we identify may however also imply an increase in default rates, within institutional contexts where this is a less costly option. See, for example, (Amromin et al., 2018).

[3]The consumption response to expected positive changes in income is documented in Parker (1999); Browning and Collado (2001); Hsieh (2003); Coulibaly and Li (2006); Stephens (2008); Scholnick (2013); Parker (2017) and Di Maggio et al. (2017), among others.

drop in expenditure. Our results indicate that unanticipated borrowing constraints, binding at expiration, are likely to be the main driver of the consumption response observed at the beginning of loan amortisation.

Second, this paper hints at one yet unexplored mechanism through which the outstanding mortgage stock can produce business cycle fluctuations many years down the line. The changing share of interest-only lending may affect future consumption growth, depending on the refinancing possibilities borrowers are faced with once their loans begin amortising. Our results thus provide empirical evidence in support to the recent literature that regards mortgages as a source of rigidity in the transmission of macroeconomic policy to the real economy (Wong, 2019; Berger et al., 2018; Eichenbaum and Wong, 2018).

The following section describes our data sources and empirical strategy. Section 3 presents the results. Section 4 concludes.

2 Data and descriptive statistics

Our analysis is based on the Danish administrative registries, covering the entire population of individuals who are tax-liable in Denmark in any given year. This data is based on third-party reporting and is maintained and administered through Statistics Denmark.

2.1 Mortgage-level data

Our analysis is based on the mortgage registry. This loan-level dataset covers the universe of mortgages held by Danish households and was made available for the first time in 2009. It contains information on the universe of mortgages outstanding at that date, as well as on all new mortgages originated after 2009. It is based on the information reported directly by mortgage institutions to Danmarks Nationalbank on an annual frequency. For each loan, we observe outstanding amount, original amount, date of origination, interest rate, maturity. We can also identify loan typology. In Denmark, not unlike in the US, borrowers can choose between fixed and adjustable rate mortgages and different maturities, up to a legal maximum of 30 years.[4]

Furthermore, since October 2003, loans can have a traditional amortisation schedule or instead be issued with an interest-only option. The interest-only (IO) option, which is available on both fixed and adjustable rate mortgages, allows borrowers to defer payment on their principal for a period up to ten years.

[4]The Danish mortgage system has one peculiarity in that FRM mortgages are funded by callable bonds, which can be prepaid at face value without penalty. This makes refinancing particularly beneficial for households when interest rates are changing.

Using this registry, we identify each IO mortgage outstanding at the beginning of each year between 2013 and 2017 that reaches the end of the amortisation period in the same year, having been originated between 2003 and 2007. For each of these loans, we observe inception date, thus being able to pin down when the loan was originated and when it will come to term.

2.2 Borrowers and expenditure imputation

The mortgage registry also includes a unique identifier of the borrower, which allows us to merge it with other registries. In particular, we link loan-level data to a variety of demographics for borrowers and their households, including income, family composition, location of residence and detailed balance sheets characteristics. As expenditure choices are joint household decisions, we focus on households as the unit of observation. We define a household as having an IO loan in any given year if any of its adult members can be linked to an outstanding mortgage with an expiring IO option between 2013 and 2017.

Households are defined as two adults who are either married, in a civil partnership or simply cohabiting, as long as they are of opposite sex and less than 15 years of age difference, or if they share custody of a minor. Household income and balance sheet characteristics are the basis for computing annual household expenditure. This consumption measure is imputed as the difference between total annual household income net of taxes, minus changes in net assets. Change in assets are defined as the sum of changes in pension savings, stock and bonds holdings (at current market value) as well as deposits in banks. Passive housing appreciation/depreciation, which does not stem from the purchase or sale of housing units, is excluded from the imputation of consumption. We then subtract changes in liabilities, defined as the sum of changes in outstanding mortgage balances and other loans from one year to the next. This procedure follows previous work using imputed consumption from Danish administrative data, including (Browning and Leth-Petersen, 2003; Leth-Petersen, 2010; Jensen and Johannesen, 2017). Following these procedures, we also exclude self-employed people and people who buy or sell a house from our estimation sample, as the consumption imputation for these categories of consumers is unreliable.

2.3 Sample selection and descriptive statistics

We focus on the outstanding stock of mortgages originated between 2003 and 2007, which begins amortising between 2013 and 2017.

This sample is composed of IO loans that survive for at least nine years from origination, without being refinanced before. Mortgages in Denmark can be refinanced easily, often at a

relatively low upfront cost to the borrower (Andersen et al., 2015). Our sample of "keepers", borrowers who never refinance over the course of ten years, may therefore be negatively selected according to some characteristics: financial literacy, age, income, or leverage.

Since our mortgage data only starts in 2009 and ends in 2017, we are unable to compare people who keep their loan for ten years to their counterparts who took up a similar loan in the same year but refinance before 2009. When loans are refinanced they change identifier, thus ceasing to exist, for the purpose of our dataset.

However, we can address this potential self-selection issue using the new originations we observe in the mortgage registry. We could then compare two groups of borrowers: those who take up a new IO mortgage in 2009 and keep it for at least nine years, until 2018 (the latest available wave of the mortgage registry) with those who take an IO loan in 2009 and refinance before the ninth year of their loan. The differences between the two groups may not be identical to the difference between keepers and refinancers whose loans were originated before 2009. Nevertheless, this comparison should provide an indication on how these groups fare with respect to each other, at origination.

Reassuringly, IO borrowers who originate their loan in 2009 and keep it until 2018 are very similar to borrowers who originate in the same year but refinance earlier (Table 1). Age, income and liquidity profiles, and loan-to-value ratios at inception are virtually identical.

Table 1: Characteristics of borrowers who take up an IO mortgage in 2009

	(1)	(2)	(3)	(4)
VARIABLES	Age	Income	Liquid Assets	LTV
Borrowers who refinance before year 10				
Mean	48	380,000	203,000	78
SD	14	145,000	312,000	22
Count	67,053	67,053	67,053	67,053
Borrowers with full-length IO				
Mean	50	380,000	196,000	76
SD	13	143,000	300,000	21
Count	8,008	8,008	8,008	8,008

Notes: Descriptive statistics on the population of mortgage borrowers with interest-only loans originated in 2009. The variables measure the characteristics of the household at origination,in nominal terms, respectively: age of the household head (years); annual disposable income after taxes (l DKK); sum of bank deposits, stock and bond holdings at the end of the year (DKK); loan-to-value ratio as assessed by the mortgage institution (percent). Source: Statistics Denmark.

A second consideration is choice at expiration. Borrowers whose loans are coming to term may decide to refinance into a new mortgage instead of starting to repay their loan as scheduled. However, the majority of IO loans are not refinanced into a new loan when amortization starts. About 60 percent of borrowers start repaying their amortization as scheduled and only 20 percent roll over their loan into a new IO one (Table 2). The rest refinances into a new loan with amortization.

Table 2 shows that borrowers who choose to keep their loan, instead of refinancing into another IO loan, have income and consumption ratios comparable to those of people who refinance into other IO loans. However, IO refinancers are significantly less leveraged on their properties. They are also significantly older and hold a higher ratio of liquid savings to income. If failure to refinance despite incentives may in general be explained by a certain degree of inertia (Agarwal et al., 2016; Andersen et al., 2015; Keys et al., 2016), these descriptives indicate that borrowing constraints may also play a significant role, in our case.

Our analysis focuses predominantly on borrowers who begin amortizing their mortgage, thus keeping the original loan intact. We exploit the variation in LTVs in this group to understand to what extent the inability to roll over the old IO loan into a new one can explain their behavior at expiration.

Table 2: Characteristics at expiration: refinancers vs keepers

VARIABLES	(1) Age	(2) Income	(3) Savings/Income	(4) LTV	(5) Consumption
Begin amortizing old loan					
Mean	56	450,000	7.7	78	344,000
SD	14	264,000	18	29	266,000
Count	8,813	8,813	8,813	8,813	8,813
Refinance into new IO					
Mean	64	412,000	14	61	361,000
SD	13	229,000	19	23	361,000
Count	1,758	1,758	1,758	1,758	1,758
Refinance into non IO					
Mean	55	479,000	7.8	83	410,000
SD	13	239,000	26	25	363,000
Count	2,160	2,160	2,160	2,160	2,160

Notes: Descriptive statistics on the population of mortgage borrowers with interest-only loans expiring between 2013 and 2017. The variables are expressed in nominal terms and measure the characteristics of households in the year before the loan expires. They are, respectively: age of the household head (years); annual disposable income after taxes (DKK); sum of bank deposits, stock and bond holdings at the end of the year divided by monthly income; loan-to-value ratio as assessed by the mortgage institution (percent); annual household expenditure (DKK). Source: Statistics Denmark.

3 Results

3.1 Baseline: behavior at expiration

Our identification strategy exploits variation in the timing of expiration of the interest-only period on IO loans. For these households, we estimate the following event study equation:

$$\frac{Y_{i,t}}{Income_{i,t-1}} = \alpha + \sum_{k=-4}^{3} \beta_k Exp_{it}^k + \gamma_i X_{i,t-2} + \theta_t + \lambda_i + \varepsilon_{i,t} \quad (1)$$

Where $Y_{i,t}$ is the outcome of interest, scaled by lagged household income, for household i observed at year t. The outcomes we are interested in are mortgage repayments, consumption as well as changes in liquid assets and mortgage debt. Exp_{it} is an event time indicator. The variable measures the years relative to the year of expiration of the non-amortization period, such that the 10th and last year of the interest-only period is marked by 0. One year after

expiration is marked by 1, two years after expiration is marked by 2 and so forth. Years prior to the expiration are marked in a similar fashion by negative values. So Exp_{it}^{k} is a dummy indicating if the individual had an IO loan expiring k periods ago. Year fixed effects, θ_t, and individual fixed effects, λ_i, capture aggregate shocks and individual time-invariant characteristics of the household, respectively. The vector $X_{i,t-2}$ controls for individual-level covariates: dummies for age of the household head, number of children and adults in the household; as well as annual gross income, mortgage amount, whether the mortgage is FRM or ARM, house value and other wealth holdings; fixed effects for the municipality of residence.

Our main focus is on households who choose not to roll over their IO loans at expiration, the largest subset of our sample. We compare their behavior across differential timing for treatment onset. The identifying assumption is that, conditional on individual-level covariates, household and time fixed effects, treatment timing is otherwise exogenous to household-level changes in saving and consumption. In other words, household behavior would have been unchanged around the tenth year of the loan, in absence of its expiration.

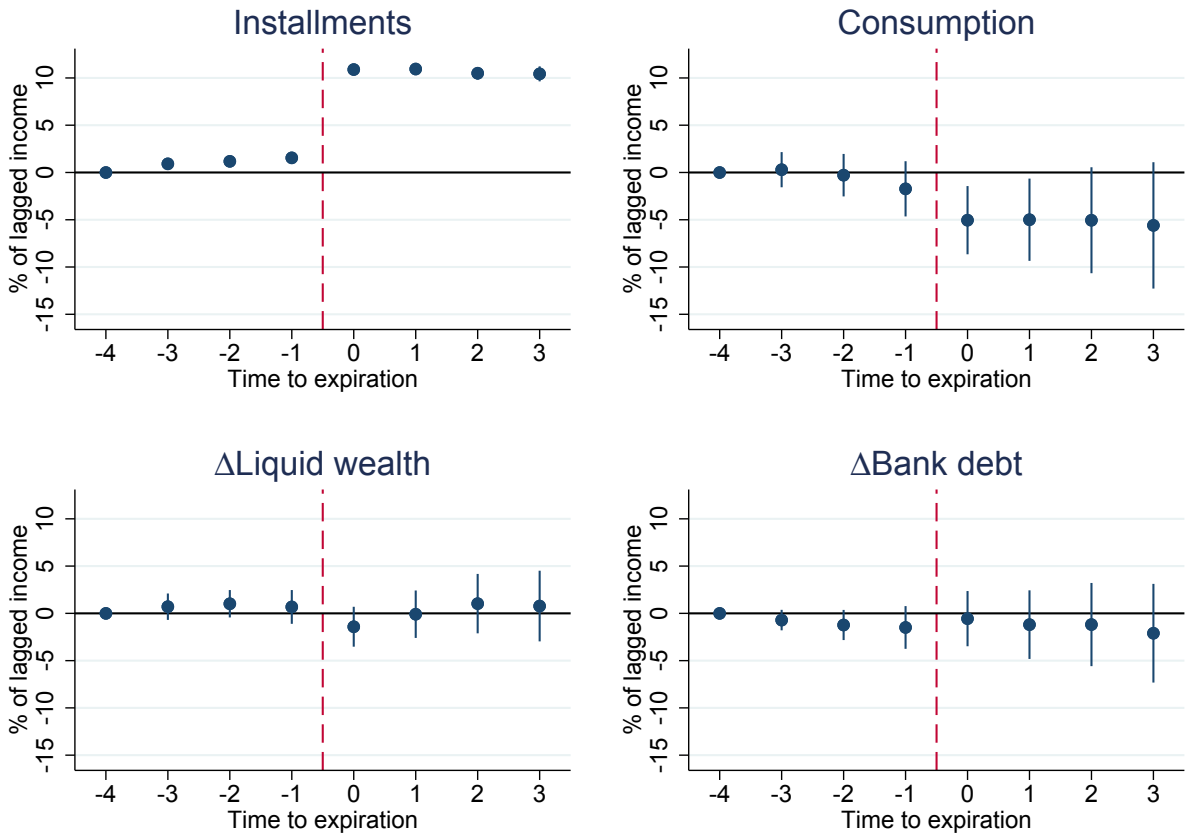
Plotting the cofficients associated with each year prior to the event suggests that this assumption is not violated (Figure 2). Installments increase drastically during the year of expiration and expenditure drops, without recovering during the subsequent three years.[5] Despite some small expenditure adjustments in the year prior to expiration, pre-trends are not significantly different from zero. Liquid savings and non-mortgage debt holdings do not display statistically significant responses around expiration, on average.[6]

Table 3 displays the average effect of beginning of amortization, reducing β_k to only one coefficient which measures the average difference before and after the expiration of the IO period. Mortgage installments increase by 9 percent of income (column 1). As a result, consumption is reduced by 3 percent of income, on average (column 2) while the remainder of the adjustment flows through a withdrawal of liquid savings (column 3) and an increase in non-mortgage debt (column 4), worth 2.6 and 1.5 percent, respectively. These results do not appear to be driven by extreme income or house price shocks affecting homeowners at expiration. Excluding people who have experienced a decline in income between loan origination and the beginning of the amortisation period does not change size or significance of the results (Table A2). The results are also robust to controlling for the role of regional time-varying shocks (Table A3) and do not reflect the role of housing depreciation over the loan lifespan (Table A4).

[5]The estimation becomes noisier over time because the sample size is progressively reduced. At three years post-expiry we rely exclusively on loans expiring in 2014, since our dataset stops in 2017.

[6]To simplify intepretation, we exclude households who roll over or choose other mortgages. Our results are nevertheless robust to the inclusion of the entire sample. In fact, Table A1 suggest that our baseline estimates, which only exploit variation in treatment timing across the "treated" population, are conservative.

Figure 2: Testing parallel trends: years relative to end of amortization period



Notes: The graphs plot the coefficients β_k associated with each year before and after the expiration date. Outcome variables are, clockwise: mortgage installments, imputed consumption, changes in non-mortgage debt and changes in liquid asset holdings. Outcomes are scaled by lagged household income. Controls are measured at year t-2 and include dummies for age, number of adults and children in the family; levels of household income, liquid and illiquid assets as well as mortgage and non-mortgage debt and dummies for FRM or ARM. Household, year and municipality fixed-effects are included. Robust standard errors (plotted) are clustered at the household level. *Source:* Statistics Denmark.

Table 3: Beginning of amortization period: average effect

VARIABLES	(1) Installments	(2) Expenditure	(3) Liquid Assets	(4) Bank Debt
Expired	0.090***	-0.031***	-0.026***	0.015***
	(0.001)	(0.008)	(0.005)	(0.004)
Observations	46,025	46,025	46,025	46,025
R-squared	0.719	0.252	0.195	0.199
HH FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
HH Controls	Yes	Yes	Yes	Yes

Notes: Expired is a dummy taking value in expiration year and all subsequent years, 0 otherwise. Outcome variables are, respectively: mortgage installments (col.1), imputed consumption (col. 2), changes in liquid asset holdings (col. 3), changes in non-mortgage debt (col. 4). Outcomes are scaled by lagged household income. Controls are measured at year t-2 and include dummies for age, number of adults and children in the family; levels of household income, liquid and illiquid assets as well as mortgage and non-mortgage debt and dummies for FRM or ARM. Household, year and municipality fixed-effects are included. Robust standard errors (in parentheses) are clustered at the household level. *** p<0.01, ** p<0.05, * p<0.1. *Source:* Statistics Denmark.

To obtain the elasticity of response of consumption to mortgage installments, we use the expiration of the interest-only period as an instrument for the increase in mortgage repayments. Table 4 shows that the MPC of the average borrower out the the increase in installments is 33% (column 3). In other words, for an average increase in mortgage installments worth 9 percent (column 2), the average borrower cuts consumption by 3 percent when amortization begins. This estimate is virtually identical to the reduced-form equation presented in Table 3. Based on average annual income for this sample, the expenditure cut corresponds to roughly DKK 14,000 (or USD 2000), per household, per year.

Table 4: Magnitude of expenditure response: 2SLS

VARIABLES	(1) Expenditure OLS	(2) Installments First Stage	(3) Expenditure 2SLS
Installments	-0.434***		-0.338***
	(0.069)		(0.076)
Expired		0.090***	
		(0.001)	
Observations	46,025	46,025	46,025
R-squared	0.254	0.719	0.039
Year FE	Yes	Yes	Yes
HH FE	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes
HH Controls	Yes	Yes	Yes
F Stat			925

Notes:This table shows the marginal effect of a percentage increase in mortgage installments on consumption, using loan expiration as an instrument for the within-household change in mortgage payments. Expired is a dummy taking value in expiration year and all subsequent years, 0 otherwise. Outcome variables are, respectively: imputed consumption (cols 1 and 3), mortgage installments (col 2). Controls are measured at year t-2 and include dummies for age, number of adults and children in the family; levels of household income, liquid and illiquid assets as well as mortgage and non-mortgage debt and dummies for FRM or ARM. Household, year and municipality fixed-effects are included. Robust standard errors (in parentheses) are clustered at the household level. *** p<0.01, ** p<0.05, * p<0.1. *Source:* Statistics Denmark.

3.2 Channels: explaining the drop in expenditure

The increase in mortgage installments around the tenth year of the loan is fully anticipated. Explaining these results within a rational framework requires borrowers to be faced with some unexpected shock around expiration. One possibility is that they believed they would be able to roll over their interest-only mortgages, avoiding amortisation for ten further years, but were unexpectedly denied the extension by their banks.

This is not implausible. After the crisis, lenders were placed under stricter rules with respect to their interest-only portfolio for private residential properties. Starting with 2013, borrowers were required to be able to service a fully-amortising 30 year mortgage at origination, which effectively capped refinancing possibilities for people with high debt servicing ratios. Furthermore, in 2014 the authorities ruled that the share of deferred amortization loans should not exceed half of the lending volume in the high LTV segment.[7] These rules,

[7]Specifically, 55 per cent of the lending volume in the LTV band above 75 per cent of the LTV limit. See recomendations by the Risk Council.

combined with a correction in property prices occurring between 2008 and 2011, effectively implied that for many borrowers it was difficult to avoid the beginning of the amortisation period.

In Table 5, we categorise IO borrowers who begin amortization in three groups, based on the distribution of their LTVs the year before their loan comes to term. Loan-to-value ratios are determined by the mortgage institutions as the total oustanding loan amount divided by the lenders' assessment of the property value at the time. The bottom quintile of the LTV distribution consists of borrowers with leverage ratios below 55 while the median is set at 75.[8] While all groups experience a significant increase in mortgage installments at expiration (column 1), the only group responding with a reduction in expenditure are borrowers with LTVs above the median, set at 75 percent (column 2). A part of the adjustment for this highly-leveraged group also flows through securing non-collateralised debt, which generally carries higher costs (column 4). Choosing a different leverage threshold, such as the LTV ratio of 80 imposed by mortgage credit institutions, delivers qualitatively similar results.[9]

About half of the group of highly-leveraged borrowers holds less than two months of disposable income in easily-accessible assets, such as bank deposits, stocks or bonds.[10] Table 6 shows that this group of liquidity-constrained borrowers drives the expenditure adjustment, cutting it on average by five percent of income (column 2). Highly-leveraged consumers who hold higher levels of savings adjust to the increase in installments by drawing from their liquid wealth, instead (column 3). This result is unchanged if we pick a different definition of liquidity constraints, based on the level of liquid savings to income relative to a reference group of peers, defined as people of the same age and income (Table A6).

Low-liquidity consumers constitute about 50 percent of the borrowers with LTVs above 75, or 25 percent of the overall sample. Our results suggest that this group of highly-leveraged, hand-to-mouth consumers treats interest-only borrowing as a revolving option. If denied the option to refinance into another IO loan, they may be forced to cut expenditure.

[8] See left-hand panel of Figure A1.

[9] Table A5 shows that the consumption response is significant below this maximum threshold, possibly suggesting that banks try to be conservative in their lending standards, as their estimation of property values is often only an approximation.

[10] See right-hand panel of Figure A1.

Table 5: Differential effect for borrowing-constrained individuals: LTVs

VARIABLES	(1) Installments	(2) Expenditure	(3) Liquid Assets	(4) Bank Debt
Expired: LTV<1st quintile	0.060***	-0.010	-0.018**	-0.000
	(0.001)	(0.012)	(0.009)	(0.005)
Expired: 1st quintile<LTV<Median	0.027***	-0.011	-0.014	0.013**
	(0.002)	(0.013)	(0.009)	(0.006)
Expired: LTV>Median	0.044***	-0.035***	-0.009	0.022***
	(0.002)	(0.012)	(0.008)	(0.006)
Observations	46,025	46,025	46,025	46,025
R-squared	0.731	0.253	0.195	0.200
HH FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
HH Controls	Yes	Yes	Yes	Yes

Notes: This table shows how the effect differs for borrowers above and below the regulatory leverage limits required to refinance into a new IO loan. Expired is a dummy taking value in expiration year and all subsequent years, 0 otherwise. The LTV bins are dummies, indicating if a household falls in the range in the year before expiration. LTVs are defined as the outstanding mortgage debt to house value (maximum across all mortgages held by the household if it holds more than one). Outcome variables are, respectively: mortgage installments (col.1), imputed consumption (col. 2), changes in liquid asset holdings (col. 3), changes in non-mortgage debt (col. 4). Outcomes are scaled by lagged household income. Controls are measured at year t-2 and include dummies for age, number of adults and children in the family; levels of household income, liquid and illiquid assets as well as mortgage and non-mortgage debt and dummies for FRM or ARM. Household, year and municipality fixed-effects are included. Robust standard errors (in parentheses) are clustered at the household level. *** p<0.01, ** p<0.05, * p<0.1. *Source:* Statistics Denmark.

Table 6: High-leverage group: differential effect over liquidity constraints

VARIABLES	(1) Installments	(2) Expenditure	(3) Liquid Assets	(4) Bank Debt
Expired	0.099***	-0.018	-0.067***	0.024***
	(0.002)	(0.014)	(0.010)	(0.007)
Expired x Low savings	-0.002	-0.049***	0.068***	-0.011*
	(0.002)	(0.013)	(0.008)	(0.007)
Observations	25,237	25,237	25,237	25,237
R-squared	0.737	0.238	0.172	0.199
HH FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
HH Controls	Yes	Yes	Yes	Yes

Notes: This table shows how the effect differs for borrowers who are borrowing constrained (LTVs higher than 75) across the distribution of liquid savings to income. Expired is a dummy taking value 1 in expiration year and all subsequent years, 0 otherwise. Low savings is a dummy taking value 1 if the household has liquid savings (defined as the sum of bank deposits, stock and bond holdings) below two months of net annual income, in the year prior to expiration. Outcome variables are, respectively: mortgage installments (col.1), imputed consumption (col. 2), changes in liquid asset holdings (col. 3), changes in non-mortgage debt (col. 4). Outcomes are scaled by lagged household income. Controls are measured at year t-2 and include dummies for age, number of adults and children in the family; levels of household income,liquid and illiquid assets as well as mortgage and non-mortgage debt and dummies for FRM or ARM. Household, year and municipality fixed-effects are included. Robust standard errors (in parentheses) are clustered at the household level. *** p<0.01, ** p<0.05, * p<0.1. *Source:* Statistics Denmark.

4 Conclusions

Interest-only lending took hold as one of the most popular housing finance products in the last decade. This option presents several advantages, among which the possibility for poorer and liquidity-constrained households to climb an otherwise often inaccessible housing ladder. Such loans are, however, granted on the assumption that households will smooth consumption and, eventually, begin amortising on their properties.

In this paper we present first-hand evidence of household consumption behavior around the expiration of interest-only loans. We show that, despite the anticipated nature of this income shock, household consumption drops by an average of 3 percent of income when amortization starts, and does not recover thereafter. This partial failure of consumption smoothing is driven by highly-leveraged, hand-to-mouth consumers, who are likely to be denied the possibility to roll over their loans. Faced with an increase in mortgage installments worth on average 9 percent of their income, they are forced to revise expenditure, as their only other option would be to sell the property.

These results have implications for macro-prudential regulation, suggesting that a large fraction of IO borrowers treat the interest-only option as a permanent state. Acting as if the current repayment path was the permanent one, these consumers are vulnerable to exogenous fluctuations in their capability to refinance: these may take place in the form of changes in regulation, or of negative house price shocks.

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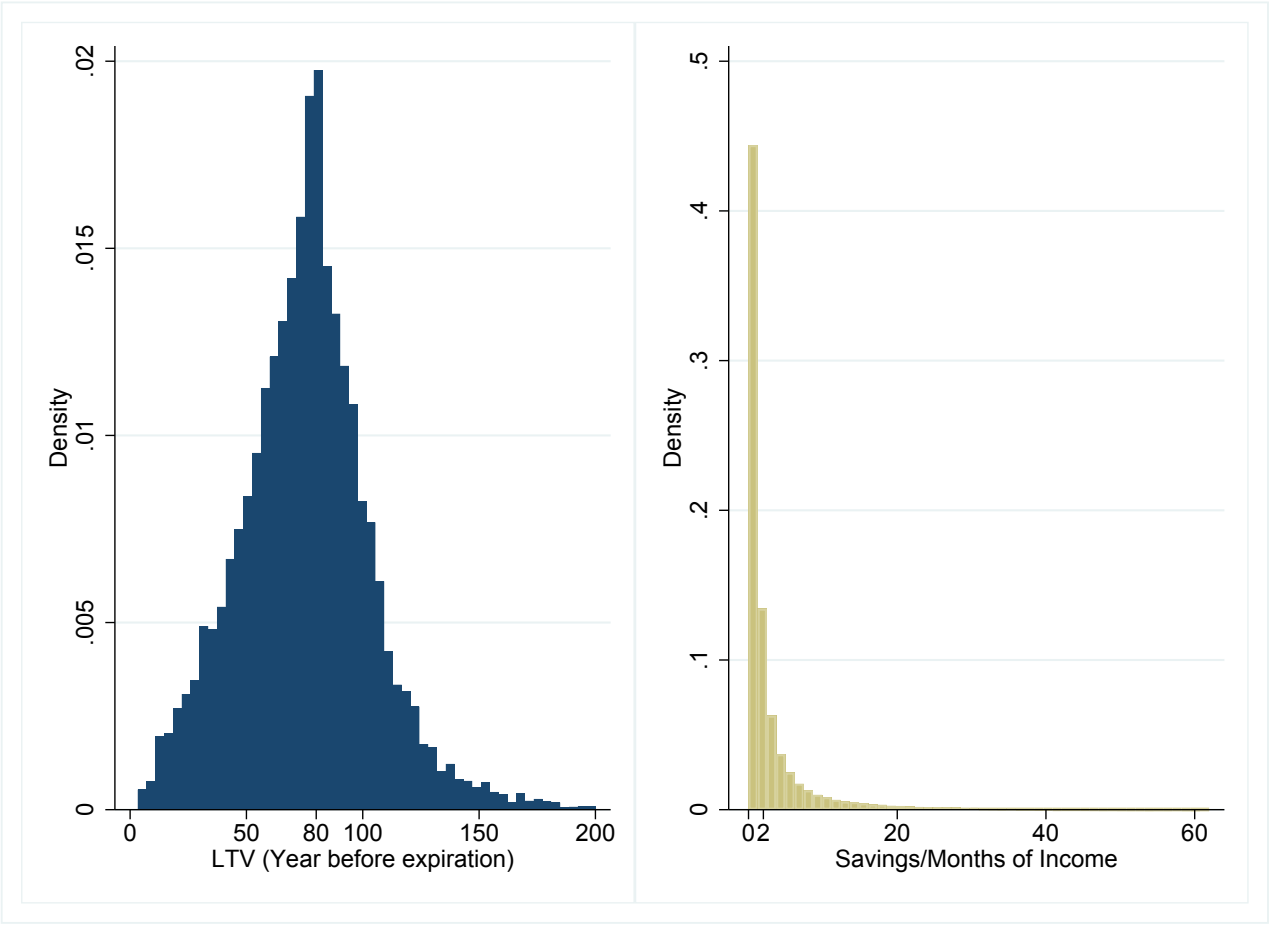
Appendix

Figure A1: Distribution of LTVs and LTIs one year prior to expiration



Notes: The left-hand panel display the distribution of loan-to-value ratios during the ninth year of the loan. The right-hand panel displays the distribution of savings-to-income during the same year for borrowers with LTVs above 75. Source: Statistics Denmark, register REAL, 2013-2017, borrowers with IO loans originated between 2003 and 2007 who keep it for 10 years.

Table A1: Choice at expiration and spending

VARIABLES	(1) Installments VS IO	(2) Expenditure VS IO	(3) Installments VS Non IO	(4) Expenditure VS Non IO
Keep: -3	0.001	-0.013	-0.002	-0.012
	(0.001)	(0.025)	(0.001)	(0.020)
Keep: -2	0.003***	-0.044*	-0.000	-0.038**
	(0.001)	(0.026)	(0.001)	(0.019)
Keep: -1	0.004***	-0.060**	-0.001	-0.016
	(0.001)	(0.027)	(0.001)	(0.019)
Keep: Expire	0.100***	-0.324***	0.038***	-0.170***
	(0.001)	(0.034)	(0.002)	(0.023)
Keep: +1	0.100***	-0.063**	0.020***	-0.051**
	(0.002)	(0.030)	(0.002)	(0.023)
Keep: +2	0.093***	-0.102**	0.021***	-0.042
	(0.002)	(0.044)	(0.002)	(0.028)
Keep: +3	0.091***	-0.180***	0.029***	-0.120**
	(0.004)	(0.060)	(0.004)	(0.055)
Observations	50,755	50,755	52,390	52,390
R-squared	0.727	0.251	0.721	0.249
HH FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
HH Controls	Yes	Yes	Yes	Yes

This table displays the coefficients associated with the interaction between time to expiration and an indicator, keep, which takes value 1 if the borrower does not refinance the loan at expiration, 0 otherwise. Cols. 1 and 2 compare keepers with borrowers who refinance into a new IO loan at expiration, cols. 3 and 4 with borrowers who refinance into an amortizing loan. Outcome variables are, respectively: mortgage installments (cols.1 and 3), imputed consumption (cols. 2 and 4). Controls are measured at year t-2 and include dummies for age, number of adults and children in the family; levels of household income, liquid and illiquid assets as well as mortgage and non-mortgage debt and dummies for FRM or ARM. Household, year and municipality fixed-effects are included. Robust standard errors (in parentheses) are clustered at the household level. *** p<0.01, ** p<0.05, * p<0.1. *Source:* Statistics Denmark.

Table A2: Effects at expiration: excluding extreme income dynamics

VARIABLES	(1) Installments	(2) Expenditure	(3) Liquid Assets	(4) Bank Debt
Expired	0.088***	-0.057***	-0.024***	0.012**
	(0.001)	(0.010)	(0.006)	(0.005)
Constant	-0.129***	1.010***	0.011	-0.151
	(0.038)	(0.338)	(0.111)	(0.297)
Observations	29,863	29,863	29,863	29,863
R-squared	0.729	0.264	0.202	0.202
HH FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
HH Controls	Yes	Yes	Yes	Yes

Notes: This table tests the effects of expiration excluding people who have experienced income growth lower than 30 percent between origination of the loan and expiration. This threshold is chosen as income growth of 30 percent over ten years is the median across all borrowers. Controls are measured at year t-2 and include dummies for age, number of adults and children in the family; levels of household income,liquid and illiquid assets as well as mortgage and non-mortgage debt and dummies for FRM or ARM. Household, year and municipality fixed-effects are included. Robust standard errors (in parentheses) are clustered at the household level. *** p<0.01, ** p<0.05, * p<0.1. *Source:* Statistics Denmark.

Table A3: Effects at expiration: including regional time-varying shocks

VARIABLES	(1) Installments	(2) Expenditure	(3) Liquid Assets	(4) Bank Debt
Expired	0.091***	-0.029***	-0.027***	0.016***
	(0.001)	(0.008)	(0.006)	(0.004)
Observations	46,018	46,018	46,018	46,018
R-squared	0.727	0.264	0.209	0.211
HH FE	Yes	Yes	Yes	Yes
Municipality x year FE	Yes	Yes	Yes	Yes
HH Controls	Yes	Yes	Yes	Yes

Notes: Expired is a dummy taking value in expiration year and all subsequent years, 0 otherwise. Outcome variables are, respectively: mortgage installments (col.1), imputed consumption (col. 2), changes in liquid asset holdings (col. 3), changes in non-mortgage debt (col. 4). Outcomes are scaled by lagged household income. Controls are measured at year t-2 and include dummies for age, number of adults and children in the family; levels of household income,liquid and illiquid assets as well as mortgage and non-mortgage debt and dummies for FRM or ARM. Household abd municipality-by-year fixed-effects are included. Robust standard errors (in parentheses) are clustered at the household level. *** p<0.01, ** p<0.05, * p<0.1. *Source:* Statistics Denmark.

Table A4: Effects at expiration: excluding households with declining house value

VARIABLES	(1) Installments	(2) Expenditure	(3) Liquid Assets	(4) Bank Debt
Expired	0.091***	-0.035***	-0.024***	0.012***
	(0.001)	(0.009)	(0.006)	(0.004)
Observations	37,144	37,144	37,144	37,144
R-squared	0.722	0.258	0.196	0.206
HH FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
HH Controls	Yes	Yes	Yes	Yes

Notes: The sample excludes households that have experienced a decline in the value of their main residence between the mortgage origination and the beginning of the amortisation period. Expired is a dummy taking value in expiration year and all subsequent years, 0 otherwise. Outcome variables are, respectively: mortgage installments (col.1), imputed consumption (col. 2), changes in liquid asset holdings (col. 3), changes in non-mortgage debt (col. 4). Outcomes are scaled by lagged household income. Controls are measured at year t-2 and include dummies for age, number of adults and children in the family; levels of household income,liquid and illiquid assets as well as mortgage and non-mortgage debt and dummies for FRM or ARM. Household and municipality-by-year fixed-effects are included. Robust standard errors (in parentheses) are clustered at the household level. *** p<0.01, ** p<0.05, * p<0.1. *Source:* Statistics Denmark.

Table A5: Alternative definition of LTVs

VARIABLES	(1) Installments	(2) Expenditure	(3) Liquid Assets	(4) Bank Debt
Expired: LTV <80	0.079***	-0.022**	-0.025***	0.008*
	(0.001)	(0.009)	(0.006)	(0.004)
Expired: LTV => 80	0.025***	-0.021**	-0.002	0.014***
Observations	46,025	46,025	46,025	46,025
R-squared	0.725	0.252	0.195	0.200
HH FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
HH Controls	Yes	Yes	Yes	Yes

Notes: This table shows how the effect differs for borrowers above and below the guideline leverage limits required to refinance into a new IO loan. Expired is a dummy taking value 1 in expiration year and all subsequent years, 0 otherwise. LTVs are defined as the outstanding mortgage debt to house value (maximum across all mortgages held by the household if it holds more than one). Outcome variables are, respectively: mortgage installments (col.1), imputed consumption (col. 2), changes in liquid assets holdings (col. 3), changes in non-mortgage debt (col. 4). Outcomes are scaled by lagged household income. Controls are measured at year t-2 and include dummies for age, number of adults and children in the family; levels of household income, liquid and illiquid assets as well as mortgage and non-mortgage debt and dummies for FRM or ARM. Household, year and municipality fixed-effects are included. Robust standard errors (in parentheses) are clustered at the household level. *** p<0.01, ** p<0.05, * p<0.1. *Source:* Statistics Denmark.

Table A6: Differential effect for liquidity constrained individuals: alternative definition

VARIABLES	(1) Installments	(2) Expenditure	(3) Liquid Assets	(4) Bank Debt
Expired	0.099***	-0.014	-0.064***	0.026***
	(0.002)	(0.013)	(0.009)	(0.007)
Expired x Non Saver	-0.002	-0.059***	0.069***	-0.015**
	(0.002)	(0.012)	(0.008)	(0.007)
Observations	25,229	25,229	25,229	25,229
R-squared	0.737	0.238	0.172	0.199
HH FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
HH Controls	Yes	Yes	Yes	Yes

Notes: This table shows how the effect differs for borrowers who are borrowing constrained (LTVs higher than 75) across the distribution of liquid savings to income. Expired is a dummy taking value 1 in expiration year and all subsequent years, 0 otherwise. Non saver is a dummy taking value 1 if in the year prior to expiration the household has liquid savings (defined as the sum of bank deposits, stock and bond holdings) below the median of their peers, defined as people with the same age and income quintile living in the same city and year. Outcome variables are, respectively: mortgage installments (col.1), imputed consumption (col. 2), changes in liquid asset holdings (col. 3), changes in non-mortgage debt (col. 4). Outcomes are scaled by lagged household income. Controls are measured at year t-2 and include dummies for age, number of adults and children in the family; levels of household income,liquid and illiquid assets as well as mortgage and non-mortgage debt and dummies for FRM or ARM. Household, year and municipality fixed-effects are included. Robust standard errors (in parentheses) are clustered at the household level. *** p<0.01, ** p<0.05, * p<0.1. *Source:* Statistics Denmark.

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