How do Interest-only Mortgages Affect Consumption and Saving over the Life Cycle?

Abstract

Using a unique data set with detailed information on Danish households and their mortgages, we show that young and old households are more likely to use IO mortgages compared to middle-aged households. Young households use IO mortgages to postpone repayment to a period with higher income, old households because it allows them to circumvent an otherwise binding liquidity constraint. Through different channels, IO mortgages thus facilitate consumption smoothing for young and old households. We further examine how households with IO mortgages differ from households with repayment mortgages in terms of leverage, debt and asset composition, and pension contributions.

Keywords: Interest-only mortgages; micro data; consumption and savings pattern; life-cycle planning; financial constraints

JEL subject codes: G11

1 Introduction

Interest-only (IO) mortgages and other non-conventional loans were—together with lenders' lax underwriting standards—heavily criticized in the debate following the financial crisis that erupted in 2007.[1] Mortgages with no or even negative amortization were issued on a large scale in 2004–2006 in the US and many other countries. When home prices subsequently plummeted, many homeowners went underwater and default rates spiked with severe macroeconomic ramifications. Due to their importance for financial stability and households' life-cycle planning, a substantial literature on IO mortgages has emerged, examining who use them (Cocco, 2013; Cox, Brounen, and Neuteboom, 2015; Gathergood and Weber, 2017; Amromin, Huang, Sialm, and Zhong, 2018), if and how IO mortgages impact financial stability (Campbell, Clara, and Cocco, 2018), whether IO mortgages lure households into excessive leverage and consumption (Laibson (1997) and references in footnote 1), and whether IO mortgages facilitate rational households' life-cycle planning by offering greater financial flexibility (Cocco, 2013). In spite of progress in our understanding of households' use of IO mortgages, important gaps remain. In particular, it is still not fully clear *which* households use IO mortgages, and *how* the extra liquidity temporarily induced by the IO mortgages affects households' consumption and investment decisions over the life cycle. This paper makes progress on these two questions using a comprehensive register-based panel data set from Denmark.

Which households use IO mortgages? In a sample of UK households of age 20-60, Cocco (2013) shows that alternative mortgages with lower initial payments are chosen more frequently by households expecting higher and safer future income. Intuitively, IO mortgages help such households smooth consumption over the life cycle, as mortgage repayments are postponed to a later period where income is higher. Cox et al. (2015) report from a Dutch data set that non-conventional mortgages are chosen more frequently by older households—and households with lower risk aversion and higher self-assessed finan-

[1] See, e.g., Baily, Litan, and Johnson (2008), Mayer, Pence, and Sherlund (2009), Bernanke (2010), Acharya, Richardson, van Nieuwerburgh, and White (2011), Demyanyk and van Hemert (2011), and United States Senate (2011).

cial literacy. In this paper, we take a life-cycle perspective and find that young and older households are both more likely to use IO mortgages, compared to middle-aged homeowners, also after controlling for differences in, e.g., income, education, and debt-to-assets. We find that young and old households consume more than current income, whereas the reverse is true for middle-aged household. This pattern indicates consumption smoothing over the life cycle.[2] The fact that young households use IO mortgages more frequently than middle-aged households is consistent with Cocco's findings as young households typically can expect a larger income growth. However, the intuition is challenged by our finding that old households take IO mortgages more frequently than middle-aged households, but face flat or decreasing future income. Also, Cocco's analysis suggests a positive relation between expected income growth and the use of IO mortgages within each age group. We show this is not the case. The relation is indeed positive for young households, in line with Cocco (2013), but among old households IO mortgages are taken more frequently by households expecting lower income growth.

We provide new evidence explaining why old households choose IO mortgages. Retirees receiving a low pension and little other income might want to reduce net wealth in order to sustain their consumption level, and thus continued saving through mortgage amortization is suboptimal.[3] This motivation applies in particular to liquidity-constrained retired homeowners for which the home equity is the dominant part of their net wealth. An IO mortgage allows such homeowners to stay in their home and at the same time to maintain a reasonable level of consumption, and, thus, avoid a potentially stressful and costly process of selling and moving. In a difference-in-difference estimation, we show that the introduction of IO mortgages in Denmark in 2003 led to a 10-17% higher annual consumption of liquidity-constrained, near-retirement households compared to similar un-

[2]Note that our comprehensive data set allows us to verify consumption smoothing more directly than Cocco (2013). We have data on both labor income and consumption, whereas Cocco (2013) only has income data. While Cocco (2013) considers a sample combining all households of age 20-60, we study the relation between mortgage choice, income, and consumption across nine age groups that also include households of age 60 and above, which gives insights into life-cycle patterns.

[3]A reverse mortgage may be preferable to an IO mortgage, but reverse mortgages are not standard products in the Danish market.

constrained households. Hence, the access to IO mortgages has significantly improved the welfare of constrained older households. We argue and test that these positive effects do not arise because of a general credit-supply shock to the economy, but are due to the greater financial flexibility that IO mortgages provide.

How do households use the extra liquidity that IO mortgages temporarily provides for? Borrowers may use part of the extra liquidity to lever up and buy a more expensive home. But this is not all. Recent papers based on US data study the relationship between mortgage-payment reductions and consumption/saving decisions, see Di Maggio, Kermani, Keys, Piskorski, Ramcharan, Seru, and Yao (2017), Agarwal, Amromin, Chomsisengphet, Landvoigt, Piskorski, Seru, and Yao (2017), and Abel and Fuster (2018). They show that the reduction in mortgage payments led to lower mortgage default rates, increases in car purchases—measured using auto loans—as well as increases in voluntary mortgage repayments. These findings advance our understanding of how IO mortgages influence parts of households' consumption (car purchases) and parts of their debt (mortgage debt), but they do not address the broader questions of whether households with IO mortgages increase their overall total consumption, total debt, and total savings, and how IO mortgages influence the composition of total debt and savings.

Our analysis shows that, at any age level, households with IO mortgages generally have a larger total debt, a larger debt-to-asset ratio, a larger loan-to-income ratio, as well as a larger consumption-to-income ratio than households with repayment mortgages. But we go further than this. We use our detailed data on the wealth composition of Danish households to provide a more complete picture of how IO mortgages impact debt and savings of households. First, access to IO mortgages can reduce life-time borrowing costs since IO borrowers can pay down other, more expensive, debt earlier. Indeed, for age 40 and above, IO borrowers have a smaller fraction of their debt as non-mortgage debt than borrowers with repayment mortgages. Secondly, we document how mortgage choice is related to stock and bond investments. For example, the stock market participation rate for middle-aged and old households is about five percentage points higher among

IO borrowers than among borrowers with an amortizing mortgage. Interestingly, among young households the stock market participation rate is lower for IO borrowers. Hence, if stock market participation reveals risk tolerance, our results question that risk tolerance is a key driver of mortgage choice, in contrast to the conclusion of Cox et al. (2015). We also find that among homeowners older than 55 years, IO borrowers make larger contributions to private pension plans. This finding indicates that households might exploit a tax-arbitrage opportunity by reducing mortgage repayments and increasing pension contributions, consistent with the idea of Amromin, Huang, and Sialm (2007).[4] Overall, we find that IO borrowers replace, at least to some extent, the reduced savings in real estate by investments in other assets, leading to a better diversified asset portfolio.[5] Notably, in our sample, these benefits of IO mortgages are not counterbalanced by larger financial difficulties during downturns. In spite of higher debt levels, debt-to-asset ratio, and loan-to-income ratio, IO borrowers in our sample did not default with a significantly higher frequency than repayment borrowers during the financial crisis.

To sum up, we offer a number of contributions relative to the current literature on IO mortgages. First, our paper is the first to take a life-cycle perspective which offers a richer description of how young, middle-aged, and old households use IO mortgages. Our finding that older households benefit from access to IO mortgages, as they relax an otherwise binding liquidity constraint, is particularly noteworthy. Furthermore, we study how IO mortgages influence other financial decisions of households (stock market investments, pension contributions, etc.), something that is difficult to do without comprehensive data on household portfolios over the life cycle. Finally, we test whether our findings are due to a general credit-supply shock or because of greater financial flexibility provided by IO mortgages.

[4]Institutional differences between the Danish and US tax and pension systems imply that the tax-arbitrage strategy in a Danish setting deviates from that suggested by Amromin et al. (2007) and only available to some households close to retirement, cf. the discussion in Section 4.3.

[5]In addition to these effects, a young household may purchase its long-term preferred residence right away by using an IO mortgage, instead of a smaller starter home with subsequent steps up the housing ladder. This could reduce total housing transactions costs over the life cycle. However, given the modest time span of our data set, we cannot detect significant differences in the transaction frequency of IO borrowers compared to borrowers choosing conventional mortgages.

There are considerable challenges involved in conducting an empirical analysis of which and how households use IO mortgages. First, one must have data for a large representative sample of households who use IO mortgages and a sample using repayment mortgages, such that the two groups can be contrasted. Second, for both groups, one needs data that allow for a calculation of consumption and savings at the household level. Third, to say something meaningful about saving decisions, information about the composition of households' portfolios is required, i.e., their holdings of bonds, stocks, etc. Finally, one needs exogenous variation in the availability of IO mortgages. With few exceptions, previous research has studied IO mortgages and other alternative mortgage products using US or UK data. US data do typically not include both households using IO mortgages and households using repayment mortgages, and lack detailed information about portfolio composition at the household level. Moreover, exogenous variation in the access to alternative mortgage products is typically unavailable.

To overcome these challenges, we use a comprehensive register-based panel data set from Denmark with detailed information on the mortgages of more than 400,000 households in the period 2001–2015 coupled with register-based data on, e.g., household wealth and income from which we can infer the household's consumption. The Danish mortgage system is renowned for its long-proven stability, efficiency, and transparency, cf. Campbell (2013) and Section 2 below. While sharing many features of the US market, the Danish mortgage market was less affected by the financial crisis, and the share of IO mortgages has remained high in Denmark. Importantly, our data span the sudden, exogenous introduction of IO mortgages in Denmark in 2003, allowing us to address the question of causality from IO mortgages to consumption and saving decisions. Furthermore, we have comprehensive data on users of IO mortgages and repayment mortgages, as well as information about the financial portfolios of households. Finally, we have information about income, education, geographical location, etc., that allows us to control for confounding effects when investigating life-cycle patterns in saving-consumption decisions of households with different mortgage types.

In addition to already mentioned literature, a number of papers examine related aspects of households' mortgage decisions. Several papers investigate the FRM/ARM choice in life-cycle models (Campbell and Cocco, 2003; Koijen, van Hemert, and van Nieuwerburgh, 2009; van Hemert, 2010), while ignoring the IO-repayment decision. In a more simplistic modeling framework, Chiang and Sa-Aadu (2014) study mortgage choice with a menu of contracts including the pay option ARM that can be seen as a combination of an IO mortgage and an equity line of credit. In a stylized dynamic contracting model, Piskorski and Tchistyi (2010) find that the optimal mortgage contract resembles such an option ARM, and that the gains from taking the non-conventional optimal mortgage are largest for homeowners who face more volatile income, buy more expensive homes given their income level, and who make no or a small down payment. Koijen et al. (2009) and Badarinza, Campbell, and Ramadorai (2018) show empirically that households' choice between fixed-rate mortgages (FRMs) and adjustable-rate mortgages (ARMs) is affected by the FRM-ARM rate spread and expectations about future ARM rates. Andersen, Campbell, Meisner-Nielsen, and Ramadorai (2018b) study the 2009–2011 refinancing behavior of Danish households with a focus on how the refinancing activity varies with household characteristics such as age, educational level, income, and wealth.[6]

Another line of research investigates the relation between house prices and household consumption, e.g. Campbell and Cocco (2007) using UK data, Mian, Rao, and Sufi (2013) and Kaplan, Mitman, and Violante (2017) using US data, and Browning, Gørtz, and Leth-Petersen (2013) using Danish data. An ongoing debate discusses whether the boom in house prices leading up to the Great Recession was primarily due to an increase in credit supply through relaxed lending standards (Mian and Sufi, 2017) or due to an increase in demand through households' expectations of future price changes (Adelino, Schoar, and Severino, 2016).

The remainder of the paper is organized as follows. Section 2 provides a short intro-

[6]Other research involving IO mortgages in Denmark includes Andersen, Jensen, Johannesen, Kreiner, Leth-Petersen, and Sheridan (2018a), Bäckman and Khorunzhina (2018), and De Stefani and Moertel (2019).

duction to the Danish mortgage market, describes our data set and the key variables in our analysis, and presents summary statistics. Section 3 examines which types of households that are more likely to use IO mortgages and how labor income and liquidity constraints influence households' decision to use IO mortgages. Section 4 documents how households with IO mortgages differ from households with repayment mortgages in terms of debt and asset composition and pension contributions. Finally, Section 5 concludes.

2 Data

2.1 Main data sources and features

In Denmark, residential mortgage loans are offered by specialized mortgage banks who act as intermediaries between households and investors. We have detailed data on more than 980,000 loans issued by a major mortgage bank in the period 2001–2015. The data contain the personal identification number of borrowers and mortgage characteristics such as a unique mortgage identification number, the loan amount, the time to maturity, and the mortgage type specifying whether the mortgage includes a repayment commitment or not, and whether the interest rate is fixed or adjustable. The time span of the data set covers both the financial crisis and the introduction of IO mortgages in 2003.

Given the borrowers' personal identification number, Statistics Denmark has supplied a number of relevant socioeconomic variables such as the educational history and, on an annual basis, the labor income, bank debt and deposits, holdings of stocks and bonds, as well as contributions paid to pension saving schemes.

We have compared the characteristics of mortgages and households in our data set to accessible data on all Danish mortgage banks in the shorter period 2009–2015. The latter data set is made available by Finance Denmark (an interest organization for financial institutions) and Danmarks Nationalbank (the central bank of Denmark) and is accessed through Statistics Denmark, which again allows us to link each mortgage to socioeconomic information about the borrower (this is the data used by Andersen et al. (2018b) and

others). We find no major differences between our sample and the larger sample in these years and see no reason to believe that our sample is not representative of all Danish mortgage holders going back to 2001 (details are available upon request).

2.2 The Danish mortgage market

Next we provide a short description of the Danish mortgage system (see also Gyntelberg, Kjeldsen, Nielsen, and Persson (2011) and Danske Bank (2017)). The Danish mortgage system dates back to 1797 and has been regulated by law since 1850 with the key objective of providing homeowners with inexpensive low-risk funding. Mortgage banks form large pools of geographically diversified mortgages having identical terms (different loan sizes, though) and then issue a series of identical covered bonds receiving payments that closely match the incoming payments from borrowers on the mortgages in the pool. While the interest rate paid on the mortgage matches the coupon rate of the associated bond, borrowers have to make additional contribution payments proportional to their outstanding debt to cover the mortgage bank's expenses and maintain its reserves.[7] Together with relatively strict regulation, an 80% maximum residential loan-to-value ratio, and conservative underwriting standards, the system has exhibited a remarkable stability even through financial crises and thus received considerable international attention (Campbell, 2013). When a borrower defaults on a mortgage, the corresponding bonds are paid out of the reserves of the issuing mortgage bank, and not a single bond default has been recorded in the more than 220-year long history of the system.

Danish mortgage-backed bonds are listed on the Nasdaq Nordic Exchange and most series trade with high liquidity (Dick-Nielsen and Gyntelberg, 2016). In June 2017 the face value of all outstanding Danish mortgage-backed bonds (residential and commercial) totaled around DKK 3,000bn (EUR 400bn, USD 450bn) making it the largest European

[7]Until 2011 the contribution rate was around 0.5% for all mortgage types. Since then the contribution rates on loans with IO, ARM, and high loan-to-value (LTV) have been increased substantially. Currently, the contribution rates range from 0.27% to 2.45% with the lowest rates for FRMs with low LTV and the highest rates for IO-ARMs with high LTV.

covered bond market. The bonds receive top ratings from international credit rating agencies, and as of April 2017 foreign investors hold 24% of the bonds whereas 69% are owned by Danish financial institutions, insurance companies, and pension and mutual funds (Danske Bank, 2017).

As in the US, the predominant mortgage in Denmark has traditionally been a 30-year annuity-style FRM with a penalty-free prepayment option. However, all Danish mortgages are recourse loans, allow the borrower to settle his debt by delivering corresponding bonds purchased at market value to the issuing mortgage bank, and can be taken over by the new owner when the underlying property is sold. ARMs were introduced in Denmark in 1996 and are offered with various rate reset frequencies. The bill allowing mortgage banks to offer IO mortgages was first debated in parliament in the spring of 2003 and was passed on June 1st, so that IO mortgages became available from October 1st, 2003. Our data set covers the period around the introduction of IO mortgages in Denmark. Both FRMs and ARMs can have an IO feature so four main mortgage types now exist: IO-FRMs, repayment FRMs, IO-ARMs, and repayment ARMs.

An IO mortgage gives the borrower up to 10 years with no repayment of debt so that only interest payments (and the above-mentioned contributions) are needed. Some mortgage banks require that the interest-only period is a continuous period starting at the initiation of the loan, whereas others grant the borrower the option to select shorter interest-only periods (totaling at most 10 years) along the way. The vast majority of IO mortgages, however, are issued with a 30-year maturity and have only interest payments in the first 10 years. Whether the IO period is a continuous 10-year period or consists of shorter IO periods, the loan has to be paid back within the full 30-year period. For this reason, the interest rate on an IO mortgage is not significantly different from the interest rate on a repayment mortgage. Given the embedded penalty-free prepayment option (subject to transaction costs, though), a borrower might decide to refinance into a new IO mortgage after the end of the 10-year IO period—and thus extending the IO period—provided that the loan-to-value ratio of the new loan is still below the 80% limit.

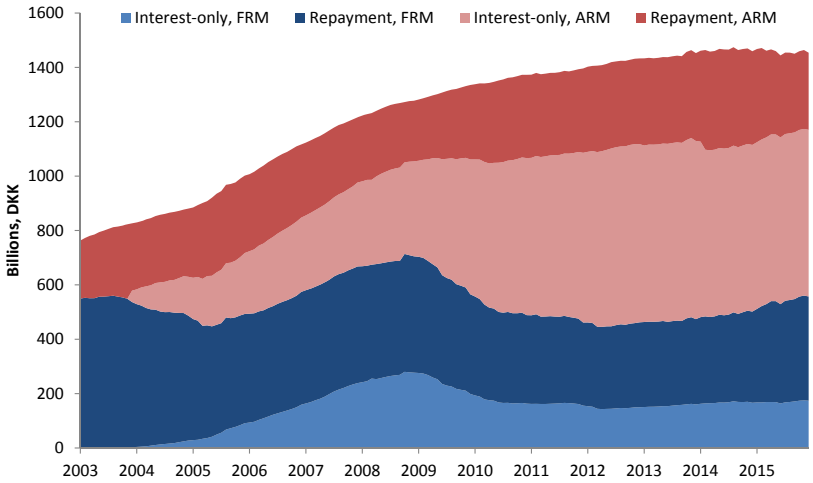

Figure 1: Outstanding mortgages by type. The graph shows the face value of outstanding residential mortgages in Denmark each month in the period 2003–2015. As of 18 September 2019, the exchange rates are DKK 1 ≈ USD 0.148 ≈ EUR 0.134. The total issuance is divided into four subgroups: interest-only FRMs (light blue area), repayment FRMs (dark blue), interest-only ARMs (light red), and repayment ARMs (darker red). Data source: Danmarks Nationalbank.

Regulation stipulates that mortgage banks are only allowed to grant a mortgage with an interest-only period or an adjustable rate or both if the borrower can afford a conventional 30-year FRM. Before the financial crisis, the regulation was "soft," however, implying that some borrowers were allowed to borrow more if taking out an IO mortgage. This is one reason why the introduction of IO mortgages affected Danish house prices, cf. Dam, Hvolbøl, Pedersen, Sørensen, and Thamsborg (2011). After the financial crisis, the Danish regulator has emphasized that mortgage banks must comply with this rule.

Figure 1 shows that the nominal value of outstanding FRMs has remained fairly stable in the 2003–2015 period, whereas the ARM market has grown substantially from around 30% of all mortgages in 2003 to 63% in 2015, a small decline from the 67-68% peak in 2012–2013. The share of IO mortgages started out around 14% in 2004, hit 40% in 2007 and 50% in 2009, and peaked at 56% in 2012–2013 after which it dropped to 52% in December 2015. In that month approximately 23% of the IO loans were issued with a fixed rate, 77% with an adjustable rate.

As additional background information, Figure 2 depicts the average short-term and

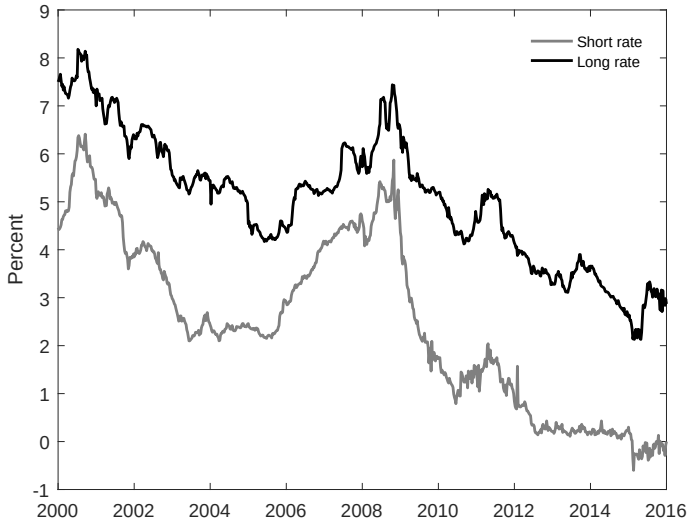

Figure 2: Average Danish mortgage rates in percent. The rates are calculated on a weekly basis and show the average yield-to-maturity on mortgage-backed bonds denominated in Danish Kroner. Data source: Finance Denmark.

long-term yields on Danish mortgage-backed bonds over the period 2000–2014. The interest rates on ARMs [FRMs] typically follow the short-term [long-term] bond yields. Yields fell before the financial crisis, rose during it, and have fallen substantially since 2009 with short-term yields even turning negative in 2015. Figure 3 illustrates how house and apartment prices have developed across the five regions of Denmark through the period 2001–2016. All regions experienced a significant increase in prices from 2001 up to around 2007 after which prices generally declined and later started to come back up, with a substantial recent increase especially for apartments. Home prices are highest in the Copenhagen area: in 2016Q4 the average price per square meter for one-family houses was DKK 22,900 in Copenhagen and DKK 8,700-11,100 in the other four regions and for apartments DKK 30,900 in Copenhagen and DKK 14,200-20,600 in the other regions.

2.3 Details of our data set

In our data from a major mortgage bank we focus on the 86.9% of mortgages issued on residential property and thus exclude commercial mortgage loans. We exclude the

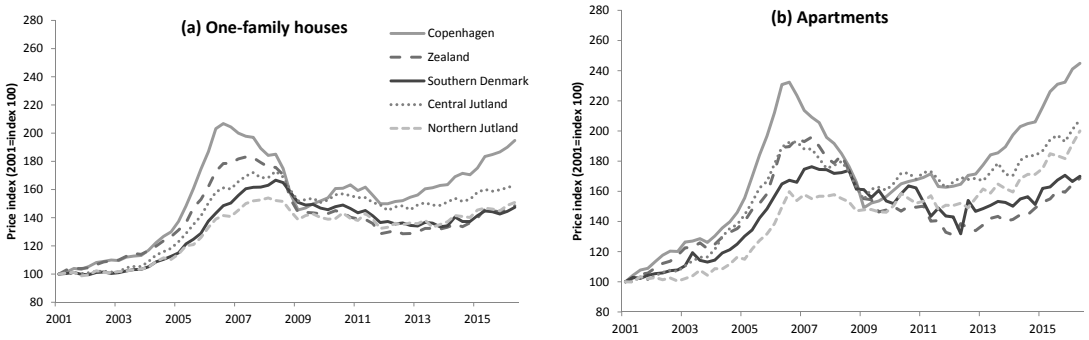

Figure 3: Home prices in Denmark. The graph shows how prices of one-family houses (upper panel) and apartments (lower panel) have developed in the five regions of Denmark in the period 2001–2016. Prices are indexed and fixed at 100 in 2001Q1. Data source: Danmarks Nationalbank.

mortgages issued before 1970 (only 0.5% of all mortgages) because of a major change in mortgage regulation that year which, among other things, reduced the maximum loan-to-value ratio and the maximum maturity.

We link individual mortgages to the household characteristics of borrowers. We define a household as one or two adults living at the same postal address. In cases where only one of the adults in the household holds the mortgage, we also include the second adult's contribution to general economic variables such as income, debt holding, stock holdings, etc., but omit the contribution from children in the household unless they are registered as one of the borrowers of the mortgage.

Almost 30% of the households have more than one mortgage; the average is 1.2 mortgages and the maximum is 15. To obtain a direct link between mortgage choice and household characteristics we use only one mortgage per household. This *dominant mortgage* is the mortgage with the highest loan amount. If the household has several mortgages with the same loan amount, the dominant mortgage is defined as the one with the highest outstanding debt. Robustness checks will test for the implications of the precise definition of dominant mortgages and of excluding other mortgages from the analysis. Households sharing mortgages with other households are excluded (e.g. divorced couples still owning a house together) to avoid having special family arrangements influencing the results. In

total and after exclusions, we have data on 983,822 mortgages issued to 733,222 individuals in 443,600 households over the period 2001–2015.

2.4 Key variables in our analysis

2.4.1 Mortgage-specific variables

The *household loan amount (outstanding debt)* is the total loan amount (outstanding debt) of all mortgages held by the household. *LTI* is the ratio of the loan amount to the annual household income. The *nominal interest rate* is the nominal rate paid on the dominant mortgage and is presented in percent. *FRM* takes a value of 1 for a fixed-rate mortgage and 0 for an adjustable-rate mortgage. Likewise, *IO mortgage* takes a value of 1 for an IO mortgage, i.e. a mortgage without a required repayment in the year in question, and 0 for a mortgage with a mandatory repayment. The *actual IO period* takes a value of 1 if no repayment on the loan is made at the given point in time, either by default or because the borrower exercises an option not to repay. Finally, the variable *at least one IO mortgage* is a dummy variable for households having at least one IO mortgage.

2.4.2 Household-specific variables

The *age* of the household is defined as the average age of the borrowers of the mortgage. From Statistics Denmark we have annual observations of various financial variables of each individual, which we aggregate to the household level. *Household total debt* is the sum of the mortgage debt, bank debt, and other types of debt registered for the household. *Household income* is the disposable income defined as total income less interest payments and tax payments. Total income consists of labor income, social welfare, unemployment benefits, child benefits, pension payouts, capital income, and inheritance. The *debt to asset ratio* is defined as total debt over total assets, where the latter includes cash, stock and bond holdings, as well as the public property value of all properties owned by the

household.[8]

Statistics Denmark reports for each individual an *education level* from 1 to 4. Level 1 represents primary school or less, level 2 secondary school or vocational education, level 3 is short-, medium-, or long-term higher education, and level 4 means PhD or researcher education. We include the few level-4 individuals in level 3 in our analysis. *Household type* corresponds to either 'Single,' 'Couple,' or 'Several families' where in the latter case the household's adults belong to different families. The geographical dimension is represented by which of the five administrative regions of Denmark (*Copenhagen, Zealand, Southern Denmark, Central Jutland, Northern Jutland*) the property is located in. Finally, the variable *Male* takes the value of 1 if the mortgage has a male borrower and 0 otherwise.

2.4.3 Consumption

We impute the household-level annual consumption from the income and wealth data supplied by Statistics Denmark, as done by Leth-Petersen (2010) and others.[9] Let c_t denote consumption and y_t disposable income in year t. Let A_t denote the value of the household's liquid assets (bank deposits including the balance of private pension schemes), M_t mortgage debt, and D_t bank debt and other debt at the end of year t. Based on the household budget constraint, total consumption is then imputed as

$$c_t = y_t - \Delta A_t + \Delta M_t + \Delta D_t, \tag{1}$$

[8]The public property value is the tax authorities' assessment of the value of the property, based among other things on recent transaction prices in the neighborhood. The value is used for calculating the property taxes to be paid by the homeowner and is typically significantly lower than the potential market value of the property.

[9]The quality of this imputation is investigated by Browning and Leth-Petersen (2003). They compare data from a Danish Expenditure Survey to administrative data for the years around the survey and conclude that the imputed consumption measure gives a good match with households' self-reported total expenditures. Koijen, van Nieuwerburgh, and Vestman (2015) find substantial reporting errors in Swedish consumption survey data and argue for the use of imputed register-based consumption. Baker, Kueng, Meyer, and Pagel (2018) document a potential measurement error arising when retail investors buy and sell assets within a year as that moves imputed consumption. Since only a small proportion of Danish households invest on their own, this issue is unlikely to significantly affect our results.

where $\Delta A_t = A_t - A_{t-1}$ is the increase in liquid assets plus private pension contributions in year t, $\Delta M_t = M_t - M_{t-1}$ is the increase in mortgage debt, and ΔD_t the increase in bank debt and other debt in year t.[10] The household's net savings in year t are $\Delta A_t - \Delta M_t - \Delta D_t$. Hence, consumption is simply income less net savings. Note, for a household paying only interest on a given mortgage, $\Delta M_t = 0$ throughout year t, whereas $\Delta M_t < 0$ in case of a repayment mortgage. Therefore, an interest-only paying household must either consume more, increase assets, or reduce bank and other debt—or a combination hereof—compared to the case where the household has a repayment mortgage of the same size.

We do not include stock and bond holdings in the household's liquid assets. Including them would make imputed consumption of the (relatively few) households with significant positions excessively volatile in years with large movements in stock prices as seen around the financial crisis.[11] Another challenge is that the actual value of the home is unobservable between transactions. Consequently, in years where the household buys or sells real estate, the imputed consumption can severely misrepresent actual consumption as only the debt side is taken into account. For example, in a year where an individual sells a house worth DKK 1.5mn and buys another worth DKK 2.0mn and finances the difference by increasing the mortgage by DKK 0.5mn, this would show up on the right-hand side of Eq. (1) only by increasing ΔM_t by DKK 0.5mn and thus consumption would appear to be DKK 0.5mn higher than otherwise. To avoid this issue, we disregard consumption in years where a housing transaction takes place. To control for differences in data registration of housing transactions, we disregard consumption in years where the total inflation-adjusted debt of the household increased or decreased by more than DKK 0.5mn in 2015-prices.[12] Following

[10] Disposable income includes private pension contributions (and excludes mandatory occupational pension contributions). Pension contributions are considered as an increase in liquid assets and are thus included in ΔA_t.

[11] We cannot distinguish between changes in asset values due to active investment decisions of the household and changes due to unrealized gains and losses caused by market movements, where the latter might have little relation to consumption decisions. We find that consumption imputed without stock and bond holdings align well with survey-based consumption data, whereas imputed consumption calculated using stock and bond holdings are excessively volatile. These results are available upon request.

[12] Years of housing transactions count 5.11% of the observations, and large changes in total debt above DKK 0.5mn count 6.11%. In total, they represent 8.50% of the observations. Increasing the threshold defining a large change in total debt does not significantly change our results.

Browning and Leth-Petersen (2003), we exclude households with self-employed individuals due to their unstable income-tax conditions and the difficulties in measuring the value of their business.

2.5 Summary statistics

We have a total of 2,664,423 household-year observations in the period from 2001–2015. The observations are not equally distributed over the years as a result of an increase in the number of customers of the mortgage bank. Table 1 presents summary statistics. In the gray-shaded part of the table, observations are divided into subperiods, whereas in the non-shaded right-hand part of the table, observations are divided according to mortgage type. In the latter case, each mortgage is represented by a randomly chosen year to ensure that all mortgages are weighted equally.

Let us first describe the general patterns of the data, i.e. summary statistics in the left-hand-side shaded columns. We focus on mortgage characteristics. The mortgage loan amount and outstanding debt as well as the household debt have increased substantially over the years, also when mortgage or total debt are measured relative to income or assets. For instance, the average loan-to-income ratio has increased from 2.25 in 2001-02 to 3.37 in 2011-15. Household income and consumption have both increased over time.[13] The consumption-to-income ratio is relatively stable around 1 over time.

The fraction of households in our sample for which the *dominant* loan is an IO mortgage has increased from 18% on average in 2003–06, to 36% in 2007–10, and 48% in 2011–15. In line with our observations for the overall Danish mortgage market, cf. Figure 1 discussed earlier, we see that 51% of the households in our sample in 2011–2015 have at least one IO mortgage. As previously mentioned some of the IO mortgages do not require borrowers not to make repayments, but grants them the option not to do so. The summary

[13]Income, consumption, debt, asset values, and pension contributions are in nominal terms. The annual inflation rate over the 2001-15 period has averaged 1.8%, peaking at 3.4% in 2008, and being as low as 0.5% in 2015. The average value of the consumer price index, CPI, is stated in the top of Table 1 with CPI=100 in 2015.

	By subperiod				By mortgage type	
	2001-02	2003-06	2007-10	2011-15	IO	Repay
CPI (2015=100)	76.31	82.01	88.27	96.46	93.86	92.09
Mortgage characteristics						
Loan amount	315.71	442.33	627.29	720.92	816.48	613.18
LTI	2.25	2.67	3.40	3.37	4.17	2.88
IO mortgage	.	0.18	0.36	0.48		
At least one IO mortgage	.	0.19	0.38	0.51		
Actual IO period	.	0.17	0.35	0.44	0.93	0.00
FRM	0.94	0.65	0.49	0.41	0.33	0.68
Nom. interest rate (%)	6.98	4.84	4.04	2.31	2.54	3.52
Household characteristics						
Total debt	405.34	528.09	726.31	818.75	1002.60	688.24
Debt to Asset ratio	0.63	0.63	0.75	0.87	0.99	0.75
Income	146.83	171.59	193.24	222.47	205.30	217.30
Consumption	134.65	165.83	186.45	203.02	199.71	198.71
Consumption to Income	0.94	1.00	0.99	0.94	1.02	0.94
Growth of mean consumption (%)	13.02	6.39	3.82	0.38	1.02	1.64
Pension contribution	21.04	29.27	36.53	36.70	34.54	40.08
Number of borrowers	1.43	1.54	1.56	1.67	1.65	1.65
Avg. age (borrowers)	48.09	49.98	48.44	50.05	48.53	47.55
age: -34	0.13	0.11	0.16	0.13	0.21	0.14
age: 35-39	0.13	0.12	0.13	0.12	0.13	0.14
age: 40-44	0.15	0.14	0.14	0.13	0.12	0.15
age: 45-49	0.16	0.15	0.13	0.14	0.10	0.15
age: 50-54	0.15	0.15	0.12	0.12	0.08	0.14
age: 55-59	0.11	0.13	0.11	0.11	0.08	0.12
age: 60-64	0.06	0.08	0.09	0.09	0.09	0.08
age: 65-69	0.04	0.05	0.05	0.07	0.08	0.04
age: 70-	0.06	0.07	0.06	0.08	0.09	0.04
Single	0.21	0.20	0.18	0.17	0.18	0.14
Household with several families	0.06	0.05	0.05	0.05	0.05	0.05
Couple	0.73	0.74	0.77	0.77	0.76	0.81
Male	0.88	0.89	0.90	0.90	0.88	0.92
Number of adult residents	1.76	1.78	1.81	1.81	1.80	1.84
Number of kids	0.85	0.83	0.91	0.92	0.92	0.99
Education level 1	0.16	0.14	0.11	0.10	0.09	0.09
Education level 2	0.46	0.44	0.45	0.43	0.42	0.43
Education level 3	0.37	0.41	0.44	0.47	0.48	0.48
Region Copenhagen	0.22	0.21	0.16	0.16	0.20	0.15
Region Zealand	0.14	0.15	0.14	0.14	0.14	0.12
Region South Denmark	0.29	0.29	0.28	0.27	0.25	0.28
Region Middle Jutland	0.22	0.23	0.26	0.27	0.26	0.27
Region North Jutland	0.13	0.13	0.16	0.16	0.15	0.17
Observations	69,492	248,915	904,666	1,441,350	257,541	329,409
Total observations	2,664,423				586,950	

Table 1: Summary statistics. The table presents average values related to the dominant mortgages. Loan amounts, debt, income, consumption, and pension contributions are in DKK 1,000, and measured as an average per adult in the household. For each subperiod the average value over the years is displayed. In the right panel, a random year of each mortgage is used as representative of the mortgage to ensure that each mortgage is weighted equally. Using a t-test, we find that all means for the two mortgage types are statistically different on a significance level of 1%, except for the educational levels. See Section 2 for a more detailed description of variables.

statistics show that 93% of the IO mortgages only pay interest in the randomly chosen year for each mortgage. In other words, more than nine out of ten households with an IO mortgage use their right to pay only interest. As in the overall Danish mortgage market (see Figures 2 and 3), the popularity of FRMs in our sample has declined over the years with a corresponding growth in ARMs. The interest rates on the mortgages in our sample have decreased over the period considered both due to the general decrease in interest rates for all types of mortgages and to the increasing use of ARMs as these typically have lower interest rates than FRMs. Also note that for IO mortgages 33% are FRMs and 67% ARMs, whereas 68% of repayment mortgages are FRMs and only 32% ARMs. This difference explains why the average interest rate is higher for repayment mortgages than for IO mortgages.

3 Which households use interest-only mortgages?

The summary statistics show a clear difference in mortgage choice across age groups. For example, 21% of all IO mortgages are held by households of age 34 or younger, whereas only 14% of all repayment mortgages are held by that age group. Also, older households have a larger share of all IO mortgages than of all repayment mortgages. In contrast, middle-aged households hold a larger share of repayment mortgages than IO mortgages. The observation that IO borrowers tend to have high debt and consumption relative to assets and income may thus be caused by life-cycle variations in these quantities.

To explore this, Figure 4 shows consumption patterns over the life cycle for households with IO mortgages and households with repayment mortgages. Ideally, we would like to compare the life-cycle profile of households with IO mortgages to households with repayment mortgages. Due to the time-span of our data this is not possible. However, inspired by Betermier, Calvet, and Sodini (2017), we can sort households by birth year into different cohorts using balanced data, and estimate the life-cycle profile of the two different types of households. In particular, using balanced data on homeowners after the introduction of IO mortgages in Q4 of 2003, we follow around 24,000 households'

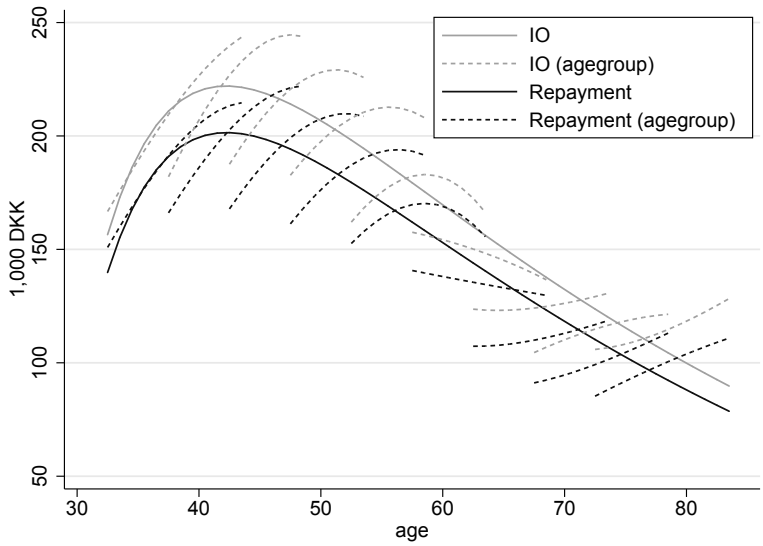

Figure 4: Consumption patterns over the life cycle. Median consumption from 2004 to 2015 for different age groups and across mortgage types. Consumption is measured per adult in the household. The figure presents a polynomial fit for each age group (dashed line) and an overall polynomial fit of all age groups (solid line). Nine different age groups are used; below 35, 35-39, 40-44, ..., 65-69, and 70+ in 2004. Each observation for an age group is illustrated at the average age in that group. The gray curves are based on homeowners holding an IO mortgage at some point within the period from 2004 to 2015, whereas the black curves are based on homeowners holding only repayment mortgages within this time period. The graph applies balanced data on homeowners from 2004 to 2015.

consumption over the 12-year period from 2004 to 2015. Based on the age in 2004, we allocate each homeowner to one of nine age groups: below 35 years, 35-39, 40-44, ..., 65-69, and 70+ years. For each age group we estimate a polynomial relation between age and consumption per adult (dashed lines). We then fit a polynomial to represent the overall consumption pattern across age groups (solid lines). The overall life-cycle consumption pattern has the hump shape well known from the US and other countries (Browning and Crossley, 2001; Gourinchas and Parker, 2002). The main innovation in Figure 4 is that we estimate separate consumption profiles for households with IO mortgages and households with repayment mortgages. We find that, across all age groups, homeowners with an IO mortgage tend to consume more than homeowners with a repayment mortgage.

Figure 5 presents additional information on the age-dependence in mortgage choice by showing the fraction of households in each age group that holds an IO mortgage in

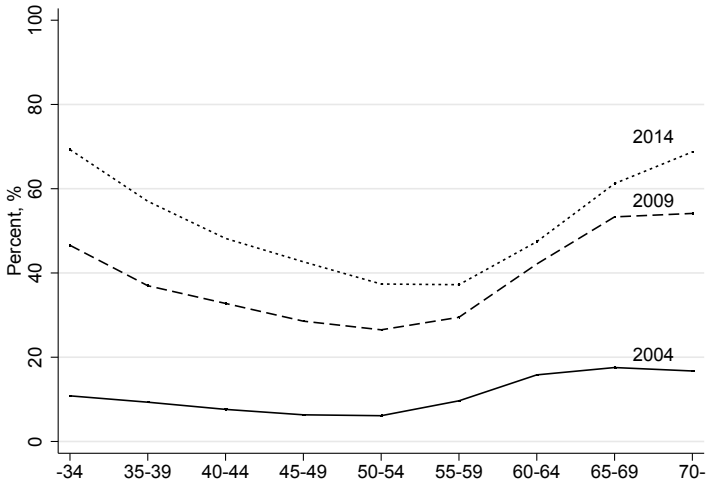

Figure 5: Fraction of IO mortgages. For each of the years 2004, 2009, and 2014, the graph shows the fraction of households in each age group that holds an IO mortgage.

year 2004, 2009, and 2014. The first important observation is that the popularity of IO mortgages has increased over the years across all age groups. Secondly, young and old households have a higher fraction of IO mortgages compared to middle-aged households. Thirdly, the difference between the take-up of IO mortgages between age groups have increased over time: the figure has become more U-shaped over time. As the rational arguments for IO mortgages apply mainly to young and older households, these patterns indicate an increasing degree of rationality in mortgage choice.

In order to investigate whether the age-dependence in mortgage choice is due to differences in background characteristics of the households, we run the probit estimation

$$P(D_i^{IO} = 1|X_i, C_i) = \Phi\left(\beta' X_i + \delta' C_i + u_i\right). \tag{2}$$

Here D_i^{IO} is a dummy variable equal to one if household i's dominant loan is an IO mortgage; X_i is a vector of dummies for nine different age groups (less than 34, 35-39, ..., 70+); and Φ is the cumulative distribution function of the standard normal distribution. The C_i in (2) is a vector of control variables and includes the mortgage interest type (ARM/FRM), the logarithm of current disposable income measured in Danish Kroner,

	APE	Robust SE
Age: -34	0.100***	(0.003)
Age: 35-39	0.022***	(0.003)
Age: 40-44	0.002	(0.003)
Age: 50-54	0.004	(0.003)
Age: 55-59	0.054***	(0.004)
Age: 60-64	0.175***	(0.004)
Age: 65-69	0.285***	(0.005)
Age: 70-	0.365***	(0.005)
FRM	-0.296***	(0.002)
Log income	-0.140***	(0.003)
Debt to Asset ratio	0.306***	(0.002)
Male	-0.055***	(0.003)
Education level 2	0.023***	(0.003)
Education level 3	0.050***	(0.003)
Number of borrowers	0.022***	(0.002)
Number of adult residents	-0.071***	(0.007)
Number of kids	0.012***	(0.001)
Observations	325,628	
Pseudo-R^2	0.220	

Standard errors in parentheses
* $(p < 0.05)$,** $(p < 0.01)$,*** $(p < 0.001)$

Table 2: Characteristics of homeowners using IO mortgages. Average partial effects and robust standard errors (in brackets) from the probit estimation stated in (2). The dependent variable is a dummy indicating an IO mortgage. Household characteristics and regional and time fixed effects are also included. The table includes homeowners with a mortgage originated between 2004 and 2015. A random year is used to represent the mortgage choice for each household.

the debt-to-asset ratio, the number of borrowers, the number of residents (adults and kids), the household type, the gender, the educational level, as well as regional dummies and time dummies. The probit estimation requires that each household is only present once, hence we represent each household by a random year after 2003. To avoid selection problems of which households borrow after 2003, we only use mortgages originated after 2003.

Table 2 presents the average partial effects (APE) together with robust standard errors in parentheses. The age group of 45-49 years is used as the base group. The table shows that the two youngest groups have a significantly higher probability of holding an IO mortgage compared to a middle-aged household with similar characteristics. Specifically, the youngest group has a 10.0% higher probability of holding an IO mortgage compared to an household of age 45-49 years, whereas the second youngest group have a 2.2% higher

probability. For the four oldest group of homeowners (age 55 and above), we also see an increasing probability of having an IO mortgage. At age 70 and above, the likelihood of taking an IO mortgage is as much as 36.5% higher than for the base group. These results confirm that IO mortgages are more popular among young and old homeowners than among middle-aged homeowners also after controlling for background characteristics.

Table 2 also shows how mortgage choice is affected by control variables after separating out the age dependence. Homeowners are less likely to hold an IO mortgage when the mortgage has a fixed rate instead of an adjustable rate, when current income level is higher, a male borrower is present, and when the household consists of more adults. On the other hand, the likelihood of holding an IO mortgage increases with the number of children, the education level, and the debt-to-asset ratio.

As indicated in Figure 5, there is a time-trend in the propensity to take out an IO mortgage, and the difference between the take-up of IO mortgages between age groups have increased over time. If this time-trend correlates with the inflow of new and younger customers this might influence our estimates in our probit regression. As mentioned, we include year-fixed effects, which should alleviate this concern. As an additional check, we rerun the probit estimation stated in (2) year by year. Figure 6 displays the average partial effects across the age groups in year 2004, 2009, and 2014. For the households above 45, we see that our results are robust over time, whereas the young have increased their tendency to take out an IO mortgage.

3.1 Consumption smoothing

A standing assumption in financial economics is that households would generally like to smooth consumption over the life cycle so that consumption is less volatile than income. Labor income typically starts out at a low level, increases significantly until age 45-55, and subsequently flattens out or even drops somewhat until retirement (Cocco, Gomes, and Maenhout, 2005; Guvenen, Karahan, Ozkan, and Song, 2019). Consumption smoothing is thus the key motivation for retirement saving and for why young households often bor-

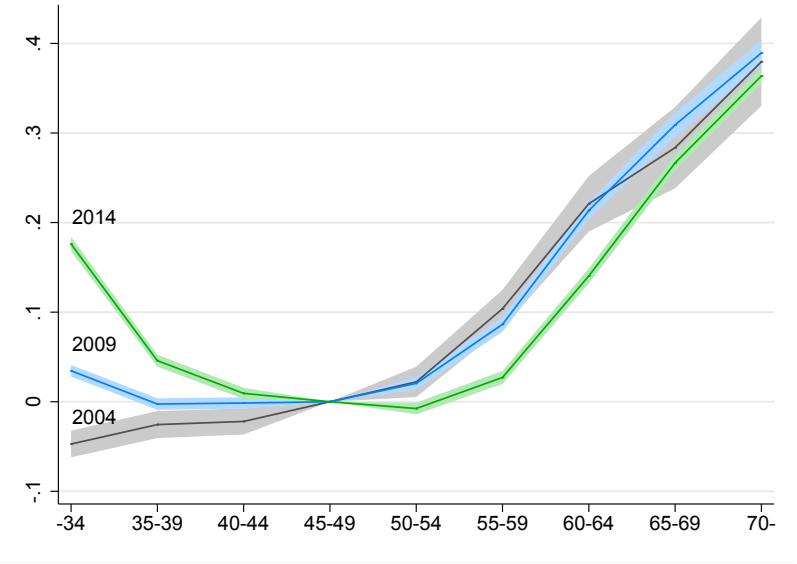

Figure 6: Average partial effects of holding an IO mortgage across age groups. Average partial effects of holding an IO mortgage across age groups in year 2004, 2009, and 2014. The shaded areas illustrate the 95% confidence intervals. The average partial effects follow from the probit estimation stated in (2), where the dependent variable is a dummy indicating an IO mortgage. In a given year all observations are used since each household is only represented once.

row funds and pay back when their income has increased. The access to an IO mortgage grants households more flexibility in life-cycle consumption planning and, in particular, facilitates consumption smoothing. More specifically, young households may find IO mortgages attractive as they typically expect significant labor income growth in the coming years. Older homeowners with no or little labor income or pension payouts would like to finance consumption by reducing net wealth. However, a repayment mortgage increases net wealth by reducing the outstanding loan balance. Hence, an IO mortgage may be attractive, in particular if the homeowner is liquidity constrained in the sense that the home equity constitutes a large share of total household net wealth. An IO mortgage may allow financially constrained older homeowners to stay in their home and avoid a stressful and costly process of selling and moving.

Section 3 already documented that young and old homeowners are more inclined to take an IO mortgage than middle-aged homeowners, which is consistent with the above consumption smoothing mechanisms. Figure 7 gives further support to this motivation.

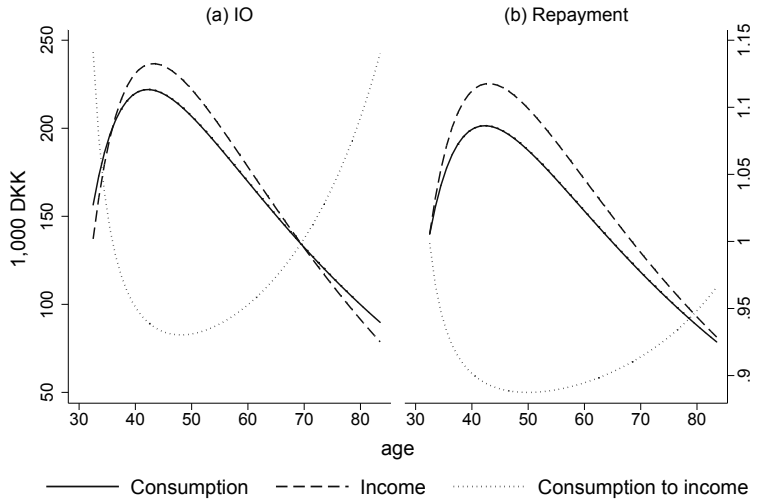

Figure 7: Life-cycle consumption and income patterns. Median of annual consumption (solid line), annual income (dashed line), and the consumption-to-income ratio (dotted line; right-hand axis) over the life cycle. Consumption and income are measured as an average per adult in the household. Panel A is based on homeowners holding an IO mortgage at some point within the period from 2004 to 2015, whereas Panel B is based on homeowners holding only repayment mortgages within this time period. The graphs are generated by polynomial fits of nine age groups defined as: below 35, 35-39, 40-44, ..., 65-69, and 70+ in 2004. Each observation for an age group is illustrated at the average age in that group. The graph applies balanced data on homeowners from 2004 to 2015.

It depicts household consumption and income over the life cycle for individuals with an IO mortgage (in Panel A) and individuals with a repayment mortgage (in Panel B); the figure is constructed in the same way as Figure 4 which showed only life-cycle consumption. Panel A shows that homeowners with an IO mortgage tend to consume more than current income when they are below 35 and above 65 years, whereas the middle-aged IO borrowers tend to be net savers. Panel B illustrates that homeowners with repayment mortgages tend to consume less than their current income and thus be net savers throughout their life cycle. These graphs indicate that IO borrowers engage more in consumption smoothing than borrowers with a conventional repayment mortgage. The following two subsections dig deeper by investigating the motives behind the IO mortgage choice separately for young and for old households.

3.2 Young households and expected income growth

According to the consumption smoothing motive, borrowers should be more inclined to take an IO mortgage the higher their expected future income growth. To test this hypothesis, we rerun the probit estimation stated in (2) with income growth added to the list of explanatory variables. As households' expected income growth is unobservable, we follow Cocco (2013) and measure the expected annual income growth rate by the average annual realized change in the logarithm of disposable income over h years, i.e.,

$$\text{income growth} = \frac{\ln(\text{income}_{t+h}) - \ln(\text{income}_t)}{h}.$$

Larger values of h reduce the noise in the income growth measure, but also lead to fewer observations in our sample. We run the regression for $h = 3, ..., 7$ with the resulting average partial effects displayed in Table 3.

Table 3 confirms that households with higher future income growth are more likely to hold an IO mortgage with strong significance for $h = 4, \ldots, 7$, whereas the effect is insignificant for $h = 3$. For example, when income growth is measured over a 7-year period, an annual increase in income of one percentage point makes the household 48.8 percent more likely to hold an IO mortgage compared to a similar household with no income growth. This clearly indicates that some households use IO mortgages to release money today when income is relatively low and wait repaying their mortgage until their income is higher. These findings are consisting with the conclusion of Cocco (2013) on a smaller UK sample, but our results are stronger and more significant.[14] Interestingly, by comparing the results in Table 3 with the age effects in Table 2, we see that the age effect for the young households decreases in Table 3, whereas the effect for households above 50 increases. Hence, the income growth seems to explain most of the age effect for the youngest homeowners, but not for the older homeowners who generally expect no or even negative income growth.

[14] Cocco (2013) only considers households up to the age of 60, and the average mortgage holder is 34 years, 14 years younger than ours.

	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$
Income growth	-0.006	0.138***	0.255***	0.412***	0.488***
	(0.013)	(0.017)	(0.021)	(0.026)	(0.034)
Age: -34	0.062***	0.037***	0.025***	0.009**	-0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Age: 35-39	0.004	-0.002	-0.008*	-0.015***	-0.018***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Age: 40-44	-0.005	-0.007*	-0.007*	-0.007*	-0.007*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Age: 50-54	0.010**	0.019***	0.025***	0.025***	0.030***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Age: 55-59	0.072***	0.084***	0.096***	0.104***	0.112***
	(0.004)	(0.004)	(0.004)	(0.005)	(0.006)
Age: 60-64	0.209***	0.225***	0.237***	0.241***	0.240***
	(0.005)	(0.005)	(0.005)	(0.006)	(0.007)
Age: 65-69	0.316***	0.327***	0.337***	0.340***	0.346***
	(0.006)	(0.006)	(0.006)	(0.007)	(0.009)
Age: 70-	0.390***	0.399***	0.404***	0.404***	0.418***
	(0.006)	(0.007)	(0.007)	(0.009)	(0.011)
Observations	302,531	284,009	269,087	234,782	164,533
Pseudo-R^2	0.217	0.214	0.210	0.203	0.203

Standard errors in parentheses
* $(p < 0.05)$,** $(p < 0.01)$,*** $(p < 0.001)$

Table 3: Characteristics of homeowners using Interest-Only mortgages. Average partial effects and robust standard errors (in brackets) from the probit estimationin Eq. (2). The dependent variable is a dummy variable indicating an IO mortgage. The regression controls for FRM, income, debt-to-asset ratio, gender, education level, number of borrowers, numbers of kids and adults and families represented in the household, and regional and time fixed effects are also included. The table includes homeowners with a mortgage originated between 2004 and 2015. A random year is used to represent the mortgage choice for each household.

Figure 8 contains one of the main messages of this paper. It shows the average partial effect of income growth measured over $h = 7$ years on the likelihood of having an IO mortgage across the different age groups; similar patterns are seen for $h = 4, 5, 6$. The main point in the figure is that the impact of future income growth on the likelihood of choosing an IO mortgage drops with age. It is large and positive for the young, and small and even negative for the old.

In more detail, for the youngest group of households we see that for an annual income growth of 1% over seven years, the likelihood for the household to have an IO mortgage increases by more than 100%. We see positive, but smaller and smaller, effect for households up to the age of 59. This supports the hypothesis that consumption smoothing over the

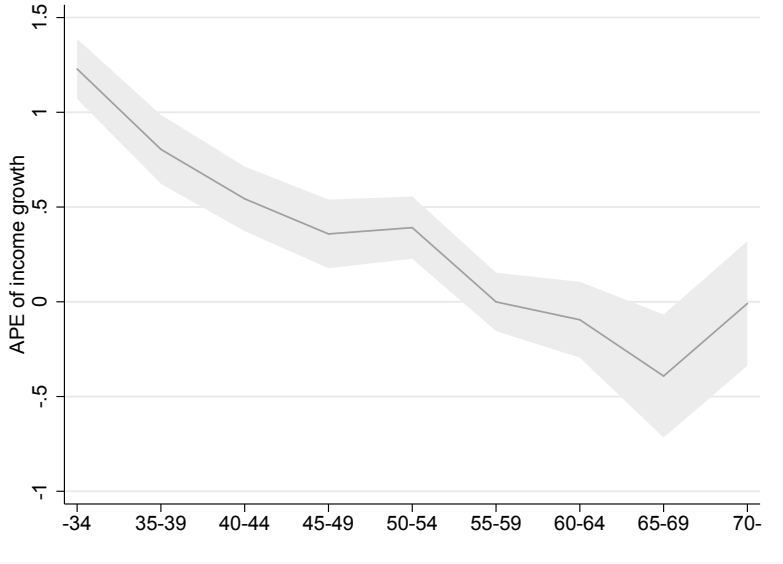

Figure 8: Average partial effects of income growth across age groups. Average partial effects (solid line) of income growth with $h = 7$ for each age group from the probit estimation stated in (2) with the income growth rate added to the list of explanatory variables. The shaded area display the confidence interval at a 5% significance-level.

life cycle by postponing repayments to periods with higher income is concentrated among younger households. These findings are qualitatively similar but quantitatively stronger than those of Cocco (2013). For households above 60 we see that a 1% increase in income growth even lowers the likelihood for the household to hold an IO mortgage. The reason for the negative sign is that income growth is negative for these age groups.

In total, a novel finding here is that there is not a uniformly positive relation between take-up of IO mortgages and expected income growth across the age-span of the population. The relation is positive for the young, but it is negative for the old. Hence, an expectation of higher income growth explains why young households take IO mortgages, as in Cocco (2013), but it cannot explain why there is a strong tendency for old households to use IO mortgages.

3.3 Old households and liquidity constraints

For older homeowners, we hypothesize that liquidity needs are the main driver of the demand for IO mortgages. In particular, we expect that homeowners with sufficient liquid funds have lower demand for IO mortgages than liquidity-constrained households since the latter can free up liquidity by taking an IO mortgage and spend the saved repayments to maintain a given consumption level. Using a term coined by Kaplan and Violante (2014), some old households are "wealthy hand-to-mouth": they have paid down most of their mortgage debt and now hold little or no liquid wealth despite owning sizable quantities of illiquid assets in form of their home equity. Kaplan and Violante (2014) argue that wealthy-hand-to-mouth households should be more responsive to fiscal stimulus. In the same vein, our hypothesis is that the introduction of IO mortgages should impact constrained households more than unconstrained households.

We test the hypothesis using a difference-in-difference (diff-in-diff) estimation in which the IO introduction in late 2003 is considered as an exogenous shock. As our data sample starts in 2001, we calculate pre-shock consumption over 2001–2003 and, to balance the before- and after-period, we measure post-shock consumption over 2004–2006. In each of these years and for each household we calculate the illiquid-asset-ratio as

$$\text{IAR} = \frac{\text{Public property value} - \text{Outstanding mortgage debt}}{\text{Total assets}},$$

where the numerator is a measure of the home equity, and the denominator includes cash, bank deposits, stock and bond holdings, as well as the public property value of all properties owned by the household (see footnote 8 for an explanation of the public property value). A high IAR indicates that a large share of the household assets is held as relatively illiquid home equity. The treatment group thus includes households having a high IAR, which we define as 50% or more, throughout the 2001–2006 period. The control group consists of households having an IAR below 50% in all of the six years.[15] We then

[15]Similar results are obtained using a threshold of 40% or 60%.

estimate the causal effect of IO mortgages on consumption by a diff-in-diff estimation of the relation

$$\log(\text{cons}_{it}) = \beta_0 + \beta_1 D_t^{\text{after IO}} + \beta_2 D_i^{\text{high IAR}} + \beta_3 D_i^{\text{high IAR}} D_t^{\text{after IO}} + \delta' C_i^{2002} + u_{it}, \quad (3)$$

where $D_i^{\text{high IAR}}$ is an indicator for the treatment group, and $D_t^{\text{after IO}}$ differentiates the time before (2001–2003) and after (2004–2006) the shock.

To align our treatment and control group we use matching. The matching is based on a one-to-one matching minimizing the difference in the propensity score. The matching is based on year 2002 values, and the same low IAR-household is used as the match for each high-IAR homeowner through time. Replacement is allowed, meaning that each low IAR-household can appear as match for several high-IAR homeowners. Replacement improves the overall match and thereby minimizes the risk of a bias in the diff-in-diff estimation. The vector of control variables, C_i^{2002}, includes type of mortgage, logarithm of disposable income, debt-to-asset ratio, number of adults, borrowers, and kids, household type, gender, educational level, as well as regional dummies. All control variables are represented by their 2002-level, i.e., before the introduction of IO mortgages, to make sure that changes in consumption are not driven by changes in the control variables.

The results of the estimation are shown in Table 4. As expected we see a significant effect only for households close to the retirement age. For example, for households in the age group 60-64 the introduction of IO mortgages implied an increase in the annual consumption of 9.9% for households with a high IAR compared to households with a low IAR. For households in the age group from 65-69, the difference is as high as 17.0%. For older households the effects is smaller but still positive. In a probit estimation not reported, we find that households with a high IAR are generally less inclined to take an IO mortgage than household with a low IAR, but the difference is smallest in the older age groups. Moreover, among the near-retirement homeowners who took an IO mortgage shortly after the introduction, we see a larger consumption increase from 2002 to 2004-06 for homeowners having a high IAR than for those having a low IAR.

	-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-
After intro of IO	0.087**	0.111***	0.083***	0.100***	-0.025	-0.022	-0.097***	-0.134***	-0.013
	(0.027)	(0.019)	(0.014)	(0.012)	(0.015)	(0.014)	(0.019)	(0.026)	(0.013)
High IAR	-0.066**	0.080**	0.015	-0.002	0.027*	-0.032*	-0.020	0.006	0.060***
	(0.025)	(0.024)	(0.014)	(0.014)	(0.012)	(0.013)	(0.018)	(0.018)	(0.012)
After intro of IO	0.055	0.007	-0.004	-0.001	0.067***	0.046**	0.099***	0.170***	0.043**
X High IAR	(0.034)	(0.023)	(0.017)	(0.014)	(0.017)	(0.017)	(0.023)	(0.029)	(0.015)
Observations	1,414	3,145	6,052	9,711	12,472	9,082	6,064	4,974	5,946
R^2	0.325	0.398	0.345	0.309	0.228	0.329	0.314	0.252	0.566

Standard errors in parentheses
* $(p < 0.05)$,** $(p < 0.01)$,*** $(p < 0.001)$

Table 4: Difference-in-difference estimation across age groups. Coefficients from the difference-in-difference estimation of Eq. (3) that examines how the 2003 introduction of IO mortgages affects consumption for homeowners with high illiquid assets relative to those with low illiquid assets. Each column includes subsamples of age groups. Propensity matching is used and is based on 2002-levels of FRM/ARM, income, debt-to-asset ratio, gender, household type, education, number of borrowers, number of kids and adults in household, and geographical region. Robust standard errors are used. Data used includes homeowners from 2001 to 2006.

These results point to an important role of IO mortgages for liquidity-constrained older households. By using IO mortgages, these households are able to free up liquidity, allowing them to consume more. In other words, had these households not have had access to IO mortgages, their consumption would have been lower and their savings in real estate higher.

One may question whether the increased consumption we document is due to a credit-supply increase, and thus not due to the introduction of IO mortgages itself. The reason is that the period before the financial crisis witnessed both the introduction of IO mortgages and an expansion of credit in the economy. To test if our findings are due to a credit-supply shock, we conduct a placebo test. We run a similar difference-in-difference estimation to Eq. (3), but instead of looking at the period before and after the introduction of the IO mortgages, we look at the period before and after the peak of the financial crisis in 2009. We compare the 2009-2011 period with the 2006-2008 period. The after-crisis 2009-2011 period saw a credit-supply tightening, but there was no change to the IO legislation during this period. In this way, we separate the credit-supply effect from the effect of the introduction of IO mortgages. If the results in Table 4 are due to a credit-supply

	-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-
After 2009	0.068***	0.067***	0.069***	0.069***	0.018***	0.029***	0.103***	0.089***	0.124***
	(0.009)	(0.007)	(0.007)	(0.007)	(0.006)	(0.008)	(0.008)	(0.009)	(0.011)
High IAR	-0.058***	-0.038***	-0.006	0.017	0.017*	-0.019***	0.041***	0.104***	0.148***
	(0.012)	(0.010)	(0.010)	(0.009)	(0.007)	(0.009)	(0.010)	(0.011)	(0.013)
After 2009	0.033**	0.024**	0.000	-0.005	0.005	0.034***	0.005	0.014	-0.016
X high IAR	(0.013)	(0.009)	(0.009)	(0.009)	(0.008)	(0.010)	(0.010)	(0.011)	(0.013)
Observations	12,365	20,249	29,064	37,848	40,753	30,918	20,665	13,872	11,765
R^2	0.302	0.372	0.278	0.237	0.284	0.286	0.391	0.465	0.450

Standard errors in parentheses
* ($p < 0.05$) ,** ($p < 0.01$) ,*** ($p < 0.001$)

Table 5: Placebo test of the difference-in-difference estimation. Coefficients from a difference-in-difference estimation of a relation like Eq. (3) examining how the financial crisis in 2009 affects consumption for homeowners with high illiquid assets relative to those with low illiquid assets. Each column includes subsamples of age groups. Propensity matching is used based on 2007-levels of FRM/ARM, income, debt-to-asset ratio, gender, household type, education, number of borrowers, number of kids and adults in household, and geographical region. Robust standard errors are used. Data includes homeowners from 2006 to 2011.

expansion, we would expect to see the opposite results in this placebo test. As seen in Table 5, this is not the case. We observe a small significant effect for the young households, but generally the results are insignificant. This suggests that our findings in Table 4 are not due to a credit-supply increase.

4 How do households use the liquidity from IO mortgages?

IO mortgages have been blamed for leading households into excessive borrowing and consumption. By relaxing a commitment constraint to pay down a mortgage, IO mortgages allow households with preferences for constraining their own future choices (Laibson, 1997) to overconsume, in particular when young. In this sense, financial liberalization, in the form of IO loans, may provide consumers with "too much" liquidity. At a first glance, our data might appear to confirm this hypothesis.

The summary statistics in Table 1 show that IO mortgages are typically larger than repayment mortgages, also relative to household income. Households with an IO mortgage have, on average, larger total debt, a larger debt-to-asset ratio, lower income, and a signifi-

cantly larger loan-to-income ratio. Furthermore, IO borrowers have a higher consumption-to-income ratio and make lower pension contributions than borrowers with a traditional repayment mortgage. Overall, these observations seem to justify the concerns raised in the public debate on alternative mortgages. However, such a conclusion is premature. A first indication of this comes from calculating default frequencies after the burst of the house-price bubble in 2008. If households with IO mortgages leveraged up too much before the crisis, one would expect more defaults among IO borrowers after the crisis, i.e. after house prices plummet (Figure 3). We find no substantial difference between default rates of IO and repayment borrowers. The average fraction of loans between 2009 and 2016 with arrears of 105 days is 0.28% for IO mortgages and 0.22% for repayment mortgages. An interesting implication is that even if households did not fully comprehend the IO features—as explored by Johnson and Sarama (2015) and Jørring (2018) using US data—IO borrowers in our Danish data set did not seem to experience more financial difficulties than repayment borrowers during times of financial stress. There are several reasons for the similarity in default rates, and why default rates are low in general. First, for most IO mortgages in Denmark amortization starts 10 years after issuance, which means in 2013 or later and thus not in the midst of the financial crisis. Secondly, IO mortgages may only be issued to households that could afford a repayment mortgage. Thirdly, should an IO borrower be financially challenged when the amortization period begins, the mortgage institutions and banks can often offer a refinancing package allowing the borrower to stay in the home.

In the next sections, we use the fact that we have detailed data on different types of debt and the asset composition of the households to see whether households with IO mortgages reshuffle their debt composition in meaningful ways and whether IO mortgages influence the asset composition and pension contributions of households.

4.1 Reduction in life-time borrowing costs

By taking an IO mortgage, households can pay down more expensive debt instead of their mortgage, and hence reduce life-time borrowing costs. Figure 9 gives a detailed picture of the financial situation of households with an IO mortgage and households with a repayment mortgage, respectively. The figure is designed like Figure 4 but illustrates patterns of total debt, other debt (i.e. bank debt and other types of non-mortgage debt), cash (balance of bank account), market value of stocks and bonds, public valuation of the home, and the contribution to pension saving schemes over the life cycle. In this section, we focus on mortgage debt and other debt, i.e. Panels (a) and (b). The other panels are discussed in subsequent sections.

Panel (a) of Figure 9 shows that at all ages homeowners with IO mortgages have higher mortgage debt relative to income than homeowners with repayment mortgages. The distance between the two curves increases with age due to the drop in income, not an increase in mortgage debt.[16] Panel (b) of Figure 9 illustrates that other debt relative to income is decreasing over the life cycle. Until the age of 72, other debt is higher for homeowners with an IO mortgage than for homeowners with repayment mortgages, whereas the reverse is true for households older than 72 years. This indicates that homeowners with IO mortgages tend to take up more non-mortgage debt in their youth, but repay that non-mortgage debt more rapidly than homeowners holding a repayment mortgage.

Motivated by these patterns, we run the simple OLS regression

$$y_i = \beta_0 + \beta_1 D_i^{IO} + \delta' C_i + u_i, \tag{4}$$

where y_i is the ratio of other debt to total debt for household i, and C_i is the vector of the standard control variables. Table 6 presents the results. We find that for age 40 and above IO borrowers have a lower fraction of other debt relative to total debt than borrowers

[16] In absolute terms it can be shown that the value of mortgage debt is higher for households with IO mortgages over the entire life cycle. Also, for both types of households we see a drop in the absolute value of their total mortgage debt. These results are available upon request.

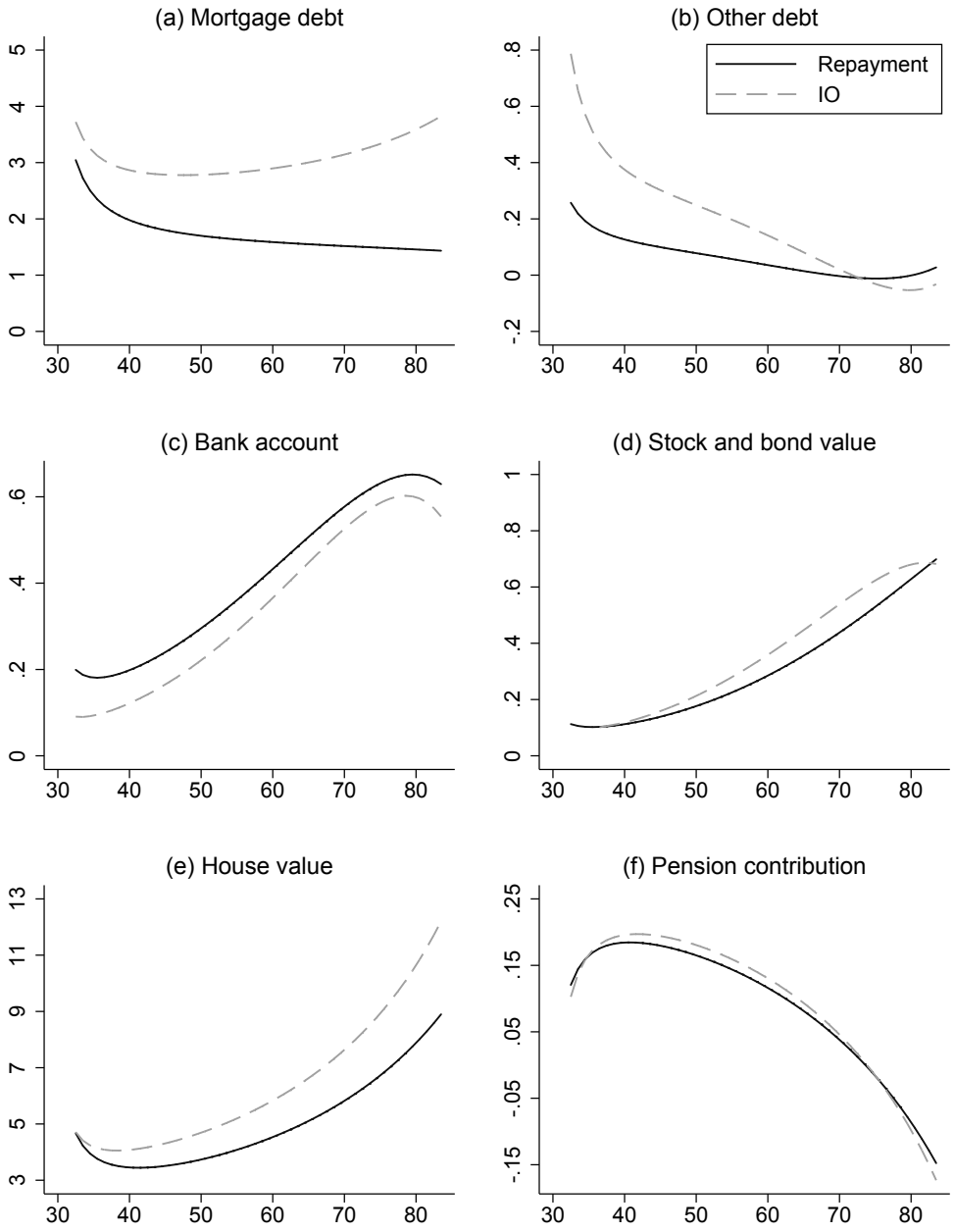

Figure 9: Life-cycle patterns for different financial variables relative to income. Medians of mortgage debt, other debt, bank account, public house value, and pension contributions, as well as means of market value of stocks and bonds, from 2004 to 2015 for different age groups and across mortgage type. All variables are measured relative to annual income. The graphs show an overall polynomial fit of all the age groups. Nine age groups are used; below 35, 35-39, 40-44, ..., 65-69, 70 and above in 2004. Each observation for an age group is illustrated at the average age in that group. The dashed curves are based on homeowners holding an IO mortgage at some point within the period from 2004 to 2015, whereas the solid curves are based on homeowners holding only repayment mortgages within this time period. The graph applies balanced data on homeowners from 2004 to 2015.

	-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-
IO mortgage	0.024***	0.007***	-0.006***	-0.010***	-0.019***	-0.030***	-0.037***	-0.040***	-0.034***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)
FRM	0.014***	0.009***	0.006***	0.014***	0.018***	0.023***	0.011***	-0.003	0.007
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)
FRM	0.004	0.005	0.008**	-0.005	-0.012***	-0.014***	-0.009**	0.008	-0.010*
× IO mortgage	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Observations	58,913	44,319	45,797	44,227	39,854	36,207	29,585	20,606	24,011
R^2	0.308	0.305	0.277	0.231	0.209	0.167	0.144	0.122	0.081
Adjusted R^2	0.307	0.304	0.276	0.231	0.208	0.167	0.143	0.121	0.080

Standard errors in parentheses
* $(p < 0.05)$,** $(p < 0.01)$,*** $(p < 0.001)$

Table 6: Other debt over total debt. Coefficients and robust standard errors (in brackets) from the OLS estimation stated in (4) across age groups. The dependent variable is the fraction of other debt relative to total debt. The regression controls for income, debt-to-asset ratio, gender, education level, number of borrowers, numbers of kids and adults and families represented in the household, and regional and time fixed effects are also included. The table includes homeowners with a mortgage between 2003 and 2015. A random year is used to represent the mortgage choice for each household.

with repayment mortgages. For example, a household in the age group 55-59 with an adjustable-rate IO mortgage has a debt-ratio 3.0 percentage points lower than a similar household with an adjustable-rate repayment mortgage. If the household instead had a fixed-rate IO mortgage, the debt-ratio would be 2.1 percentage points lower compared to a household with a fixed-rate repayment mortgage (the sum of the three coefficients in the column 55-59 is -0.021). Interestingly, we see this pattern only for the middle-age and old households, whereas the young households with an IO mortgage have a higher fraction of other debt relative to total debt. Hence, it seems that, except for young households, IO mortgages are used for reducing financial costs related to other, more expensive loans.

4.2 Improved diversification

Homeowners may benefit from reducing their mortgage repayments and instead investing in financial assets to obtain a more diversified portfolio. Panel (c) of Figure 9 shows that homeowners with repayment mortgages hold more money in bank accounts relative to income than homeowners with IO mortgages. This indicates that IO mortgages are not chosen with the purpose of increasing cash balances.

On the other hand, Panel (d) in Figure 9 reveals that savings in stocks and bonds relative to income are slightly higher for IO borrowers. The market value of stock and bond holdings relative to income increases with age both for IO borrowers and borrowers with repayment mortgages but, in particular for middle-aged and older households, financial asset holdings are larger for IO borrowers. This suggests that some age groups choose IO mortgages to increase investments in stock and bonds. To explore the effect in more detail, we run the probit estimation

$$P(D_i = 1|X_i, C_i) = \Phi\left(\beta' X_i + \delta' C_i + u_i\right), \tag{5}$$

where D_i is a dummy variable equal to one if household i holds stocks, X_i is the vector of interest and includes dummies for the nine different age groups, and C_i is a vector of standard control variables. The probit estimation requires that each household is only present once, hence we represent each household by a random year after 2003. The results listed in Panel A in Table 7 show that the probability of investing in stocks increases with approximately 5% for middle-aged and old households with an IO mortgages, whereas among young households IO borrowers are slightly less inclined to participate in the stock market than borrowers holding a repayment mortgage.[17] These findings question the view that risk tolerance is a key driver of mortgage choice as was suggested by Cox et al. (2015). If IO mortgages are predominantly taken by more risk-tolerant households, we should see more stock market participation among IO borrowers across all age groups, but the younger households contradict this pattern.

4.3 Pension contributions

As explained by Amromin et al. (2007) homeowners may benefit from reducing their mortgage repayments and instead increasing their contributions to retirement saving ac-

[17] When running the probit estimation with D_i indicating participation in the stock or the bond market (or both), the age-group coefficients are slightly higher, e.g., 0.063 for the 60-64 year old instead of 0.058 with stock market participation only. Details are available upon request.

counts. Panel (f) of Figure 9 shows that pension contributions in our data are hump shaped, peaking around the age of 45, and turning negative in the late 60s when the pension payout period typically starts. The pension contributions seem almost unrelated to the mortgage type. To investigate this in more detail, we first run a probit estimation similar to (5), but with the dummy variable D_i being equal to one if household i contributes to a private pension saving account. All working households in Denmark pay into a labor-market pension program. On top of that households may voluntarily pay contributions to a private pension scheme. Hence, our probit regression tells us if households with an IO mortgage are more likely to make voluntary pension contributions, in this case indicating that they use some of the saved repayments to pension contributions. Panel B of Table 7 show that very young households are less likely to make private pension contributions if they have an IO mortgage than a repayment mortgage. On the other hand, households above 55 seem to use the saved repayments to pay into a private pension.

To assess the magnitude, we run an OLS regression similar to (4), but with the dependent variable y_i being the average total pension contribution per adult per year. The results stated in Panel C of Table 7 show that households above 45 with an IO mortgage pay a larger amount to a voluntary pension contribution than households with a repayment mortgage. For example, in the age group 50-54 a household with an adjustable-rate IO mortgage pays on average 4,761.6 DKK more into their pension account per adult compared to a household with an adjustable-rate repayment mortgage. A household with a fixed-rate IO mortgage pays 7,203.6 DKK more into their pension account than a household with a fixed-rate repayment mortgage. Interestingly, the coefficients are only significant for households in the age groups 45-49, 50-54, and 55-59, and the biggest difference is for households in the age group of 50-54. Hence, it seems that for households in the late 40s and 50s, some of the saved repayments from their IO mortgages are used to increase their pension savings, and in this way smooth consumption over the life cycle.

Amromin et al. (2007) suggest a role for non-conventional mortgages in tax arbitrage. US households can save taxes by reducing mortgage repayments and investing a similar

	-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-
Panel A: Probit, Stock Market Participation									
IO mortgage	-0.015***	-0.013*	0.003	0.030***	0.039***	0.056***	0.058***	0.059***	0.045***
	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.008)	(0.008)
Observations	58,913	44,319	45,797	44,227	39,854	36,207	29,585	20,606	24,011
Pseudo-R^2	0.047	0.060	0.065	0.067	0.063	0.058	0.049	0.055	0.055
Panel B: Probit, Private Pension Participation									
IO mortgage	-0.028***	-0.013*	-0.012*	0.001	0.013*	0.024***	0.016**	0.003	
	(0.004)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	
Pseudo-R^2	0.065	0.054	0.055	0.058	0.068	0.088	0.090	0.111	
Panel C: OLS, Pension contribution									
IO mortgage	-345.4	182.9	739.0	1893.9***	4761.6***	4089.2***	698.1	268.0	
	(245.9)	(374.7)	(418.8)	(495.0)	(630.4)	(717.8)	(711.3)	(528.1)	
FRM	1311.9***	1540.8***	513.8	413.1	-5.8	-746.7	531.8	-243.4	
	(236.5)	(344.0)	(382.0)	(468.6)	(439.1)	(597.4)	(677.1)	(459.4)	
FRM	448.2	1235.5*	3081.6***	3909.6***	2442.0*	4548.8***	1573.8	1347.3*	
× IO mortgage	(323.1)	(564.4)	(803.4)	(895.7)	(1055.7)	(1129.7)	(1079.9)	(606.2)	
R^2	0.364	0.303	0.311	0.279	0.267	0.233	0.245	0.131	
Adjusted R^2	0.363	0.302	0.310	0.278	0.266	0.233	0.245	0.130	

Standard errors in parentheses
* $(p < 0.05)$,** $(p < 0.01)$,*** $(p < 0.001)$

Table 7: Asset diversification. Coefficients (OLS), average partial effects (probit), and robust standard errors (in brackets) from the probit and OLS estimations stated in (5) and (4), respectively, across age groups. The dependent variable in Panel A is a dummy variable indicator for the homeowner investing in bonds and stocks. In Panel B the dependent variable is a dummy indicator for the homeowner contributing to a private pension saving account. In Panel C the dependent variable is the average pension contribution per adult in the household. The regression controls for income, debt-to-asset ratio, gender, education level, number of borrowers, numbers of kids and adults and families represented in the household, and regional and time fixed effects are also included. The table includes homeowners with a mortgage between 2003 and 2015. A random year is used to represent the mortgage choice for each household. Households above 70 are ignored in the analysis of pension contributions.

amount in tax-favored retirement saving schemes (in mortgage bonds to keep the overall risk unchanged). A similar strategy can be implemented by Danish homeowners who (i) have less than ten years to retirement and can thus take an IO mortgage until retirement and (ii) pay the highest marginal tax rate while working but a lower tax rate during retirement. Consider a mortgage with a 2% interest rate and a 0.5% contribution rate to the issuer. Since tax deductability of interest rate (and contribution) expenses is about 25%, the after-tax borrowing cost is $(2\% + 0.5\%) \times (1 - 0.25) = 1.875\%$, which is the costs of postponing repayments. When investing in a similar 2% mortgage bond through a pension fund, the return is taxed at 15.3%, leaving an after-tax return of $2\% \times (1 - 0.153) = 1.694\%$, which is lower than the saved mortgage costs and thus apparently not an arbitrage. However, pension contributions are deductable from labor income so the household can increase their investment by more than the saved repayment. On the other hand, pension payouts are also taxed as labor income. But due to the progressive tax system, the income tax rate for some households is considerably higher before retirement when the extra pension contributions are made than after retirement where income is typically lower and where the extra pension payouts are received. For such households an arbitrage-like strategy involving IO mortgages is possible also in a Danish context.[18] Unlike the case for some retirement saving schemes in the US, pension savings cannot be paid out prematurely in Denmark, so the above strategy is not feasible for younger households. As mentioned, Panel B of Table 7 reveals that in particular households above 55 seem to have used saved repayments to increase pension contributions. Given that the average retirement age in Denmark is around 65, this could very well reflect the tax arbitrage described above.

5 Summary and conclusion

We make two main contributions to the literature on households' use of IO mortgages. First, we show that there is not a uniformly positive relation between future income growth of households and households' use of IO mortgages. The relation is positive for

[18] The strategy is mentioned in the Danish media and on webpages of Danish pension funds.

young households, as has been reported in the literature, but not for old. In fact, for old households, the relation is negative, as they face flat or declining income. To explain the large use of IO mortgages among old households, we propose and verify empirically that IO mortgages relax an otherwise binding liquidity constraint, by allowing old households to reduce repayment of existing mortgages, thereby increasing liquidity and improving consumption smoothing.

Second, we use the fact that we have access to detailed data on the debt and asset composition of households to show that households with IO mortgages are more indebted, but pay down other non-mortgages debt to a larger extent, save more in stocks, and contribute more to pension savings, compared to households with repayment mortgages.

Our findings thus indicate that by relaxing a borrowing constraint IO mortgages facilitate household consumption smoothing over the life cycle and, in particular, they can improve the welfare of young households expecting increasing income and old, liquidity-constrained households. Furthermore, IO mortgages allow households to reduce life-time borrowing costs and to obtain a better diversified asset portfolio. When assessing the overall welfare implications of IO mortgages, these benefits can be contrasted with the higher leverage of households with IO mortgages.

We look at the microeconomic evidence. We cannot rule out that interest-only mortgages have additional macroeconomic effects that cannot be covered in full by studying microdata. For instance, as mentioned earlier, Dam et al. (2011) find that the introduction of IO mortgages contributed to the surge in home prices during the housing boom in Denmark. This not only harms prospective homeowners but also the broader economy by potentially contributing to a boom-bust dynamic. Further, increasing the ability for households to lever up may lead to a misallocation of credit to the household sector relative to more productive sectors and can thereby reduce innovation and growth, cf. Jappelli and Pagano (1994). It is outside the scope of this paper to evaluate these macroeconomic effects.

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