Household Debt and Monetary Policy: Revealing the Cash-Flow Channel*

Martin Flodén
Sveriges Riksbank and CEPR

Matilda Kilström
IIES, Stockholm University

Jósef Sigurdsson
IIES, Stockholm University

Roine Vestman
Stockholm University and SHoF

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Abstract

We examine the cash-flow channel of monetary policy, i.e. the effect of monetary policy on spending when households hold debt linked to short-term rates such as adjustable rate mortages (ARMs). Using registry-based data on Swedish households, we estimate substantial responses to a change in the monetary policy rate depending on homeowners' debt-to-income ratio and depending whether homeowners hold ARMs or FRMs. Our findings imply that monetary policy will have a stronger effect on real economic activity when households are highly indebted and have ARMs. For homeowners with a debt-to-income ratio exceeding 2 and who hold ARMs, the response is equivalent to a marginal propensity to consume of 0.5 out of interest expenses.

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1 Introduction

A fundamental question in macroeconomics is to which degree and via which mechanisms monetary policy can affect the real economy. Although being a widely studied area, there remains limited consensus about exactly how monetary policy exerts its influence. A subtler question is whether households are unequally affected by monetary policy. In this paper we study how monetary policy can differentially affect household consumption by directly affecting the disposable income of households that hold loans with interest rates that vary with the short-term market interest rate.

In standard macroeconomic models with nominal rigidities, such as the contemporaneous New Keynesian paradigm, the primary mechanism through which monetary policy operates is the *interest rate channel*. Because of rigid nominal wages and prices, an increase in the nominal interest rate is not fully and instantaneously reflected in changes in expected inflation, and therefore translates into an increase in the real interest rate and the user cost of capital. According to the Euler equation, an increase in the real interest rate raises households' value of future consumption relative to current consumption, leading to postponement in consumption and private investment. Although this mechanism is the one which is at the heart of the textbook macroeconomic models, many researchers, e.g. Bernanke & Gertler (1995), have found that changes in monetary policy have a more powerful effect on the real economy than predicted by conventional estimates of the intertemporal interest rate elasticities of consumption and investment. This observation implies the existence of other important transmission mechanisms than the standard interest rate channel. Among other channels that have been studied extensively are the wealth channel (Ando & Modigliani, 1963) and the credit channel (Bernanke & Gertler, 1989).

In modern economies, where a large share of households hold debt, monetary policy can also have a direct effect on household spending via its effects on households' cash flows and disposable income. For example, a tightening of monetary policy raises interest rate expenses for households with adjustable mortgage rates and therefore has a negative impact on disposable income of such households. If the household is forward-looking and has good access to financial markets, such variations in cash flows need not result in consumption responses. But if for some reason the household cannot or does not want to increase its debt in response to temporarily lower disposable income, monetary policy will affect consumption also through this *cash-flow channel*.[1]

One would suspect that the importance and effectiveness of this channel depends on a number of factors such as how wealth and debt is distributed across households, how the marginal propensity to consume out of disposable income varies between savers and borrowers, and how elastic market interest rates are to changes in monetary policy. In particular, institutional details in the mortgage market matter. If the market is dominated by fixed-rate mortgages (FRMs), as in the United States, Germany, and France, one would expect the cash-flow channel to be muted. But in economies where most mortgages have an adjustable rate (ARMs), as in the United Kingdom,

[1] This terminology has previously been used by for example Cloyne *et al.* (2016) whereas Berben *et al.* (2004) and Di Maggio *et al.* (2014) refer to the same channel as the "income channel".

Spain, and Sweden, the cash-flow channel may be important for the transmission of monetary policy. However, to date there remains limited evidence on how households are influenced through this channel.

In this paper we investigate the heterogeneity in the response to consumption of a monetary policy induced change in the short-term rate. We study these effects using Swedish household data. For several reasons, Sweden is the perfect lab for this analysis. First, ARMs is a standard, non-exotic, product. Throughout our sample period, ARMs as a share of the aggregate value of outstanding mortgages oscillated between 30 and 40 percent. Most of indebted Swedish homeowners have at least a share of their mortgages with adjustable interest rates (Holmberg *et al.* , 2015). A possible concern is that households may select into adjustable vs. fixed interest rates based on household-specific characteristics that are correlated with macroeconomic developments.[2] More importantly, the choice between ARMs and FRMs does not seem to be driven by endogenous selection. One indication of this is that households that we identify as having variable rates in our sample have observable characteristics very similar to households identified as having fixed rates.[3] A second reason to focus on Sweden is data availability. A common challenge in most previous empirical studies on the impact of unearned income on consumption is lack of datasets that feature both a high quality measure of consumption and data on households' wealth and balance sheets. We overcome this problem by using administrative panel data based on tax reports, which allows us to impute a measure of consumption, as in Koijen *et al.* (2015), as well as providing us with detailed information on all earnings, income, assets and debt positions.

A typical identification problem when trying to estimate the impact of monetary policy is that changes in monetary policy are endogenous to the economic development. It is therefore difficult to identify the causality from monetary policy to economic outcomes. Such problems are mitigated with the household-level data that we use. All households are affected by the same monetary policy, but the impact varies from household to household because they have different balance sheets and financial contracts. In particular, we examine how monetary policy affects consumption choices for households with large debt positions, measured as debt-to-income ratios, and how it affects homeowners with ARMs relative to homeowners with FRMs.

We are thus able to study how households that are more likely to be credit constrained and have a higher degree of variability in their mortgage interest rates respond to interest rate changes

[2]In general, it is not possible to characterize an optimal mortgage contract. Rather, Cocco (2013) points out the benefits of offering households a menu of contracts. Campbell & Cocco (2003) study the selection between ARMs and FRMs in a life-cycle model with risky labor income and borrowing constraints. Their results suggest that households with a large mortgage, risky labor income, high risk aversion, a high cost of default, and a low probability of moving are less likely to prefer an ARM. Further, Campbell & Cocco (2015) show, in an incomplete markets model, that ARMs have a higher default rate than FRMs when interest rates increase. Badarinza *et al.* (2015) study the determinants of within- and cross-country variation in the ARM share. They find evidence suggesting that households consider both current interest costs, consistent with borrowing constraints, as well as life-time cost minimization.

[3]Moreover, a recent study on Swedish households by Holmberg *et al.* (2015), which has access to precise details in the mortgage contracts and to the banks' assessment of household default probabilities, does not find that the default probability correlates with the choice of interest-rate fixation.

induced by monetary policy. Our main finding is that among the most indebted homeowners, the consumption responds more to changes in the monetary policy rate. I.e., the debt-to-income ratio interacts with changes in the repo rate. Comparing a homeowner who owes three times her disposable income instead of an identical homeowner who owes two times her income, the former responds by reducing consumption by 0.43 percent more for a one-percentage point increase in the monetary policy rate. Moreover, the effect is entirely concentrated among highly indebted homeowners who hold ARMs. Among highly indebted holders of ARMs, the MPC out of changes in interest expenses is estimated to approximately 0.5. I.e., among this group of homeowners – which represents about one sixth of all homeowners – half of the monetary policy induced change in interest expenses is absorbed by household consumption.

Our paper contributes to several strands of literature, of which Cloyne *et al.* (2016) is most similar to us. They study the response of expenditure and income to monetary policy in the UK and the USA.[4] They find that the dollar change in mortgage payments is three times as large in the UK, however they argue that the general equilibrium effect of monetary policy on income is quantitatively more important that the direct effect of cash-flows.

Another strand of the literature uses quasi-experiments to deduce effects of changes to the mortgage rate. Di Maggio *et al.* (2014) study consumption and deleveraging decisions of households prior to, and following, a change in their monthly interest payments. They study data for the subsample of US households with non-agency mortgages which have interest rates that remain fixed for 5 years but are then automatically adjusted. Differences in the timing of these adjustments allow for difference-in-difference estimation. The authors find strong responses in consumption to a change in interest expenses. At the reset date, monthly interest payments drop by about a half, causing a substantial increase in car purchases, the authors' main measure of consumption. In addition, they find that a share of the increase in disposable income generated by lower expenses is devoted to saving through deleveraging on the mortgage. Applying a similar identification strategy, Keys *et al.* (2014) study proprietary loan data and estimate the balance sheet effects of a change in interest payments following the reset date. They find that a reduction in mortgage payments causes a decrease in defaults, a drop in credit card debt, and an increase in new auto debt, indicating an increase in durable consumption. Unlike these studies we use a comprehensive expense-based measure of consumption to study responses of a representative sample of the Swedish population. Since changes to the monetary policy rate are partly predictable and partly unpredictable, we are able to disentangle the two. Our instrumental variables estimates based on monetary policy shocks indicate that predictable changes are at least as important for the heterogeneity in response as unpredictable ones.

We also contribute to the general literature studying the transmission mechanisms of monetary policy (see e.g. Bernanke & Gertler, 1995; Kashyap & Stein, 2000) and, in particular, to the literature on the relation between household debt and the transmission mechanisms of monetary policy. Calza *et al.* (2013) document that the transmission of monetary policy shocks to resi-

[4] As in Sweden, ARMs make up a large share of mortgages in the UK.

dential investment and house prices is stronger in countries with more flexible and developed mortgage markets, and that responses in consumption are stronger in countries where there is higher prevalence of ARMs. Rubio (2011) builds a New Keynesian model with a housing market and collateral-constrained households, extending the framework in Iacoviello (2005) by allowing for both adjustable and fixed rate mortgages. Monetary policy has a stronger effect when a larger share of mortgages have adjustable rates. However, in general equilibrium the partial equilibrium effects are muted by a redistribution between borrowers and savers as well as by labor supply responses. In a recent paper, Garriga *et al.* (2015) view mortgages with contract frictions that prevent interest rates to adjust instantly as a nominal rigidity which they incorporate into a general equilibrium model as the only source of nominal friction. The authors find that monetary policy shocks have larger real effects under ARMs than FRMs since not only does an increase in the nominal interest rate reduce consumption growth through a reduction in new borrowing but also by increasing (real) mortgage payments.

The long period with extraordinarily expansionary monetary policy after the outbreak of the financial crisis has resulted in a discussion about the distributional impact of monetary policy (see for example Bullard, 2014; Mersch, 2014; Bernanke, 2015). By estimating disaggregated household reactions to monetary policy, our paper contributes to the recent literature that analyzes this distributional impact. In previous theoretical work, Garriga *et al.* (2015) find that monetary policy shocks redistribute income from homeowners to capital owners under ARMs, but vice versa under FRMs. Auclert (2016) develops a model to evaluate the redistributional effect of monetary policy on consumption. The model provides two important predictions. First, unhedged interest rate exposure is an important channel in household's response to monetary policy. Second, this is an asymmetric effect, with interest rate increases reducing consumption more that interest rate cuts would raise it.[5] Another recent contribution is Greenwald (2016), who shows that inclusion of a payment-to-income constraint in a DSGE model generates substantial aggregate effects. Recently, Hedlund *et al.* (2016) study the interaction between monetary policy, house prices and consumption responses in a rich quantitative model.

Our study is also related to a series of papers studying household consumption responses to shocks to unearned income and fiscal stimulus programs. Shapiro & Slemrod (2003), Johnson *et al.* (2006), Agarwal *et al.* (2007), Shapiro & Slemrod (2009), and Parker *et al.* (2013) study the effect of 2001 and 2008 economic stimulus payments in the US on consumer spending.[6] Agarwal & Qian (2014) study the effect of a one-time cash payout from the Singaporean government which, in contrast to the US stimulus payments, were unanticipated by Singaporean households. In all cases, the authors find a considerable consumption response to these income shocks. And the response is stronger for those that are more likely to be liquidity constrained, e.g. have low liquid assets or a low credit card limit. These papers study consumption responses to a positive shock

[5] For recent empirical studies on the redistribution channel of monetary policy, see, e.g., Sterk & Tenreyro (2015) and Casiraghi *et al.* (2016).

[6] For studies on the consumption responses to other sources of shocks to disposable income, see, e.g. Stephens (2008), Kueng (2015), and Hsieh (2003).

to disposable income as a result of fiscal policy programs. One way to view our paper is as a monetary policy analogue to the fiscal policy programs studied in this literature.

Lastly, we contribute to a literature that studies whether sensitivity of household spending to changes in income is related to mortgage debt or house prices. Mian *et al.* (2013) study household consumption response to large negative shocks to household wealth, finding that households with different levels of wealth have a different marginal propensity to consume out of a dollar lost. Baker (2014) finds that the consumption elasticity of income is significantly higher in households with high debt. This relation is not causal, however, since level of liquid assets and access to credit drive most of the heterogeneity in consumption responses to an income shocks and debt by itself plays a minor role. Using Danish administrative data, Andersen *et al.* (2015) study if household leverage prior to the financial crisis amplified the reduction in household spending during the crisis. They find a negative correlation between pre-crisis debt growth and consumption growth during the crisis but no relation between high debt at the time of the crisis and a spending decline over the course of the crisis.[7]

The remainder of this paper proceeds as follows. Section 2 provides details on the dataset we use and our measure of consumption as well as presenting general summary statistics. Section 3 presents empirical and theoretical motivation as well as a discussion of the empirical strategy. We present our main findings in Section 4. Section 5 concludes.

2 Data and Summary Statistics

Data description The main dataset we use is the Swedish registry-based panel dataset LINDA (Longitudinal INdividual DAta for Sweden). This dataset is representative for the Swedish population, covering a random sample of 300,000 households and their members. Since in Sweden, as in other Scandinavian countries, each tax payer has a unique social security number, we are able to construct a panel using several sources of administrative data. Our sample period covers 2000-2007. During this period, Sweden levied a wealth tax which meant that taxpayers were required to provide the tax authority with comprehensive information on all taxable wealth, in addition to information on earnings and income. The tax registers therefore include information about all taxable income and transfers, tax payments, liabilities and taxable wealth, including value of real estate (i.e., houses, apartments and cabins), cash holdings on bank accounts, bonds, stocks, and mutual funds.[8] Values of real estate are the tax-based values for houses and cabins, which are a function of a long list of characteristics of the property and updated yearly using a price index which is constructed from transactions in a given municipality in each year. Values of financial assets are detailed and, for instance, each household reports each and every listed stock or mutual fund it holds in its tax filings. The dataset contains information on total household debt which is

[7] The paper by Andersen *et al.* (2015) is relevant for out study also because they use a similar dataset and, as we, impute consumption from changes in households' balance sheets.

[8] For further details on the dataset used in the current paper see Koijen *et al.* (2015), and see Edin & Fredriksson (2000) for a detailed account of the data collection process for LINDA.

the debt measure we use in the empirical analysis.[9] In addition, the dataset includes residential location for each household and various demographic variables.

Sampling restrictions We restrict the sample in four ways. First, we restrict the households in our sample to be represented by a household head which is 18 years or older. Second, since changes in the family structure, such as divorces, may affect our consumption measure, we exclude observations for unstable households, i.e. when the household head is not the same as in previous period. Third, we exclude observations for those years when households buy or sell residential housing. The reason for this restriction is that we have an imperfect measure of the value of the real estate, and changes in this variable – which is undoubtedly the largest component in households' asset portfolio – might bias our consumption measure. Fourth, we restrict our attention to households that remain in our panel for 3 or more years. The main reason for this restriction is, as we explain further in Section 3, to be able to compute the correlation between each household's interest rate and the monetary policy rate, which is our measure of fixed and adjustable rate loans.

We exclude outliers in our sample in four ways. First, we exclude observations when our consumption measure is negative. Negative consumption is likely to reflect some measurement issues that we are unable to account for in the consumption imputation process. Second, we exclude the bottom 3rd percentile in the income distribution. Third, we exclude the top 3rd percentile of the distribution of household specific interest rates. Fourth, we exclude the bottom and top 5th percentiles of the distribution of consumption growth rates. These restrictions leave us with a sample of around 50,000 households on average per year, of which about 30,000 per year are homeowners. The latter group is of our main focus since those holding mortgages have interest expenses that may be affected by monetary policy. Finally, in our empirical analysis we use predetermined debt-to-income values. We restrict the sample to include households with information on debt-to-income lagged by two years.

Imputing consumption We use this detailed dataset to impute a measure of consumption based on the approach in Koijen *et al.* (2015). This is a vital part of our exercise since the main outcome of interest is spending. Although our data is reported at the individual level, we construct the measure of consumption for the household. Information for the individual tax payer is aggregated to the household level using marital status, residential location, and parent-child linkages. Household characteristics, such as age and education, represent a household head, which we take as the oldest individual in the household unless more than one individual is of that same age, in which case we choose the oldest male.

A common way of describing a given household i's budget constraint in year t is as follows

$$C_{i,t} = Y_{i,t} + \Delta D_{i,t} - r^D_{i,t} D_{i,t-1} - \Delta A_{i,t} + r^A_{i,t} A_{i,t-1} \tag{1}$$

[9] We are unable to separate household debt into mortgages and other components. However, given that our main sample consists of homeowners, the main share of household debt will likely consist of mortgage debt.

That is, consumption, C, is constrained by disposable income, Y, the change in outstanding debt, ΔD, interest payments, $r^D D$, savings, ΔA, and their returns $r^A A$. Based on the notion that the budget constraint can serve as an accounting identity in a given year, it can be used to impute a measure of consumption as total income net of change in wealth from previous period. This is possible since all terms on the right-hand side of equation (1) are observable in our data. Mapping equation (1) into the detailed structure of our data gives the identity

$$c_{i,t} = y_{i,t} + \Delta d_{i,t} - r^d_{i,t} d_{i,t-1} - \Delta b_{i,t} - \Delta v_{i,t} - \Delta h_{i,t} - \Delta \psi_{i,t} - \omega_{i,t} \tag{2}$$

where the household's disposable income, y_i, includes labor income, transfers and benefits (all net of taxes), and financial income, Δd is the change in debt, $r^d d$ are interest payments, Δb is the change in deposits on bank accounts, Δv is active re-balancing of mutual funds, stocks, and bonds, Δh is the change in housing wealth (due to buying/selling), $\Delta \psi$ are changes in capital insurance accounts, and ω are contributions to private pension savings.

Equation (2) is identical to the imputation method of Koijen *et al.* (2015), who show that the correlation between the imputed measure and a survey-based measure of consumption exceeds 0.5 at the household level. Relative to Koijen *et al.* (2015), one refinement has been made which concerns bank accounts. Bank account deposits are only reported if certain criteria are met and those changed in 2006. In 2000-2005, a deposit in a bank account was reported in the Swedish tax records if the earned interest from that account exceeded SEK 100, while in 2006 and 2007 the deposit was only reported if the balance on the account exceeded SEK 10,000. Overall, the new rule implies an improvement in accuracy. However, to avoid over-stating savings between 2005 and 2006 we artificially implement the reporting rule of 2000-2005 also on the latter period when imputing consumption.

Imputing mortgage type Our proposed transmission channel for monetary policy relies on a high prevalence of adjustable rate mortgages (ARMs). Figure 1 shows the division of fixed-rate periods of new mortgages in Sweden during the relevant period. ARMs are defined as mortgages with a fixed-rate period of three months or shorter. It is clear that a nontrivial share, approximately fifty per cent, of new mortgages had adjustable rates during the period. Figure 2 reports the division of fixed-rate periods in the stock of outstanding mortgages. The value-weighted share of ARMs increases from 30 to 40 percent during the time period. Taken together, these aggregate statistics suggest that the cash-flow channel may be an important transmission mechanism.

We now turn to the measurement of household-specific interest rates in our microdata set. We do not observe household debt contract details in our data. However, we observe both interest payments and balance on loans every year. For each household we therefore define the interest rate $r^d_{i,t}$ as the total interest expenses divided by total debt in the same period,

$$r^d_{i,t} = \frac{\text{interest payment}_{i,t}}{\text{debt}_{i,t}} \tag{3}$$

The left panel of Figure 4 illustrates how the value-weighted household interest rate moves with

the repo rate. The U-shaped pattern of both rates highlights the prevalence of ARMs, with the average household interest rate sligthly lagging the policy rate. However, we cannot directly observe in our dataset if a household has a fixed or adjustable rate mortgage. Instead, we first calculate the correlation between household-specific interest rates, $r^d_{i,t}$, and the repo rate, r_t:

$$corr_i = \text{corr}\left(r_t, r^d_{i,t}\right). \tag{4}$$

Figure 3 shows the density of the household interest rate (left panel) and the correlation measure in our sample (right panel). We see that there is substantial variation both in the household-specific interest rate and in its correlation with the repo rate. We then classify indebted homeowners as having a high variability of their interest rates ("ARM") or low variability ("FRM") if the correlation of their interest payments with the repo rate is above or below the median correlation in the sample (the median correlation is 0.55). The average correlation among homeowners with ARMs equals 0.85 whereas it is 0.15 among homeowners with FRMs.[10] Using this definition, the fraction of homeowners with ARMs in our sample is 39%. The right panel of Figure 4 provides a graphical documentation of there being a strong effect of our classification. We see that the (value-weighted) interest rate for households with ARMs co-moves strongly with the repo rate year-by-year, while the interest rate for households with FRMs is much less sensitive to monetary policy.

Summary statistics We report summary statistics for the main variables in our dataset. An important part of our analysis is to identify groups of households that (i) are likely or unlikely to be credit constrained, and (ii) have interest expenses that are either sensitive or insensitive to changes to monetary policy shocks. Therefore, we split the sample along two dimensions and present summary statistics by groups. First, we split the sample by debt-to-income (DTI) ratios, our primary measure of (in)ability to smooth shocks to interest expenses. Second, we split the sample by mortgage type.

Figure 5 provides motivation why it is sensible to hypothesize that homeowners with higher DTI are more sensitive to interest rate changes than less indebted homeowners. The figure displays the cross-sectional variation in assets, debt and interest expenses among homeowners. The cross-section of homeowners is split into four groups of debt-to-income, homeowners with no debt and in addition three equally large groups sorted into low, medium and high debt-to-income. The top panels show liquid assets, illiquid assets, and debt. Whereas illiquid assets is relatively evenly distributed among the four groups (the mean varies between 1.88 for the no debt category to 5.1 for the high category), both liquid assets and debt are more unevenly distributed. The least indebted homeowners ("No debt") have on average liquid assets equal to 1.37 years of disposable income. In contrast, the most indebted group ("High DTI") has on average liquid assets equal to 0.30 years of disposable income and a debt-to-income ratio of 3.04. Strikingly, the median liquid assets position in the most indebted group is amounts to only 0.13 years (one and a half month) of disposable income. The bottom panels of Figure 5 display cross-sectional variation in interest

[10] Appendix **??** provides further evidence on how households' interest payments respond to repo rate changes.

expenses relative to disposable income and consumption. Homeowners in the high DTI category spend on average 0.14 years (0.16 years) of disposable income (consumption) on interest expenses. (The median shares are very similar.) A doubling of the interest rate that homeowners face would thus imply that the median homeowner in the high DTI category would deplete liquid assets within one year, unless they adjust their income and/or consumption. Kaplan *et al.* (2014) show the importance of considering the varying liquidity of household assets. They emphasize the significant share of "wealthy-hand-to-mouth" households. These households are wealthy in terms of illiquid wealth but hold very little liquid wealth. Importantly, these wealthy households have a large propensity to consume out of changes in transitory income and do not react strongly to news about future income changes. In this light the pattern we observe in the raw data strengthens our hypothesis of the sensitivity of indebted households to changes in interest expenses. To summarize, the figure documents that although high-income households are wealthy in terms of illiquid wealth they hold low levels of liquid assets, are highly indebted and have high interest expenses relative to their income. When faced with increased expenses, such as after a sudden increase in their mortgage interest rate, these households may face a difficulty in retaining their level of consumption unless being able to access additional credit. If credit constrained, these households are likely to have to reduce their level of consumption when faced with increased expenses. The Appendix reports the analogous figure for an even split of homeowners into quintiles of debt-to-income (Figure 7).

Table 1 reports further summary statistics for the full sample (column 1), for renters (column 2), and for three groups of homeowners (column 3-5). Indebted homeowners have been split into three equally large groups based on DTI and in addition homeowners with no debt have been added to the low category. Going forward, this is our main classification of homeowners. We report all monetary values in Swedish kronor (SEK).[11] On average, homeowners with high debt have favorable characteristics compared to the average homeowners. They have higher disposable income (SEK 366,000 vs SEK 311,000), are younger (46 years vs 54), and have more household members (3.2 household members vs 2.6). They are also better educated. 43 percent have more than high school education compared to 32 percent among all homeowners. These differences also spill over to consumption. Highly indebted homeowners consume SEK 342,000 whereas homeowners on average consumption SEK 295,000. Most of the difference is driven by household size – once scaled by adult equivalents (denoted by a.e.) the difference is only SEK 1,000. Highly indebted homeowners have twice as much debt as the average homeowner (SEK 1,031,000 vs SEK 466,000). The difference in debt-to-income is of about the same magnitude. Highly indebted homeowners have a lower interest rate (4.6 percent vs. 5.0 percent) but a higher interest share out of disposable income (12.8 percent vs. 6.2 percent) as a result of the higher debt-to-income. The correlation between the household interest and the repo rate is about the same as for the average homeowners (0.52 vs 0.48). The greater debt is matched by a greater position in illiquid assets (i.e., real estate). Highly indebted homeowners have a on average illiquid assets worth SEK 1.7

[11] During our sample period the average exchange rate to the U.S. dollar was about 8 SEK/USD.

million whereas the average is SEK 1.1 million. Notably, highly indebted homeowners fair worse in terms of liquid assets (SEK 110,000 vs SEK 196,000), liquid assets to income (0.29 vs 0.71) and loan-to-value (0.81 vs. 0.49).

In Table 2 we report summary statistics for homeowners with ARMs and FRMs. The sample is remarkably balanced along this dimension. The two groups have similar wealth (both financial assets and real estate), income, and consumption. The also have similar LTV ratios. Homeowners with a short duration of debt has slightly more debt and a slighly higher DTI ratio but overall these differences are small. The third column reports the coefficient estimates from a single-variable regressions of each characteristic on an indicator of having a high variable interest rate. While the coefficients are statistically significant apart from a few exceptions, the magnitude of the coefficients are small in the economic sense. Put differently, the differences in balance sheet positions across the two groups are small.

3 Empirical Framework

Theoretical motivation To motivate our empirical framework we briefly consider models of consumer behavior. A natural starting point for studying consumption and savings decisions are the aforementioned life cycle/permanent income models. In these types of models consumers have concave preferences which induces a consumption smoothing motive. This implies that, for unconstrained households that are forward-looking and maximize expected utility, consumption will only react to unanticipated income changes. In the most extreme setup, where markets are complete and allow households to fully insure against idiosyncratic risks, the consumption growth rate will be identical for all households. The first-order conditions for household optimization then reduce to

$$\Delta \log c_{i,t} = \lambda_t \tag{5}$$

where λ_t captures anticipated and unanticipated macroeconomic developments that are common to all households.[12] A somewhat more general specification that does not rely on full insurance between households results in the first-order condition

$$\Delta \log c_{i,t} = \lambda_t + \varepsilon_{i,t} \tag{6}$$

where $\varepsilon_{i,t}$ contains news on idiosyncratic consumption possibilities for the household. According to these theories, a change in monetary policy will be captured by the term λ_t and therefore have an identical impact on consumption growth for all households. But it is well-established that there is little empirical support for a strict interpretation of the theories behind equations (5) and (6). For example, it has been found that consumption, in violation of equation (6), often responds to predictable household-specific income changes. One suggested remedy to explain such behavior

[12] Although not explicitly captured in this specification, preference shifters, such as age or household composition, may then still generate variation in consumption growth between households.

is to introduce borrowing constraints. Carroll & Kimball (1990) is an early theoretical contribution showing that the average marginal propensity to consume increases in the presence of borrowing constraints and uncertainty. Campbell & Mankiw (1990) introduce "rule-of-thumb" consumers as another potential explanation for the excess sensitivity of consumption.

If binding borrowing constraints or hand-to-mouth behavior due to other factors are prevalent in the economy, interest-rate changes will affect consumption growth more for some households than others. To motivate an empirical specification that allows for such cash-flow effects, consider a hand-to-mouth household that for some reason lets marginal changes in disposable income feed directly into consumption. If the household holds assets and debt constant, the budget constraint (2) implies that

$$\Delta c_{i,t} = \Delta y_{i,t} - d_{i,t-1}\Delta r^d_{i,t}. \tag{7}$$

After log-linearizing, this can be approximated as:

$$\Delta \log c_{i,t} = \alpha_i \Delta \log y_{i,t} - \alpha_i DTI_{i,t-1}\Delta r^d_{i,t} \tag{8}$$

where α_i is the inverse of the consumption-to-income share for household i and DTI is the debt-to-income ratio. An implication of equation (8) is that (aggregate) interest rate changes has a different impact on consumption growth at different positions in the cross-sectional distribution of DTI. This is the cash-flow channel. If cash-flow effects work through binding borrowing constraints that are updated period-by-period, households may respond even more strongly to news. In particular, if there are binding debt-to-income restrictions households may respond more strongly to income news than indicated by (8), and if there are binding loan-to-value restrictions households may respond also to changes in house prices.

Empirical strategy Our empirical strategy aims at estimating the extent to which the cash-flow channel of monetary policy generates a heterogeneous effect on household consumption growth. If these cash-flow effects of monetary policy have an impact on household behavior, that impact is likely to be most visible for households with ARMs and high DTI. In order to test this hypothesis, we estimate the following regression equation:

$$\Delta \log c_{i,t} = \beta_0 + \beta_1 \Delta r_t + \beta_2 DTI_{i,t-2} + \beta_3 \Delta r_t \times DTI_{i,t-2} + \beta_4 \mathbf{X}_{i,t} + \delta_t + \phi_i + \varepsilon_{i,t} \tag{9}$$

where Δr_t is the change in the repo rate and $DTI_{i,t-2}$ is the DTI ratio lagged two years. I.e., compared to equation (8) we lag the DTI ratio one additional year. The purpose of doing so is that we can regard it as predetermined with respect to $c_{i,t-1}$. We prefer to use the change in the repo rate, Δr_t, rather than the change in the household-specific rate. This avoids any bias that would arise if unobserved idiosyncratic events (e.g., negative news about future income) affect both the household's consumption path and households' credit worthiness. $\mathbf{X_{i,t}}$ is a vector of controls consisting of various factors influencing preferences for consumption. We include in this vector a fourth order polynomial in age, education, household size and the change in household size. δ_t includes a

full set of year fixed effects and ϕ_i are household fixed effects. The year fixed effects capture the change in the repo rate during the year and other common macroeconomic factor. The household fixed effects capture the mortgage holder type and time-invariant unobservable characteristics. Our attention is on the implications of cash-flow effects of interest-rate changes, and hence on the parameter β_3. The empirical specification in (9) is intended to capture the theoretical implications from the previous subsection. If markets are complete as in (5), all effects of interest-rate changes on household consumption are captured by the year fixed effects. We then expect $\beta_3 = 0$ for all households.[13] On the other hand, if the effect of monetary policy has a differential impact across the distribution of DTI, β_3 is non-zero. More specifically, for a constrained household that consumes all its disposable income, (8) implies that $\beta_3 = -\alpha_i DTI_i$, i.e. proportional to the household's DTI ratio. Furthermore, we wish to emphasize that the inclusion of year and household fixed effects implies that we measure relative responses less the aggregate effect. In other words, our specification allows us to make inference about heterogeneous responses to monetary policy but not to make inference about the aggregate effect per se.

We extend (9) to include an interaction term for mortgage type:

$$\begin{aligned}\Delta \log c_{i,t} = \gamma_0 + \gamma_1 \Delta r_t + \gamma_2 DTI_{i,t-2} + \gamma_3 \Delta r_t \times DTI_{i,t-2} ARM_i + \gamma_4 DTI_{i,t-2} \times ARM_i \\ + \gamma_5 \mathbf{X}_{i,t} + \delta_t + \phi_i + \varepsilon_{i,t}\end{aligned} \tag{10}$$

where ARM_i is a dummy variable that takes on a value of one if the household is classified as a holder of an adjustable rate mortgage and otherwise zero. γ_3 measures the differential impact on consumption growth between a holder of an FRM and an ARM and is the main coefficient of interest. Again, we are focusing on the differential impact between holders of ARMs and FRMs rather than the aggregate response.

By estimating (9) and (10) on households with different DTI ratio (i.e., "low", "medium", or "high"), we attempt to capture non-linear effects over the cross-sectional distribution. We also estimate (9) on other selected sub samples, such as households with little liquid assets, households with a high loan-to-value, households with a low income, or young households. In addition we estimate equation (9) for the sample of renters.

IV estimates One reasonable hypothesis is that levered households respond differently to expected and unexpected changes to the repo rate. In order to investigate whether this is the case we instrument the repo rate changes with monetary policy shocks.

We calculate monetary policy shocks using an approach similar to the work of Gertler & Karadi (2015). They use high frequency identification of monetary policy shocks. This approach is developed to identify exogenous innovations in monetary policy that are due entirely to policy shifts, i.e. innovations that are unrelated to the macroeconomic development. With such an instrument,

[13] Strictly speaking, this is not entirely correct since we allow for group-specific year fixed effects as we estimate one regression for each group of households.

we address the simultaneity problem which would arise if monetary policy reacts to a macroeconomic development that has a heterogeneous impact on the household groups that we analyze.

To identify this innovation, we use a tight window around the time of a monetary policy announcement to isolate the effect of policy surprise on market interest rates. In Sweden, the monetary policy decision is announced the day after the meeting where the policy rate, the repo rate, is determined. In contrast to Gertler & Karadi (2015), we do not have access to futures instruments for the full period that we study. We instead use the change in the Treasury bill short term interest rate on the day of the announcement, and assume that the movement in the interest rate that day is dominated by the innovation in monetary policy. More precisely, we construct the monetary policy shock as the difference between the interest rate at the end of the day of the policy announcement and the day before the announcement,

$$MPS_d = {i_d}^{1M} - i_{d-1}^{1M}$$

where i_d^{1M} is the interest rate on the 1-month Swedish Treasury bill and d is the day of a monetary policy announcement. We time aggregate the monetary policy shocks to an annual measure by summing them year-by-year. Figure 8 shows that the resulting monetary policy shocks have a similar development as the repo rate, but that the magnitude of these innovations is considerably smaller than the repo rate changes. Using this measure of monetary policy shocks we construct an instrumental variable in similar fashion as before by interaction with the correlation, or sensitivity, measure

4 Results

In this section we present our main findings.

4.1 Main results

Table 3 reports our main findings. It focuses on homeowners with different debt-to-income ratios.The first three columns focus on the role of the DTI ratio and corresponds to regression equation (9). Column (1) indicates a small amount of heterogeneity in response to repo rate changes for different DTI ratios. For a homeowner with a high DTI ratio (a ratio of 3.3 on average), a one percentage point increase in the repo rate implies a shift in consumption growth of –0.043 percent (3.3×-0.013). For a homeowner with a medium or low DTI ratio (a ratio of 0.75 on average), a one percentage point increase in the repo rate implies a shift in consumption growth equal to -0.01 (0.75×-0.013). These are very moderate differences.

However, column (2) and (3) focus on high and medium/low DTI households separately to detect non-linear relationships. The main finding from these specifications is that the role of the DTI ratio is very different in different parts of the cross-sectional distribution. For high DTI homeowners (column 2), a one-percentage point increase in the repo rate has quite a different impact depending on the DTI ratio. For two identical homeowners in the high-DTI category who differ

only so that one of them has additional debt worth one year of disposable income – say, e.g., that one homeowner has a DTI ratio of 3.0 and the other a ratio of 4.0 – the more indebted of the two responds by contracting consumption by an additional -0.44 percent if the repo rate increases by one percentage point.

The impact of a change in the repo rate depends on the outstanding DTI ratio among low and medium DTI homeowners too (column 3). Each additional unit of debt (say a comparison between a ratio of 1.0 and 2.0) implies an incremental positive response to consumption growth by 1.26 percent if the repo rate increases by one percentage point. We conclude that the small negative relationship reported in column (1) masks a non-linear relationship.

Columns (4) to (6) illustrate the impact of ARM holders in comparison to FRM holders, corresponding to regression equation (10). Column (4) indicates that previous specifications in column (1) to (3) mask quite a bit of heterogeneity. Unlike column (1), we see that the differences between ARM and FRM holders are large. The average FRM holder, with a DTI ratio of 1.6, responds by increasing consumption by 1.7 percent (1.6×1.06) in the event of a one-percentage point increase of the repo rate. The average ARM holder, with a DTI ratio of 1.9, responds by decreasing consumption by -0.03 percent ($1.9 \times (1.055 - 1.071)$). Recall that these responses are net of a baseline aggregate response (see discussion of the aggregate effect in Section 3).

Among highly indebted households (column 5) we measure an even greater variation in the response. For FRM holders, we measure a positive response of 1.83 percent (evaluated at a DTI ratio of 3.3). For ARM holders, we measure a negative response of -1.78 percent (again, evaluated at a DTI ratio of 3.3). Assuming an immediate one-to-one response of rates of ARMs, a net MPC (i.e., net of some average aggregate effect) can be calculated for ARM holders. Using that 95 percent of disposable income is consumed for ARM holders, the (net) MPC equals 0.5. This implies that half of the cash-flow effect is absorbed through adjustment of consumption. For low and medium homeowners (column 6), we find variation in the response too. The effect is 1.84 percent for holders of FRMs and -0.14 percent for holders of ARMs (evaluated at the average DTI ratio of 0.75).

Though we only measure the relative effect of changes to repo rate between homeowners, and not the aggregate effect, we argue that it it is highly plausible that the aggregate effect is smaller than the heterogeneity in the response. To further investigate the relative effect for different groups of homeowners, we plot the difference in consumption growth between different sub-groups of homeowners in Figure 6. The figure also plots the change to the repo rate, distinct U-shape. The left panel displays the median consumption growth of all homeowners minus the median consumption growth of homeowners that belong to the high DTI group. There is a strong positive correlation between the two series, indicating that as the repo rate increases, the consumption of high DTI homeowners falls behind. The right panel displays the median consumption growth of homeowners that belong the high DTI group minus median consumption growth of homeowners in the high DTI group that also hold ARMs. Similar to the left panel, it is evident that as the repo rate increases, the consumption of high DTI homeowners with ARMs falls behind.

4.2 Sub-groups

Our hypothesis is that some household types are more likely to behave as hand-to-mouth consumers, i.e. as in equation (8), whereas other household types are more likely to behave as in equation (6). Table 4 breaks down our analysis further with this model of consumer behavior in mind. It considers the effect of monetary policy among different sub-groups of homeowners that are likely to adversely affected by a tightening of monetary policy. Column (1) repeats the specification of column (2) of Table 4, focusing on the high DTI group. Column (2) then restricts the sample further to those that have low liquid assets, defined as a share of liquid assets relative to disposable income below the median. The effect of DTI is the same within this group as within the high DTI group in its entirety. Column (3) focuses on high DTI homeowners who have a high LTV ratio as well. (A high LTV ratio is defined as belonging to the top third of all households which corresponds to a ratio equal or greater than 0.67.) At a coefficient of -0.765, the effect is greater than among the high DTI group in its entirety. Among low income (defined as having a disposable income below the median, or below SEK 283,000) and young households (column 4 and 5), the effect of DTI is more modest. In particular among young households (age 40 or less), there is no role of DTI in conjunction with repo rate changes. The effect among homeowners who have low liquid assets and a high LTV is on the other hand quite stark. At a coefficient of -1.102, the heterogenous effect is nearly twice as large in this sub-group. On the other hand, if one simply focuses on homeowners with low liquid assets and low income, there is no differential response that depend on the DTI ratio.

4.3 Instrumental variables regression

We estimate (9) and (10) using instrumental variables to see if unexpected changes to the repo rate have a different impact than expected changes. Table 5 presents the estimates. Quantitatively, the estimates are much smaller but qualitatively they remain similar. Among high DTI households there is a negative effect of increases in the household interest rate whereas among low and medium DTI households the effect is positive. Similar to before, there is a wedge between holders of FRMs and ARMs (column 4 to 6). We conclude that unexpected changes to the repo rate have, if anything, a smaller differential impact on levered versus unlevered homeowners.

5 Conclusion

This paper studies a transmission mechanism of monetary policy that operates through interest rate changes on households' outstanding debt. The effects on households' spending are heterogenous and depend on whether the household has debt with variable interest rates. We study this channel for monetary policy using an administrative panel dataset for a large representative sample of Swedish households. The dataset contains both detailed information about the balance sheet of households and their consumption. Most Swedish households hold some share of their

overall debt in loans with variable interest rates. Importantly, adjustable rate mortgage contracts is a standard, non-exotic, form of mortgage contract in Sweden.

We estimate a small negative response of consumption growth to increases in the policy rate (i.e., the repo rate) for levered homeowners. There is however substantial heterogeneity in effects at different parts of the debt-to-income distribution and the negative effect is mainly attributed to the most levered homeowners. Highly indebted homeowners (i.e, homeowners with a debt-to-income ratio exceeding 2) respond more negatively to repo rate increases the more leveraged they are. Furthermore, we find that holders of fixed rate and adjustable-rate mortgages respond differently. Our results suggest that the negative effect of repo rate increases is entirely concentrated among highly leveraged homeowners who hold ARMs. For those, half of the cash-flow effect induced by repo rate changes is absorbed by changes in spending. The findings are robust to including the use of monetary policy shocks as an instrumental variable for the repo rate.

Our results have important implications for the role of monetary policy. They indicate that in economic environments where households are highly indebted, face restricted access to credit, and hold loans with interest rates that respond directly to variations in short interest rates, monetary policy is very potent. Monetary policy will have a stronger effect on real economic activity than in other environments since households will respond to monetary policy-induced interest rate changes by a larger magnitude than predicted by conventional estimates of the intertemporal elasticity of substitution.

It is in order to emphasize the limitations of our study and the interpretability of our results. Our focus is only on the cash-flow effect of changes in interest rates, but not on the effect that monetary policy may have on the supply of credit. This may be an important channel, particularly at times when central banks make large changes to its policy rates. We are also unable to characterize the general equilibrium effect of the cash-flow channel on aggregate consumption in the economy. Another channel that we have abstracted from but believe to be important is that monetary policy may have heterogeneous effects on household consumption by affecting the distribution of wealth in the economy. As a result of these alternative channels we are unable to make claims about the welfare implications of the cash-flow channel of monetary policy. Studying such implications remains as interesting but challenging tasks for future research.

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Table 1: Summary statistics

	All	Renters	Homeowners	High DTI	Low/Medium DTI
	(1)	(2)	(3)	(4)	(5)
Sociodemographics					
Disposable income	262	187	311	366	291
	(148)	(94)	(155)	(154)	(151)
Disposable income a.e.	152	134	163	169	161
	(57)	(47)	(60)	(60)	(59)
Age	55	56	54	46	57
	(17.1)	(19.1)	(15.5)	(11.1)	(15.8)
Household size	2.3	1.8	2.6	3.2	2.4
	(1.5)	(1.4)	(1.5)	(1.5)	(1.4)
Education					
< High school (share)	17.50	24.60	13.48	6.20	16.58
High school (share)	53.09	50.94	54.31	50.50	55.94
> High school (share)	29.41	24.46	32.21	43.30	27.48
Consumption measure					
Consumption	253	187	295	342	278
	(148)	(99)	(158)	(168)	(151)
Consumption a.e.	147	135	155	156	155
	(61)	(53)	(65)	(67)	(64)
Balance sheet items					
Debt	311	74	466	1,031	260
	(450)	(152)	(509)	(563)	(280)
Debt-to-income	1.2	0.90	1.4	3.3	0.75
	(107)	(170)	(14.7)	(28.3)	(1.3)
Interest rate	5.0	5.1	5.0	4.6	5.2
	(3.3)	(4.9)	(2.1)	(1.3)	(2.3)
Correlation measure	0.38	0.13	0.48	0.52	0.46
	(0.54)	(0.58)	(0.48)	(0.46)	(0.49)
Interest share	4.2	1.2	6.2	12.8	3.8
	(5.4)	(2.8)	(5.9)	(5.5)	(3.7)
Illiquid assets	705	0	1,166	1,706	968
	(949)	(0)	(976)	(1,102)	(843)
Liquid assets	150	81	196	110	227
	(292)	(216)	(324)	(179)	(358)
Liquid assets-to-income	0.62	0.48	0.71	0.29	0.87
	(2.4)	(3.2)	(1.8)	(1.7)	(1.8)
Loan-to-Value (-p99)	0.49	-	0.49	0.81	0.38
	(0.44)	-	(0.44)	(0.37)	(0.41)
Observations	257,921	102,033	155,888	41,720	114,168

Notes: High DTI and Low/Medium DTI represent groups separated based on homeowners' Debt-to-Income (DTI). High DTI represents the top third of the DTI distribution for homeowners with positive debt. The Low/Medium DTI group includes the bottom two thirds and homeowners without debt. The split is based on DTI lagged by two years, and we display average predetermined DTI. Values are in 1,000 Swedish Krona or in percent (averages). Values in parenthesis are (s.d.). 'a.e.' refers to adult equivalent. The scaling factor follows OECD, assigning a weight of 1 to the first household member, 0.7 to each additional adult and 0.5 to each child. Age and education refers to the household head.

Table 2: Summary statistics and balance by mortgage type

	FRM	ARM	ARM – FRM
	(1)	(2)	(3)
Sociodemographics			
Disposable income	336	348	12.102***
	(148)	(152)	(1.433)
Disposable income a.e.	168	171	2.193***
	(59)	(61)	(0.553)
Age	50	50	0.044
	(12.9)	(12.8)	(0.130)
Household size	2.8	2.9	0.086***
	(1.5)	(1.5)	(0.015)
Education			
< High school (share)	11.64	10.09	-
High school (share)	55.72	54.85	-
> High school (share)	32.64	35.06	-
Consumption measure			
Consumption	315	330	15.607***
	(153)	(160)	(1.401)
Consumption a.e.	157	161	3.790***
	(63)	(66)	(0.536)
Balance sheet items			
Debt	532	607	75.238***
	(498)	(514)	(4.782)
Debt-to-income	1.6	1.9	0.282***
	(5.4)	(22.9)	(0.095)
Interest rate	5.3	4.7	-0.548***
	(2.4)	(1.7)	(0.017)
Correlation measure	0.15	0.85	0.694***
	(0.45)	(0.10)	(0.003)
Interest share	7.4	7.6	0.002***
	(5.8)	(5.5)	(0.001)
Illiquid assets	1,201	1,310	110.036***
	(970)	(1,022)	(9.336)
Liquid assets	152	159	6.934***
	(248)	(262)	(2.281)
Liquid assets-to-income	0.40	0.42	0.022***
	(0.79)	(1.53)	(0.009)
Loan-to-Value (-p99)	0.59	0.62	0.031***
	(0.42)	(0.41)	(0.004)
Observations	67,258	60,804	186,840

Notes: Columns (1) and (2) report summary statistics by groups with different duration of debt, where High (Low) represents groups with a correlation of household interest rates with the repo rate below (above) the median among home owners. Values are in 1,000 Swedish Krona or in percent (averages). Values in parenthesis are (s.d.). Column (3) reports regression coefficients from single variable regressions on an indicator of having a highly variable interest rate. Standard errors, reported in parenthesis below, are clustered at the household level. See table 1 for further details.

Table 3: Main results – effects for homeowners

	All	High DTI	Medium and Low DTI	All	High DTI	Medium and Low DTI
	(1)	(2)	(3)	(4)	(5)	(6)
$DTI_{t-2} \times \Delta r_t$	-0.013**	-0.435***	1.260***	1.055***	0.555**	2.450***
	(0.006)	(0.140)	(0.398)	(0.119)	(0.259)	(0.458)
$DTI_{t-2} \times \Delta r_t \times ARM$	–	–	–	-1.071***	-1.114***	-2.644***
	–	–	–	(0.119)	(0.158)	(0.260)
DTI_{t-2}	0.000***	0.002***	0.113***	0.019***	0.010***	0.108**
	(0.000)	(0.001)	(0.038)	(0.006)	(0.002)	(0.045)
$DTI_{t-2} \times ARM$	–	–	–	-0.019***	-0.007**	0.025
	–	–	–	(0.006)	(0.003)	(0.058)
Observations	156,574	41,720	114,168	128,062	41,720	86,342

Notes: All specifications include year fixed effect, household fixed effects, a fourth polynomial in age, household size, and growth in household size. DTI denotes the ratio of debt to income. Δr_t is the year-on-year change in the repo (monetary policy) interest rate, set by the Central Bank's monetary policy committee. ARM is an indicator for having ones own interest rates that correlate strongly with the repo rate (above median correlation). Standard errors in parenthesis are clustered at the household level. *, ** and *** denotes significance at the 10 percent, 5 percent and 1 percent level, respectively.

Table 4: Sub-groups

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$DTI_{t-2} \times \Delta r_t$	-0.435***	-0.427**	-0.765**	-0.329**	-0.191	-1.102***	-0.243
	(0.140)	(0.205)	(0.307)	(0.151)	(0.514)	(0.389)	(0.193)
DTI_{t-2}	0.002***	0.002**	0.004**	0.002**	0.082***	0.005***	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.013)	(0.002)	(0.001)
High DTI	Yes	Yes	Yes	Yes	Yes	Yes	
Low liquid assets		Yes				Yes	Yes
High LTV			Yes			Yes	
Low income				Yes			Yes
Age $\leq$40					Yes		
Observations	41,720	22,450	25,969	15,184	15,489	15,888	8,638

Notes: Low liquid assets is defined as having a liquid assets to income ratio that is below the median (0.17). High LTV is defined as having an LTV in the in the highest third of all households (above 0.66). Low income is defined as having a disposable income below median (below SEK 283,000). All specifications include year fixed effect, household fixed effects, a fourth-order polynomial in age, household size, and growth in household size. Standard errors in parenthesis are clustered at the household level. *, ** and *** denotes significance at the 10 percent, 5 percent and 1 percent level, respectively.

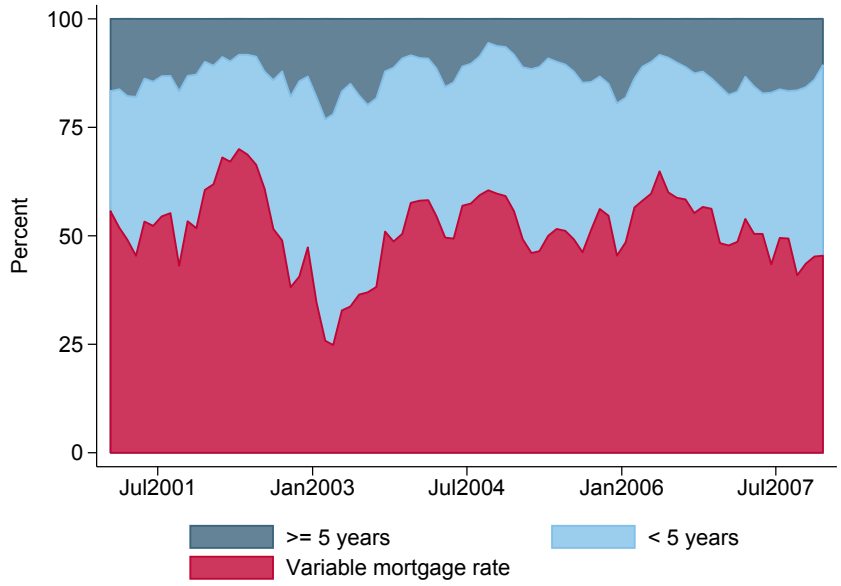
Table 5: Instrumental variable regressions

	All	High DTI	Medium and Low DTI	All	High DTI	Medium and Low DTI
	(1)	(2)	(3)	(4)	(5)	(6)
$DTI_{t-2} \times \Delta r_t$	-0.027**	-0.017***	0.269***	0.079	0.164	0.859***
	(0.012)	(0.004)	(0.099)	(0.080)	(0.144)	(0.213)
$DTI_{t-2} \times \Delta r_t \times ARM$	–	–	–	-0.107	-0.183	-1.884***
	–	–	–	(0.081)	(0.143)	(0.211)
DTI_{t-2}	0.000***	0.000***	0.004***	-0.000	-0.002	0.003
	(0.000)	(0.000)	(0.001)	(0.001)	(0.002)	(0.002)
$DTI_{t-2} \times ARM$	–	–	–	0.001	0.002	-0.011***
	–	–	–	(0.001)	(0.002)	(0.003)
Observations	155,888	41,720	114,168	128,062	41,720	86,342

Notes: All specifications include year fixed effect, household fixed effects, a fourth polynomial in age, household size, and growth in household size. DTI denotes the ratio of debt to income. Δr_t is the year-on-year change in the repo rate, instrumented by monetary policy shocks. ARM is an indicator for having ones own interest rates that correlate strongly with the repo rate (above median correlation). Standard errors in parenthesis are clustered at the household level.

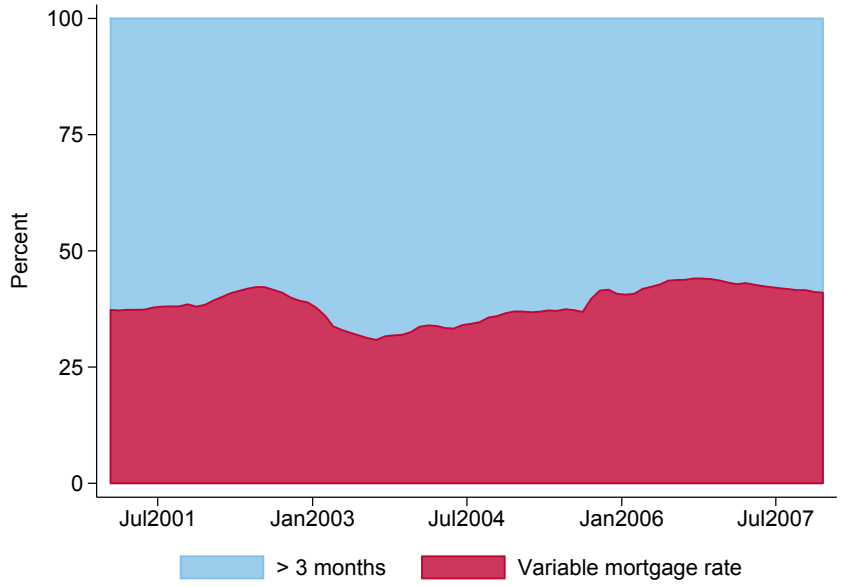
*, ** and *** denotes significance at the 10 percent, 5 percent and 1 percent level, respectively.

Figure 1: Share of mortgage issuances by duration of interest rate fixation



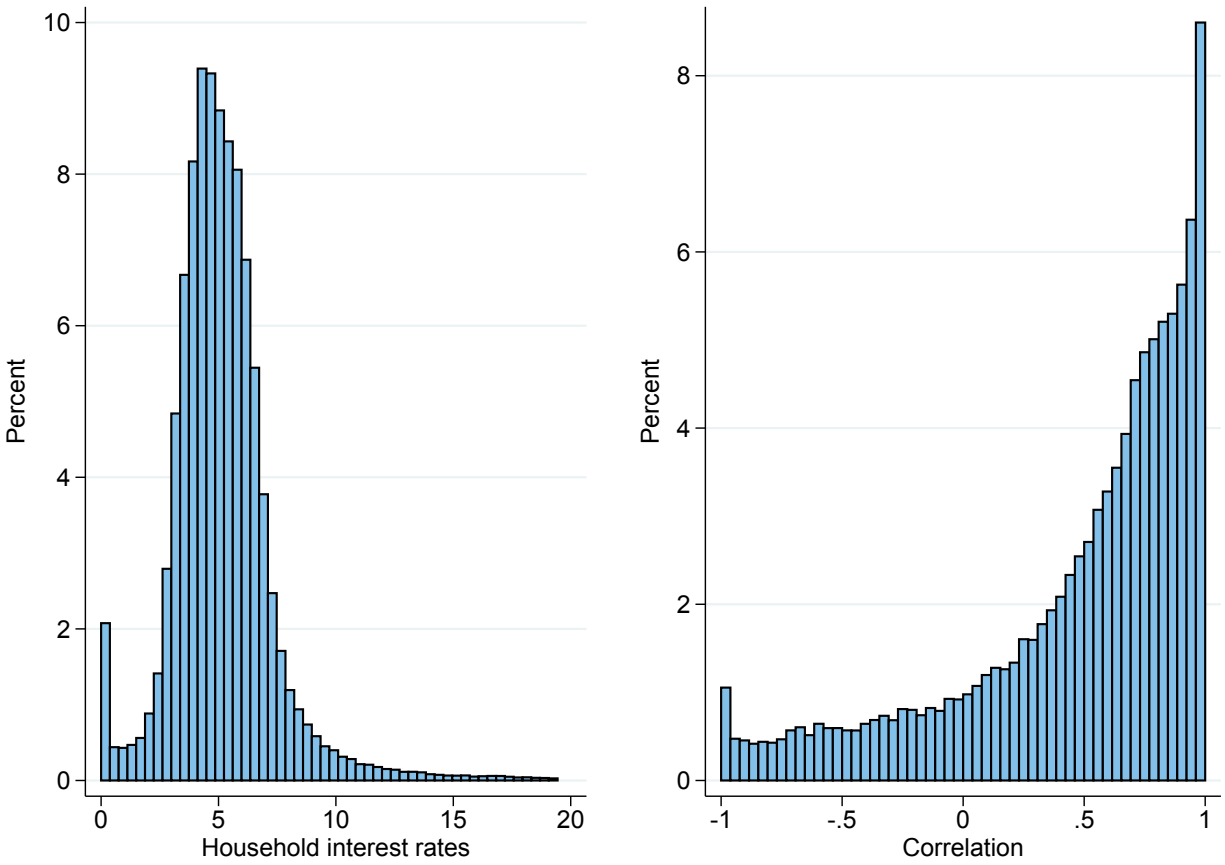
Note: Variable mortgage rate is defined as 3 months or shorter. The data source is Figure A18 in Riksbanken (2012).

Figure 2: Shares of the mortgage stock by duration of interest rate fixation



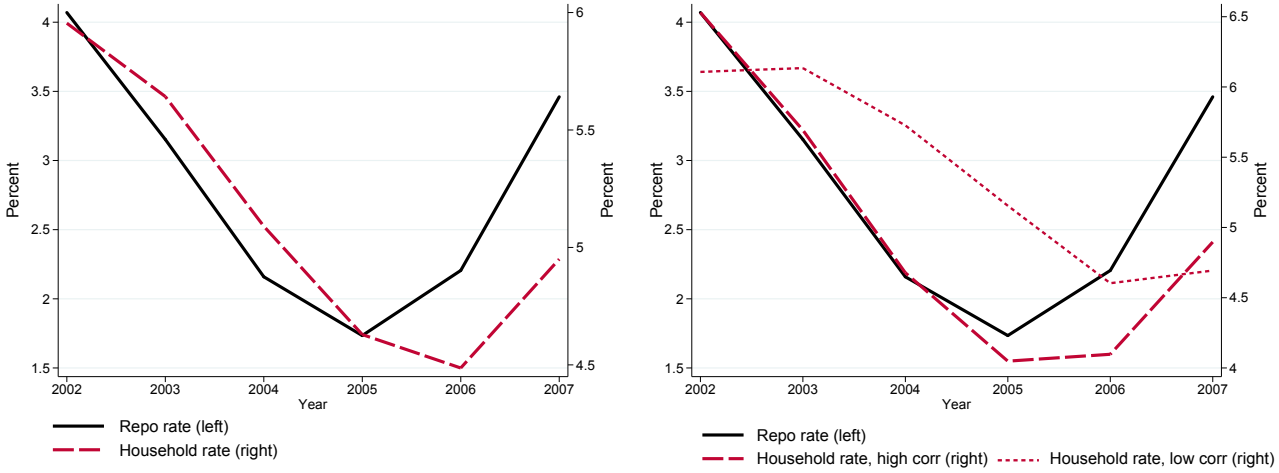
Note: Variable mortgage rate is defined as 3 months or shorter. The data source is Figure A30 in Riksbanken (2015).

Figure 3: Household interest rates and correlations with the repo rate



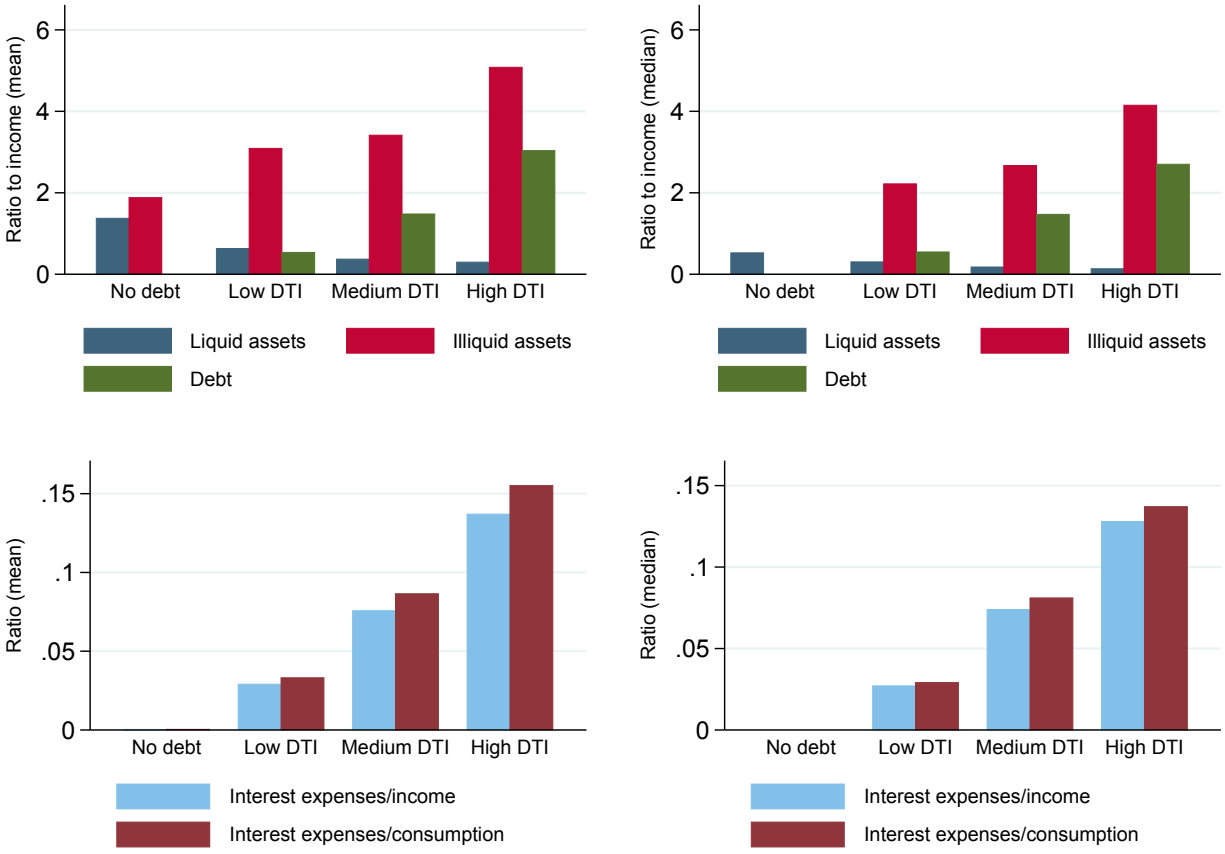
Note: The left panel displays the cross-sectional distribution of correlations between the repo rate and the household interest rate. The right panel displays the cross-sectional distribution of household interest rates.

Figure 4: The repo rate and household interest rates



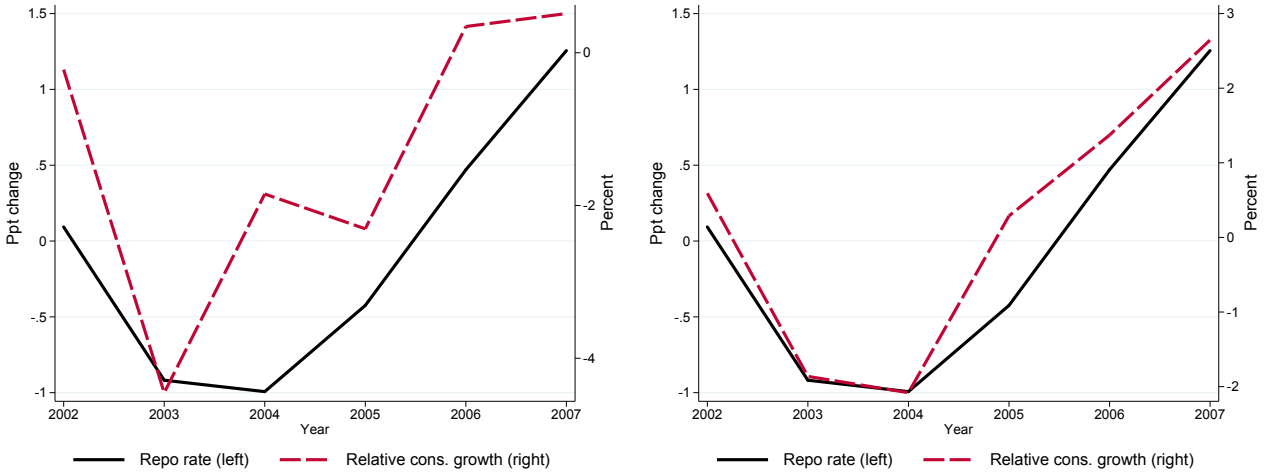
Note: The left panel displays the repo rate and the average household interest rate. The right panel displays the repo rate, and the average household interest rate separated into households with a low correlation (dotted line) and high correlation (dashed line).

Figure 5: Homeowners' assets, debt, and interest expenses



Note: The figure displays home owners' assets, debt, and interest expenses normalized by disposable income across four groups of the debt-to-income distribution. Homeowners are sorted into "No Debt" and in addition, into three equally large categories. The cut-off points for the three equally large groups are debt-to-income ratios of 1.03 and 1.97. The left panels display means and the right panels display medians within each group.

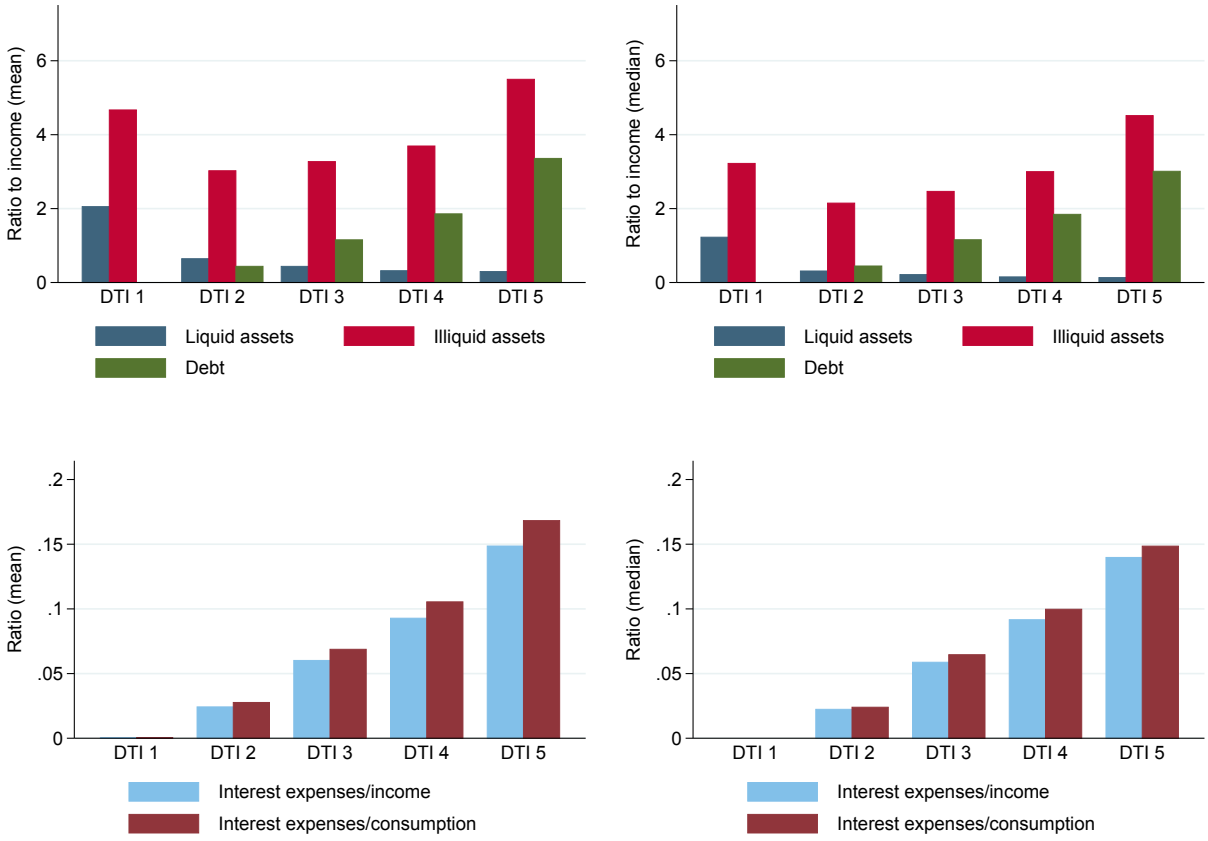
Figure 6: The repo rate and relative consumption growth



Note: The left panel depicts relative consumption growth measured as the median consumption growth among all homeowners minus the median consumption growth of homeowners with a high debt-to-income ratio who hold an ARM. The right panel depicts relative consumption growth measured as the median consumption growth of homeowners with high debt-to-income ratio minus the median consumption growth of homeowners with high debt-to-income ratio who hold an ARM.

Appendix

Figure 7: Homeowners' assets, debt, and interest expenses (by quintiles of DTI)



Note: The figure displays home owners' assets, debt, and interest expenses normalized by disposable income across quintiles of the debt-to-income distribution. The left panels display means and the right panels display medians within each quintile.

Figure 8: Change in the repo rate and monetary policy shocks