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The Mortgage Cash Flow Channel of Monetary Policy Transmission: A Tale of Two Countries

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Abstract:
We study the mortgage cash flow channel of monetary policy transmission under fixed-rate mortgage (FRM) versus adjustable-rate mortgage (ARM) regimes by comparing the United States with primarily long-term FRMs and Spain with primarily ARMs that automatically reset annually. We find a robust transmission of mortgage rate changes to spending in both countries but surprisingly a larger effect in the United States—and provide two explanations for this finding. First, there are channels of transmission other than the mortgage cash flow effect since other interest rates co-move with the mortgage rate. Second, while mortgage resets in Spain are automatic and typically small, mortgagors in the United States must actively refinance to lock in lower rates. As a result, the mortgage cash flow effect in Spain is homogeneous across mortgagors and symmetric for rate increases and decreases, whereas in the United States the effect is largest when rates decline, especially for households identified as likely refinancers.

JEL Classifications: E21, E52, D15
Keywords: consumption, intertemporal household choice, monetary policy transmission, adjustable-rate mortgages, fixed-rate mortgages

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1 Introduction

In this paper, we study the transmission of monetary policy to household consumption with a special focus on the mortgage cash flow effect—that is, the change in consumption due to a change in mortgage payments. The mortgage institutional setting that determines the interest sensitivity of mortgage payments is an important determinant of the extent of this effect. As such, a comparison of monetary policy transmission under different mortgage market institutions can yield insights into the mortgage cash flow effect. To this end, we compare two countries with very different institutional settings for mortgages, Spain and the United States. While most households in Spain hold *true* adjustable-rate mortgages (ARMs) with automatic annual resets, the US mortgage market is dominated by fixed-rate mortgages (FRMs). While ARMs exist in the United States, they are less common and typically have an extended initial fixed term (often 5, 7, or 10 years) before they reset, so they do not automatically adjust when the policy rate changes. This makes a within-country comparison of monetary policy transmission under ARMs versus FRMs difficult in the United States, but a cross-country comparison can help.

To empirically analyze the mortgage cash flow effect, we estimate the relationship between mortgage rate changes and expenditure growth using survey data on household-level expenditures. These data are the *Encuesta de Presupuestos Familiares–Base 2006* (EPCF–2006) for Spain and the *Consumer Expenditure Survey* (CEX) for the United States. Both data sets contain very detailed information on household expenditures, basic information on household income, demographics, and homeownership status. Unfortunately, information on household wealth and detailed mortgage characteristics is more limited. Our approach exploits the variation in the timing of households' interviews (households are exposed to different rate changes over the period in which they remain in the survey) to estimate the impact of (lagged) mortgage rate changes on expenditure growth. We simultaneously control for changes in other factors that could impact expenditure growth, including income growth and local and aggregate economic conditions. While lagged mortgage rate changes are unlikely to be endogenous with respect to expenditure growth at the household level, we also compute instrumental variable (IV) estimates of the mortgage cash flow effect using shocks to the mortgage reference rates around monetary policy meetings as instruments for mortgage rate changes in each country.

A priori, we expect the mortgage cash flow effect to be stronger under ARMs than under FRMs since mortgage payments with true ARMs adjust frequently (annually or more

frequently in Spain). However, our data show that a one percentage point (p.p.) decrease in the mortgage rate leads to 1.65 p.p. higher expenditure growth in Spain compared to 2.8 p.p. higher expenditure growth in the United States. The larger effect under the primarily-FRM regime in the United States is somewhat counterintuitive but can be explained by two factors. One, households with FRMs (or even ARMs) in the United States can refinance to lock in new rates, and policy rates and mortgage rates were falling during much of our sample period (2007–2018). Two, mortgage rates co-move with other interest rates in the economy, which makes it hard to isolate the mortgage cash flow effect from the other channels of monetary policy transmission to consumption. Thus, the larger estimated effect in the United States could potentially be driven by these other channels impacting the expenditure of households with or *without* mortgages.[1]

To better understand the role of channels other than the mortgage cash flow effect in the transmission of monetary policy to consumption, we build a model, based on Slacalek, Tristani, and Violante (2020), where a representative household holds both net short-term and long-term debt. The household is subject to a standard intertemporal budget constraint and its long-term debt (mortgage) follows a typical amortization structure. We focus on the direct (partial equilibrium) effect of interest rate changes on consumption to better match our empirical analysis, where we can control for the general equilibrium effects stemming from income growth and macroeconomic conditions. We show that the direct effect of monetary policy transmission on consumption can be analytically decomposed into the sum of an intertemporal substitution (IES) effect, a cash flow effect due to the net interest exposure of the household's short-term positions (including nonhousing debt), and a cash flow effect due to the interest exposure of the household's long-term debt (mortgage). The IES effect is negative and its strength depends inversely on the household's marginal propensity to consume (MPC).[2] The cash flow effect of the short-term position is negative for a net short-term borrower but positive for a net short-term saver. The mortgage cash flow effect is negative for true ARMs and FRMs with the option to refinance, but zero for FRMs when refinancing does not occur. Furthermore, the strength of the two-part cash flow effect depends positively on the household's MPC.

We use the insights from the model to differentiate the mortgage cash flow effect from the

[1]Note that we use the terms "consumption" and "expenditure" interchangeably, but we are aware of the conceptual difference, particularly for durable goods.

[2]We call the effect negative if it implies a negative association between consumption and the interest rate change: that is a higher rate, lower consumption.

other channels in the data by comparing similar household types in each country (in terms of net short-term non-mortgage debt and MPCs). Specifically, following the approach in Cloyne, Ferreira, and Surico (2020), we estimate our baseline regressions for three different groups of households: outright homeowners, homeowners with a mortgage (mortgagors), and renters. We find a negative relationship between mortgage rate changes and expenditure growth for all three housing groups in each country (with renters in Spain being least sensitive and renters in the United States being most sensitive). The large and significant impact of mortgage rate changes on the expenditure growth of non-mortgagors highlights the relevance of the channels of monetary policy transmission to consumption other than the mortgage cash flow effect.

To more directly study the mortgage cash flow effect of monetary policy changes, we further focus our analysis on comparing the consumption behavior of mortgagors in the United States and Spain. We similarly find a larger spending response for mortgagors in the United States, which suggests that these households are indeed realizing significant cash flow benefits through refinancing. We also study whether the effects of mortgage rate changes within the two countries are symmetric and homogeneous. Automatic mortgage rate (and mortgage payment) resets should imply similar effects of rate increases and rate decreases for households in Spain. In contrast, mortgage rate increases should have less of an effect than rate decreases in the United States, as refinancing is desirable when rates decline. As for homogeneity, with automatic mortgage rate resets for most mortgagors in Spain, we expect similar rate effects across households (other things equal). This might not be the case in the United States because active refinancing is needed to take advantage of lower rates and not all mortgagors are equally willing and able to refinance. Consistent with these conjectures, we find that the effect of mortgage rate changes is indeed symmetric in Spain, while interest rate decreases generally have a larger effect on consumption than rate increases in the United States. We also find that the consumption response in Spain is indeed quite homogeneous for mortgagors, irrespective of their age, education, income, house size, and so on. In contrast, the sensitivity of consumption to interest rate declines is heterogeneous among mortgagors in the United States. The largest effects are for mortgagors who likely have the ability to refinance and the most to gain from doing so. Among these mortgagors, the effects are larger for those who have likely actually refinanced (there is no direct refinancing indicator in the CEX) or who have experienced a recent large decline in interest rates. In addition, when comparing mortgagtors with FRMs versus ARMs within the United States, the effects are larger for mortgagors with ARMs—consistent with these households being more financially

savvy and attuned to rate changes, and potentially having more to gain from refinancing from a lifetime cash flow perspective.

Overall, our findings point to a robust transmission of monetary policy changes to expenditure growth under both ARMs and FRMs. This occurs via a mix of intertemporal substitution, mortgage cash flow effects, and non-mortgage cash flow effects. In Spain, the mortgage cash flow effects are automatic and homogeneous, while in the United States they are the result of active refinancing and fairly heterogeneous.

Related Literature

This paper relates to multiple strands of a growing literature on the transmission of monetary policy to consumption via changes in mortgage rates. First, we complement studies that directly analyze the cash flow channel of monetary policy transmission. Hughson et al. (2016) use household-level panel data from Australia to quantify a borrower channel (lower interest rates increase cash flow by reducing interest payments on net liabilities) and a lender channel (lower interest rates decrease cash flow by reducing interest receipts on net assets), and find that the borrower channel is stronger overall, so that a rise in interest rates is contractionary. Flodén et al. (2019) similarly use Swedish household data and find that the cash flow channel is strongest when households are highly indebted and have adjustable-rate loans. We complement these papers by studying two additional countries, the United States and Spain, and by focusing particularly on the mortgage cash flow effect.

Second, we complement the literature analyzing the causal effect of changes in mortgage rates on expenditure. Di Maggio et al. (2017) use the variation in the timing of automatic interest rate resets to identify the effect of mortgage rate changes on expenditure. Relative to this quasi-experimental design, we use an instrumental variable strategy, where we instrument for mortgage rate changes using shocks to the mortgage reference rate in a daily window around monetary policy meetings following the the high-frequency approach of Gürkaynak and Sack (2005) and Cochrane and Piazzesi (2002). Our IV strategy contrasts with the existing literature that uses the monetary policy shocks directly as a regressor to analyze the transmission of monetary policy. We believe that by using the shocks as an instrument rather than a regressor and having the effects run through mortgage rates, we are focusing on a subset of channels through which monetary policy affects consumption—mainly the mortgage cash flow channel that we want to study—thereby making the identification stronger.

Third, in order to analyze the differential effect of ARMs versus FRMs for the mortgage

cash flow channel, we compare two countries with very different mortgage markets in addition to comparing differentially indebted households within the same country. Here our analysis is closest to Cloyne, Ferreira, and Surico (2020), who compare monetary policy transmission in the United States versus the United Kingdom and use housing tenure status as a proxy for household debt positions. While their analysis is at the level of pseudo-housing tenure groups, our unit of analysis is the household. Additionally, while their analysis stops in 2007 to avoid the zero-lower-bound period, our analysis covers 2007–2018, so we complement their work by exploring the mortgage cash flow channel during a period of low interest rates.

Fourth, our empirical analysis complements and is motivated by the recent theoretical literature incorporating mortgages into general equilibrium models to analyze monetary policy transmission under ARMs versus FRMs. Rubio (2011) builds a New Keynesian DSGE model with variable- and fixed-rate mortgages and shows that the transmission of monetary policy shocks to consumption is stronger under a variable rate mortgage regime. This is due to a combination of the cash flow effect (changes in interest payments), the wealth effect (changes in house prices, which feed into the collateral constraint), and differential MPCs of borrowers versus savers. The model assumes that the variable rate moves one-for-one with the policy rate, while the fixed rate on existing debt is unaffected by the policy rate, as there is no refinancing option. Our analysis highlights that mortgage refinancing is an important direct channel of monetary policy transmission under FRMs. Garriga, Kydland, and Šustek (2017) incorporate mortgages into an incomplete asset market framework to highlight the differential effect of inflation on the real payments on outstanding debt under FRMs versus ARMs. Wong (2019) builds a quantitative life cycle model with fixed-rate mortgages and the ability to refinance after paying a cost. She finds that the transmission of policy shocks to consumption is strongest for young homeowners who refinance. Eichenbaum, Rebelo, and Wong (2018) find that refinancing varies systematically with the pool of savings from refinancing, making the effects of monetary policy state dependent. Beraja et al. (2019) provide empirical evidence using loan-level data that refinancing depends positively on home equity. Motivated by these papers, we compare a country where mortgages are mostly true ARMs and reset automatically with one where FRMs dominate and active refinancing is needed to take advantage of mortgage rate declines. Importantly, we study the differential response of consumption to mortgage rate changes for households that likely can refinance and have the most to gain from doing so. We also control for house-price appreciation and inflation expectations as part of our robustness analysis.

The rest of the paper is organized as follows. Section 2 presents the model. Section

3 presents the data and empirical specifications for Spain and the United States, respectively, and also discusses the institutional differences in the two countries' mortgage markets. Section 4 presents the main findings, their discussion, and robustness checks. Section 5 concludes.

2 Model

We begin with a simple model that analytically decomposes the direct (partial equilibrium) channel of monetary policy transmission to consumption growth. The framework closely follows Slacalek, Tristani, and Violante (2020) with two main differences: we incorporate the typical amortization structure of debt and assume all debt and assets are real.[3]

In this framework, households are infinitely lived, with intraperiod utility $u(c)$, where $u' > 0$ and $u'' < 0$. They hold long-term mortgages, short-term non-mortgage debt, and short-term assets in their portfolios. Let m denote the long-term mortgage amount, and b denote *net* short-term assets—that is, short-term assets net of interest-sensitive (non-mortgage) short-term debt. Mortgages follow a typical amortization structure, where p is the required payment amount, which depends on the mortgage interest rate r, the mortgage principal amount m, and the remaining duration of the mortgage contract $T - t$ (T is the initial term of the mortgage).

Households maximize expected lifetime utility, discounting the future at rate $\frac{1}{\beta}-1$, subject to an intertemporal budget constraint and the amortization structure of their mortgage. The recursive formulation of their optimization problem is:

$$V(b, y; r) = \max_{c,b'} \left[u(c) + \beta V(b', y'; \bar{r})\right] \tag{1}$$

s.t.

$$b' = (1 + r)(b + y - c - p) \tag{2}$$

[3]We could alternatively consider nominal long-term debt, as in Slacalek, Tristani, and Violante (2020)'s framework, and then set the aggregate price level equal to a constant (zero inflation) as we are only interested in the direct (and not general equilibrium) effect of monetary policy on consumption. With no inflation, the real interest rate will equal the nominal interest rate and hence, we would be back in the purely real world that we consider.

$$p = \frac{mr}{1-(1+r)^{-(T-t)}} \quad [4] \tag{3}$$

On the right side of the value function, we set $r = \bar{r}$ because we want to consider the effect of a one-time unexpected change in the real interest rate r after which the rate goes back to its steady state. Since the focus of our analysis is on the direct, partial equilibrium channels of monetary policy, we shut down the indirect general equilibrium channels by treating y as a constant throughout the model.

Appendix A.3 contains full details of the model solution. Here, we briefly discuss the steps that yield the final decomposition of the direct effect of interest rate changes on consumption. The first order condition of the household optimization problem yields the Euler equation:

$$u_c = \beta(1+r)V_b' \tag{4}$$

Totally differentiate the Euler equation, set the general equilibrium effects to zero ($dy = 0$), and combine the resulting equation with equation (4). This yields an expression linking the change in consumption (dc) to the change in the policy rate (dr):

$$dc\left[u_{cc} + \beta(1+r)^2 V_{bb}'\right] = \frac{u_c}{1+r}dr + \beta(1+r)V_{bb}'(b+y-c-p)dr - \beta(1+r)^2 V_{bb}' dp \tag{5}$$

Next, define the marginal propensity to consume out of income (MPC) $= \mu = \frac{\partial c}{\partial y}$, and using equation (3) solve for dp in terms of dr.[5] Then, for small positive r, we can rewrite equation (5) in terms of μ as follows:

$$\frac{dc}{dr} = \underbrace{(1-\mu)\frac{u_c}{u_{cc}}}_{\text{IES effect}} + \mu \left[\underbrace{(b+y-c-p)}_{\text{cash flow effect of net short-term position}} - \underbrace{\frac{\partial p}{\partial r}}_{\text{mortgage cash flow effect}} \right] \tag{6}$$

Equation (6) shows that the direct effect of a change in the real interest rate on consumption can be decomposed into the sum of the intertemporal substitution (IES) effect and a (two-part) cash flow effect. The IES effect is a function of the household's risk aversion, summarized by $\frac{u_c}{u_{cc}}$, and is negative. Its strength depends inversely on the household's

[4] For a FRM, p is constant over time, and equation (3) can also be written as $p = p_0 = \frac{m_0 r}{1-(1+r)^{-T}}$.

[5] Note that since p is a function of r (m and T are parameters), the total derivative of p with respect to r is the same as the corresponding partial derivative. That is, $p = p(r) \implies dp = \frac{\partial p}{\partial r}dr \implies \frac{dp}{dr} = \frac{\partial p}{\partial r}$.

MPC—the higher the MPC, the lower the absolute value of the IES effect. The cash flow effect is made up of two parts. The first is the cash flow effect from a change in the interest rate due to the net interest rate exposure of the household's short-term asset position $(b+y-c-p)$. This effect is positive if the household is a net short-term saver and negative if it is a net short-term borrower. The second is the cash flow effect due to the impact of a change in the interest rate on mortgage payments, $\frac{\partial p}{\partial r}$, which captures the household's net interest exposure due to its long-term balance sheet position. The strength of the total cash flow effect depends positively on the MPC—the higher the MPC, the larger the overall cash flow effect from a change in the interest rate.

Note that for a hand-to-mouth household the MPC is 1. Therefore, the IES effect disappears, while the cash flow effect is largest (ceteris paribus). Also, under an FRM, the r that appears in equation (3)—let's call it r^{FRM}—will typically be different from the policy rate r, except in the period of the FRM issuance. Therefore, $\frac{\partial p}{\partial r} = \frac{\partial p}{\partial r^{\text{FRM}}} \times \frac{\partial r^{\text{FRM}}}{\partial r}$. In the case of an FRM where the mortgagor does not refinance, $\frac{\partial r^{\text{FRM}}}{\partial r} = 0 \implies \frac{\partial p}{\partial r} = 0$. Therefore, the cash flow effect is determined only by the household's net short-term balance sheet position.

3 Data and Empirical Framework

3.1 Expenditure Surveys

Spain: EPCF-2006 To study the relationship between mortgage rate changes and expenditure growth in Spain, we use a household-level data set of annual spending conducted by the Spanish National Institute of Statistics (INE) called the *Encuesta de Presupuestos Familiares-Base 2006* (ECPF-2006).[6] Our analysis uses the survey data from 2007 through 2018.[7] The main objective of the ECPF-2006 is to generate estimates of aggregate expenditure in Spain at the national and regional levels as well as by certain household characteristics. The survey is a rotating panel of approximately 24,000 households, who are interviewed for two consecutive years. Each survey year is divided into 26 two-week periods, and households' interviews are uniformly distributed during the year. (This interview schedule provides for

[6]The data can be obtained from the INE. See https://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176806&menu=ultiDatos&idp=1254735976608.

[7]While earlier ECPF data are available, the methodological differences between the EPCF-2006 and its predecessor, the ECPF-1997, are too large to expand our analysis to earlier years. The ECPF-1997 was quarterly and interviewed just 4,000 households. Moreover, the expenditure data are inconsistent with households reporting on all expenditure categories in some quarters, but only on selected categories of goods and services in others.

some within-year variation for our analysis.) The EPCF-2006 contains very detailed expenditure information, along with demographic information and basic household-level income data. The income measure is net of taxes, and for a small fraction of the households, the income information is imputed from income interval reports by the INE.

US: CEX For the United States, we use household-level public use microdata from the Consumer Expenditure Survey (CEX) interview survey, which is a rotating panel of roughly 6,900 households per calendar quarter.[8] While earlier data are available, we employ data from 2007 through 2018 to coincide with the time period of the Spanish data. Households are interviewed in every month and asked to report their spending over the previous three months. Each household is surveyed every three months for a maximum of four quarters before it is dropped from the sample and replaced. Although a household is interviewed quarterly, its spending may not cover a traditional calendar quarter given the timing of the interviews. Spending in the public use microdata (FMLI files) is divided (evenly) between the current quarter (CQ) and previous quarter (PQ). We combine these data to determine total spending corresponding to the three months prior to each household's interview month. We account for this interview and timing structure in our analysis and align the timing of non-CEX data, such as interest rates and monetary policy shocks, accordingly. We discuss this timing convention further in Section 3.4. Like the EPCF-2006, the CEX contains detailed data on expenditures along with demographic information and some after-tax income data. While expenditure data are collected in each interview, income data are only recorded in the first and last interviews. In recent survey years these data are imputed, where necessary, by the BLS.[9]

Expenditure Measures and Data Discussion Given the detailed expenditure data available in the EPCF-2006 and CEX, it is possible to construct several different measures of aggregate expenditures. We use total expenditures excluding housing-related expenses as

[8]The CEX data are collected by the Census Bureau for the Bureau of Labor Statistics (BLS). The primary purpose of the survey is to "revise the relative importance of goods and services in the market basket of the Consumer Price Index." See https://www.bls.gov/cex/ for further details on the design and goals of the survey.

[9]Prior to 2015, households in the CEX were interviewed five times (five quarters), which included a preliminary "bounding" interview that collected mainly background information on the household. Income data were collected in the second and fifth interviews in this framework. See Appendix A.1.1 for additional details on how we construct relevant data from the CEX for our analysis.

the baseline consumption measure in our analysis.[10] We also consider spending on durables and spending on nondurables and services as part of our robustness checks. For income, we use households' reported after-tax income. All relevant (nominal) expenditure and income data are converted to real values using the Spanish regional CPI in the EPCF-2006 and the CPI for all urban consumers (CPI-U) in the CEX.

The main caveat of both of our data sets is the lack of wealth data or detailed mortgage information. The EPCF-2006 records whether households own their homes and whether they have mortgages, but not any wealth data or information on mortgage balances, mortgage types, or when mortgage rates reset. The CEX's main monthly files contain data on households' quarterly mortgage interest payments but have no data on wealth, mortgage balances, or total monthly mortgage payments, or whether or when a household refinances. However, there are supplementary data that we can use to determine a household's mortgage type (FRM versus ARM; details in the appendix). Despite these data caveats, annual variation plus the uniform distribution of households' interviews during the year along with the different institutional settings for mortgage contracts in Spain and the United States (as we discuss shortly) allow us to exploit time variation in interest rates and monetary policy shocks to conduct our analysis.

3.2 Mortgage Rates and Monetary Policy Shocks

For Spain, our mortgage rate data come from the official reference mortgage rate from the Bank of Spain.[11] For the United States, we use data on the 30-year fixed-rate mortgage rate from the Federal Home Loan Mortgage Corporation.

In some of our analysis, we instrument for actual mortgage rate changes using monetary policy shocks. For both countries, we identify these monetary policy shocks using asset price changes in a daily window around monetary policy announcements. In Spain, the Euribor is used as the reference rate for a large number of mortgage contracts; we focus on the three-month Euribor contract, which has the highest correlation with actual mortgage rate changes

[10] In the EPCF-2006, our measure of expenditure is constructed by subtracting expenditure on Group 4 items from total spending. Group 4 spending includes rental payments (actual and imputed for homeowners), utility payments, and housing-related maintenance spending. In the CEX, our measure of total expenditures excludes housing costs (actual or imputed rents and utilities) as well as contributions to retirement plans. (Our results are similar if we do not exclude retirement contributions.)

[11] Specifically we use the average rate on mortgage loans with a duration over 3 years offered by credit institutions in Spain for home purchases each month (series 7 on Table 19.1). See https://www.bde.es/webbde/en/estadis/infoest/temas/sb_tiintref.html.

calculated using the Bank of Spain series. Therefore, we measure the surprise component of the European Central Bank (ECB) monetary policy announcement as the difference between the rate on the three-month Euribor contract on the day of minus the day before the ECB General Council (GC) meeting.[12] In the United States, movements in mortgage rates are most closely tied to the yields on long-dated Treasury securities—in particular, the 10-year US Treasury rate. Therefore, we measure the surprise component of the Federal Open Market Committee (FOMC) monetary policy announcement as the difference between the yield on the 10-year US government bond of constant maturity on the day of minus the day before the FOMC meeting. To interpret these surprises as monetary policy shocks, we multiply them by -100, so that a positive shock is expansionary while a negative shock is contractionary. Section A.1.2 in the Appendix describes the shocks' construction in greater detail.[13]

3.3 Institutional Settings for Mortgages

Homeownership in Spain was more prevalent than in the United States during our sample period, and relatively fewer households held mortgages on their main residence or another property. (Home equity loans in Spain are and were rare.) Over 90 percent of mortgages in Spain during our sample period were ARMs indexed to the Euribor or another official mortgage rate index. The most common ARM contract included yearly interest resets against the prevailing rate at the contract review date. Some banks charged a higher rate in the first year of the contract, and minimum rates (floor rates) were typically built into the contracts, sometimes in opaque ways.[14] Early repayment penalties were also common, but were limited by law (some lenders had lower penalties than others, and some had no early payment penalties at all). Starting in 2015, the Bank of Spain encouraged banks to offer more mixed-rate (with interest rates fixed for two, three, or more years) and fixed-rate (for the duration of the loan) mortgage contracts. Rates for FRMs in Spain are higher than those for ARMs and their terms are usually shorter (around 12 years) than in the Unites States.

[12] Using alternative instruments such as MP1 shocks, as described in Appendix A.1.2, or shocks to the 12-month Euribor contract, to which many mortgages are indexed, delivers similar results.

[13] The asset price data for both countries is obtained from Bloomberg and Haver Analytics. The GC meeting dates are obtained from the website of the ECB (https://www.ecb.europa.eu/press/calendars/mgcgc/html/index.en.html), and the FOMC meeting dates come from the website of the Board of Governors of the Federal Reserve System (https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm).

[14] A 3 percent interest rate floor was very common during our sample period. Since 2019, interest rate floors are no longer allowed beyond some minimum protections for lenders against negative rates.

FRMs also face higher prepayment costs.[15] Despite the recommendations from the Bank of Spain, ARMs with yearly resets still constituted the majority of mortgages in Spain by the end of our sample period.

Importantly, over our sample period it made sense for Spanish consumers to repay their mortgages on time whenever possible because of stringent default and late-payment regulations along with the large spreads between mortgage rates and saving instruments. In particular, all mortgages were recourse mortgages, and interest rates on late payments at the time were extremely high—in many cases higher than 20 percent. The popular press is full of anecdotal evidence documenting widespread wage garnishing after houses were repossessed during and following the financial crisis, along with stories about the many individuals who lost their unmortgaged properties due to delinquent relatives whose loans they had guaranteed. On the other hand, most households in Spain save using bank accounts, including certificates of deposit (CDs), which paid relatively little over our sample period. Both direct and indirect participation in equity markets is low.[16]

To better understand how mortgage rate changes affected household finances in Spain, we use data from the INE's *Encuesta de Condiciones de Vida* (ECV), which has some information on mortgage payments by households.[17] The survey has both a cross-sectional and a longitudinal component (households remain in the sample for up to four years) that contain slightly different information about the households—the two components cannot be combined in the data available to us. We use data from both components to illustrate the evolution of mortgage payments in Spain over our sample period.

The cross-sectional data in the ECV have information on households' total monthly mortgage payments (principal plus interest). The top panel of Figure 1 shows the evolution of mortgage rates, monthly rental payments, and mean and median monthly mortgage payments during our sample period. Mean and median payments clearly decrease with the interest rate. In contrast, there is an overall negative correlation between rental payments and interest rates (raw correlation of –0.35). The bottom panel of the figure shows the mort-

[15] Another product offered in the Spanish market is a fixed-repayment mortgage. This product is a variable-interest loan that looks like a FRM in the sense that the borrower always pays the same amount each period irrespective of interest rate changes. The difference is that, if rates increase (decrease), the repayment period is extended (shortened).

[16] Bank of Spain (2019) provides a report of the financial position of Spanish households.

[17] The ECV interviews about 13,000 households each year. For more detailed information on this survey, see https://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176807&menu=metodologia&idp=1254735976608.

gage payment distributions in three different years when rates were declining, which are also consistent with payment reductions when rates were lower.

The longitudinal component of the ECV has information on mortgage interest payments starting in 2008, which is summarized in Table 1.[18] The first two columns show the reference mortgage rate from the Bank of Spain and its change. The third column reports average mortgage interest payments relative to income in the ECV, which clearly vary with changing interest rates. Mortgage interest payments, on average, represented 13.7 percent of household income in 2008 but only 4.6 percent in 2018. Column (4) shows that a large fraction of Spanish households experienced mortgage interest reductions each year, with a higher proportion benefiting during periods with large rate declines. As shown in columns (5) and (6), the absolute and relative-to-income magnitudes of savings from lower rates for those households with interest reductions were non-negligible, ranging from €670 a year (2.4 percent of household income) to €1,970 (6.8 percent) depending on the year. Overall, the ECV data show that ARMs with frequent resets impact household cash flows as interest rates change.

The institutional details of mortgage markets in the United States are better known than those in Spain, but we briefly describe some of the main features. First, FRMs with long maturities dominate the US mortgage market. According to the *National Mortgage Database*, a nationally representative five percent sample of residential mortgages in the United States maintained by the FHFA, the share of ARMs in the United States during our period of analysis was just 5.3 percent. FRMs with a 15-year maturity represented 19.5 percent of all mortgages during this period, while 75.2 percent of mortgages were FRMs with maturities over 20 years. The average maturity at origination for loans during this period was roughly 26 years, consistent with 30-year FRMs being the most common product.

Second, many mortgages in the United States are guaranteed by the government (FHA-insured and VA-guaranteed loans account for about 24 percent of all loans from 2007 to 2018) or get sold to to the government-sponsored enterprises (GSEs) Freddie Mac and Fannie Mae. The GSEs buy about half of the mortgage loans that lenders make (56.4 percent during our sample period). When lenders sell their loans to the GSEs, they obtain capital to make additional loans. Because lenders want to sell their loans to the GSEs, they structure the mortgages according to the GSEs' underwriting standards, which became stricter following the financial crisis.

The share of ARMs in the United States was much higher prior to the financial crisis

[18]The longitudinal part of the ECV does not have information on mortgage principal payments.

(21.6 percent between 2000 and 2006). The difference in ARM shares pre- and post-2007 is consistent with a structural break in both the products offered to consumers by lenders and consumers' choices after the subprime crisis. Among other factors, ARMs had higher default rates during the financial crisis and have subsequently faced stricter underwriting standards. However, ARMs have remained a large share of bigger loans—especially those greater than $1 million—consistent with the idea that wealthier and more financially savvy mortgagors are the ones generally holding ARMs over our sample period.[19] It is also important to note that, unlike in Spain, most ARMs in the United States typically have an initial interest rate that is fixed for 5, 7, or 10 years before resetting, so on a relative basis they behave more like a FRM. Many of these loans are also refinanced before they reset.

In addition, most mortgages in the United States are securitized, especially the GSE loans, which is not the case in Spain. Securitization removes the loans from banks' (and the GSEs') balance sheets and packages them into mortgage backed securities (MBS), which pools and transfers the interest rate and prepayment risks of the loans to a diverse set of investors. In comparison, there is not widespread use of securitization in Spain and most mortgage loans remain on banks' balance sheets. As a result, Spanish banks likely want to make sure the mortgage contracts they offer match the duration of their liabilities as much as possible. In addition, as shown by Krainer et al. (2010), the Federal Reserve began large-scale purchases of GSE mortgage-backed securities (MBS) starting in January 2009, adding significant secondary market demand for fixed-rate mortgages in the United States. In sum, the reason why mortgages look so different in the United States and Spain is due to important institutional differences between the two countries—namely the presence of securitization. This is consistent with Fuster and Vickery (2015), who find that the share of FRMs is sharply lower when mortgages are difficult to securitize.

Finally, Figure 2 is the US counterpart to Figure 1 for Spain. Despite the market dominance of long-term FRMs, which require refinancing to realize the benefits of lower interest rates, mortgage interest payments in the United States decline as mortgage rates fall, similar to Spain.

[19] For more details see Figure 3 in a 2018 report on ARMs by CoreLogic available at https://www.corelogic.com/intelligence/are-adjustable-rate-mortgages-more-popular-as-mortgages-rates-rise/#_ftnref1.

3.4 Empirical Specifications

Spain Taking advantage of the fact that the ECPF-2006 interviews each household i for two consecutive years, we estimate

$$\Delta \log C^i_{t,t-12} = \alpha_0 + \alpha_1 \Delta \log Y^i_{t,t-12} + \alpha_2 \Delta r_{t-1,t-13} + \alpha_3 \Delta U^{ccaa}_{q,q-4} + \alpha_4 \Delta \log GDP_{q,q-4} + \mathbf{X^i_t}\Gamma + \text{FE} + \epsilon_{it}, \tag{7}$$

where $\Delta \log C^i_{t,t-12}$ is log consumption growth from the previous year, $\Delta \log Y^i_{t,t-12}$ is log income growth from the previous year, $\Delta r_{t-1,t-13}$ is the one-year change in the mortgage rate, $\Delta U^{ccaa}_{q,q-4}$ is the change in the unemployment rate in the region in which household i resides (Spain has 17 regions or CCAAs and two autonomous cities that are lumped together in the survey), and $\Delta \log GDP_{q,q-4}$ is the log real GDP growth from the previous year. Since households are interviewed at different times throughout the year, we assign to each household the month (for the mortgage rate) and the quarter (for the regional unemployment rate and national GDP, which are only available at the quarterly frequency) of their interview when calculating the growth rates or changes in these variables. $\mathbf{X^i_t}$ is a matrix of household-level controls including the age, gender, education level, citizenship (Spanish or other), marital status, labor force status (employed, unemployed, or out of the labor force), and labor force status and marital status changes from the previous interview of the head of the household, number of household members, number of earners in the household, household size changes, the main source of household income (wages, self-employment, or other income), and the presence of children. FE denotes fixed effects that include CCAAs and interview weeks. The regional unemployment rate and the national real GDP growth are included to capture local and aggregate economic conditions that might impact spending behavior across households. Standard errors are clustered at two-week period $\times$ year, the level of variation of our regressor of interest, the mortgage rate change. We restrict our analysis to households with heads aged 18 to 64 years old.

The mortgage rate change is lagged one month relative to the month of the household's final interview, since even if the mortgage rate resets in a given month, consumers might not see their savings until their next billing cycle. (Most mortgage payments in Spain are monthly.) Not lagging or lagging the mortgage rate more does not change the results significantly. In the IV specifications, we aggregate monetary policy shocks in the last 12 months to create an instrument for the 12-month change in mortgage rates. We similarly lag this instrument one month.

United States To match the time horizon in the Spanish data as best possible and to utilize the available income data in the CEX, we measure consumption (and income) growth between households' first and last interviews. This amounts to consumption and income growth over a nine-month period, which is slightly shorter than the one-year horizon in the Spanish data. Recall that households report their expenditures for the three months prior to each interview. For example, a household first interviewed in April 2017 reports expenditures for January to March 2017. The last interview for the same household (assuming that they do not exit the survey early) would be in January 2018 when they report spending for October to December 2017. We calculate growth in quarterly expenditures over this nine-month period and follow the same procedure for other households based on when their first and last interviews occur. In addition, a household first interviewed in April 2017 reports household income data covering the prior 12 months in April 2017, and then again in January 2018. We calculate the growth in income between these two reporting periods. While the slightly overlapping 12-month time horizons are not ideal, we are limited by the available data and believe that it is important to control for income growth in our regressions.

Our main empirical specification for the United States is similar to the one for Spain:

$$\begin{aligned} \Delta \log C^i_{t,t-9} &= \alpha_0 + \alpha_1 \Delta \log Y^i_{t,t-9} + \alpha_2 \Delta r_{t-3,t-12} + \alpha_3 \Delta U^s_{t,t-9} + \alpha_4 \Delta logGDP_{q,q-4} \\ &\quad + \omega_t \mathbf{X^i_t} + \delta^q + \eta^s + \epsilon_t, \end{aligned} \tag{8}$$

where $\Delta \log C^i_{t,t-9}$ is log consumption growth between household i's first and last interviews, $\Delta \log Y^i_{t,t-9}$ is log income growth between household i's first and last interviews, $\Delta r_{t-3,t-12}$ is the nine-month change in the mortgage interest rate, $\Delta U^s_{t,t-9}$ is the unemployment rate change in the state in which household i resides between its first and last interviews, and $\Delta logGDP_{q,q-4}$ is the 4-quarter percent change in real GDP as of the calendar quarter that corresponds to the majority of the expenditure months covered by household i's final interview. The mortgage rate change is lagged three months relative to the month of a household's final interview.[20] In the IV specifications, we aggregate monetary policy shocks over the five months leading up the household's final three expenditure months. While we tried a number of different aggregation approaches, including the full nine-month window over which the mortgage rate change is measured, we found that the rate changes were most highly corre-

[20]Returning to our previous example, if a household's first interview is in April 2017 and its last interview in January 2018, then its consumption growth covers spending from October to December 2017 relative to spending from January to March 2017. The change in interest rates is therefore between December 2016 and September 2017.

lated with shocks aggregated over this shorter window. Results using alternative aggregation windows are similar.

Finally, returning to equation (8), $\mathbf{X_t^i}$ is a matrix of household-level controls including age and age squared (of the reference person), household size, number of earners in the household, and dummy variables for the education level of the reference person (less than high school, high school, some college, college or more), whether there is a change in family size, and whether there is a change in the reference person's marital status over the estimation window. We include quarter fixed effects, δ^q, and state fixed effects, η^s. The quarter fixed effects are based on the calendar quarter most closely aligned with the expenditure months reported in a household's final interview and are designed to capture potential seasonal variation in expenditures. State fixed effects capture differences across locations in the average level of unemployment and other unobserved, local, time-independent factors that might impact income and spending. Standard errors are clustered at the month $\times$ year level. We restrict the sample to households with nonmissing housing tenancy information where the reference person is between 18 and 64 years old.

Estimation We estimate equations (7) and (8) first using OLS. While lagged changes in mortgage rates are likely non-endogenous for individual households, these changes might have been anticipated by households, which could bias our estimates of α_2 in both equations. To address this issue, we also present IV estimates where use monetary policy shocks as an instrument for mortgage rate changes. In our baseline regressions, we use nominal mortgage rate changes. We later show that the results are similar when we either use real mortgage rate changes or control for changes in inflation expectations. Even though the actual mortgage rate and the instrument have some within-year variation because consumers are interviewed at different times throughout the year, this variation is somewhat limited. For example, for the instrument, there are months without monetary policy meetings, so aggregated monetary policy shocks might not vary from month to month during certain periods. Also, while yearly interest resets for ARMs were the most common in Spain during our period of analysis, we do not know exactly when mortgage rates reset for each household, as this information was not collected in the survey. Similarly, for the United States, we do not know when households last refinanced. For these reasons, our baseline regressions do not include year fixed effects (which likely will soak up too much of the variation in mortgage rate changes). However, we do present alternative specifications that include year fixed effects as part of our robustness analysis.

4 Results

4.1 Rates and Spending in Spain

Table 2 presents estimates of equation (7). When pooling all consumers, column (1), we estimate an average elasticity of expenditure with respect to income of 0.18 (the average expenditure-to-income ratio in the sample is 0.99, so this elasticity is very close to an MPC). This estimate is in line with existing studies that follow a similar approach. For example, Fisher et al. (2019) find an elasticity of around 0.1 using US household-level data, which is similar to the results in Dynan (2012). Most estimates of the aggregate MPC out of income range between 0.2 and 0.6—see Carroll et al. (2017) for a summary.[21] A one p.p. higher regional unemployment rate is associated with 0.9 p.p. lower expenditure growth, and an increase in GDP growth of one p.p. is associated with 0.53 p.p. higher expenditure growth. Since our regressions control for household-level income growth as well as many other household-level characteristics, the estimated coefficients for these aggregate controls likely capture the impact on expenditure growth of expectations and uncertainty about the future due to higher (lower) unemployment (GDP growth). Note that the income decline associated with realized job loss should already be captured by the household-level income growth variable. Turning to our variable of interest, the change in the mortgage rate, a 1 p.p. decrease in the mortgage rate is associated with 1.65 p.p. higher expenditure growth using the OLS specification. The IV estimate of the effect of a change in the mortgage rate on household expenditures, column (2), is very similar to the OLS estimate.

Other columns of Table 2 repeat the analysis separating consumers into three groups: outright homeowners (without mortgages), homeowners with mortgages (mortgagors), and renters/other.[22] The MPC is largest for renters and lowest for outright homeowners. Mortgagors fall in the middle. In Spain, renters are on average younger and poorer (in terms of income) than other consumers. Relative to outright homeowners, mortgagors are younger but have similar expenditure levels and slightly higher income (see summary statistics in Appendix Tables A.1 and A.2). Mortgagors' higher MPC out of income is consistent with more binding liquidity constraints, perhaps due to their mortgage payment commitments. The estimates for the effects of the aggregate unemployment and GDP controls are also

[21] Our estimates differ perhaps because we do not attempt to separate permanent and transitory income components, and also because we have many more controls than these other studies.

[22] "Other" includes the Spanish households living rent-free in properties that belong to their employers or the government.

larger for mortgagors relative to outright homeowners. In contrast, the estimated interest rate effect on expenditure growth is slightly larger for homeowners without mortgages. The estimated effect for renters is smaller and not statistically significant.

Mortgage rate changes having an effect on the expenditure growth of homeowners without mortgages speaks of channels of monetary policy transmission other than the mortgage cash flow effect. Interest rates for other loans as well as interest rates for savings products such as CDs, extensively used for saving purposes in Spain, move in unison with mortgage rates (see Appendix Figure A.1). Outright homeowners are likely net savers, who should see their interest income increasing (declining) when rates increase (decrease). However, changes in interest rates also affect the IES, as highlighted in our simple model. That is, outright homeowners might forego current expenditure when rates go up in order to consume in the future, and *vice versa*. The latter effect seems to dominate for outright homeowners in Spain over our sample horizon, since we find a negative correlation between expenditure growth and mortgage rates for this group of consumers. This result is consistent with our model's prediction that a lower MPC increases the relative strength of the IES effect. In addition, it is possible for some of these outright homeowners to be co-signers of mortgage contracts of (younger) relatives. While they would respond "no" to having a mortgage on their own property or properties, they might help pay for their relatives' mortgages. In this case, the mortgage rate change might affect their spending directly even though they do not have their own mortgage debt.

Our goal is to determine whether mortgage institutional differences between Spain and the United States can account for any differential effects of monetary policy on mortgagors' spending between the two countries. To investigate this further, we next consider whether the effect of mortgage rate changes on consumption growth in Spain are symmetric as well as homogeneous across mortgagors.

Rate Increases versus Rate Declines

We first explore whether the effect of mortgage rate changes is symmetric—results in Table 3. We find a larger effect for mortgage rate increases (relative to declines), although the difference is statistically significant only for outright homeowners (OLS and IV specifications) and for mortgagors (IV only). Mortgage and other interest rate declines are more likely during recessions, so prudence might partly offset the IES effect (for outright homeowners) and the mortgage cash flow effect (for mortgagors). Also, mortgage rate floors were likely binding for many mortgagors towards the end of our sample period, so the lower

mortgage rates at that time might not have translated into lower mortgage payments for them. Another interesting finding when comparing the OLS to IV results for mortgagors is the larger (smaller) reaction of expenditure growth to unexpected rate increases (declines). For outright homeowners, the OLS and IV estimates are closer together. This result could similarly be explained by prudence and mortgage floor caps.

Heterogeneity across Mortgagors

Next we explore the variation in the interest rate effects across consumers, focusing on mortgagors—results in Table 4. We divide mortgagors across different demographic and economic dimensions, as indicated in the column headings. In particular, we split them into younger or older, more or less educated (above or below secondary education levels), with more or less income (above or below €2,000 per month), with large or small houses (above or below 100 square meters), with or without sizeable income declines from the previous year (10 percent or larger), with heads who work or don't work (employed versus the rest), and those facing house price appreciation versus depreciation (based on regional house price indices). Additional controls are the same as in our previous regressions but are not tabulated.

The estimated coefficients are a bit larger for the mortgagors who are young, who are in more advantaged groups (high education, high income, large house, working), who experience large income declines, and during periods of house price appreciation. However, the differences are small and not statistically significant except for the split based on regional house prices (OLS only). A higher (lower) mortgage rate is more strongly associated with lower (higher) expenditure growth in periods of house price appreciation. Consumers might become more prudent in periods of home depreciation, choosing to put away some of their mortgage interest savings. A prudence effect could also be at play for households with heads out of work, who also have lower (but noisier) estimated coefficient for rate changes. Overall, though, interest rate effects seem to be similar across the board for mortgagors.

Robustness

In our baseline specification, we regress real expenditure growth on nominal mortgage rate changes, whereas our theoretical framework (and the macroeconomic theory literature in general) links real expenditure growth to real mortgage rate changes (nominal rates less expected inflation). Inflation expectations matter for the future cost of debt as well as the cost of future expenditure, so it is possible that households take inflation expectations into account when making their current spending decisions. Table 5 shows that our results

are robust to including changes in inflation expectations as an additional control, or to using real rate changes (nominal rate change minus the expected inflation change) instead.[23] Results are also similar if we control for house price changes at the regional level to proxy for changes in household wealth (although this control is highly correlated with the regional unemployment rate and has no statistical significance on its own). When we include year fixed effects in the specification, the estimated effects are relatively smaller—especially the IV estimates—but still significant with OLS. (These estimates only use within-year variation in rate changes.) The estimated coefficients are also lower for spending on nondurables/services and significantly larger for durable expenditure. The difference in the magnitude of the estimated coefficients for durables and nondurables/services is not surprising, as durables spending itself is interest-sensitive when financed through loans. Also, the IES effect is likely larger for durable goods, as the service flow from durable purchases can be enjoyed for many years. Overall, our results are quite robust to alternative specifications and controls.

4.2 Rates and Spending in the United States

Table 6 parallels the setup in Table 2 and presents estimates of the relationship between mortgage rate changes and expenditure growth in the United States using equation (8). Column (1) shows results for all households in our sample. The elasticity of expenditure growth with respect to income growth is 0.12, roughly in line with the estimates using Spanish data as well as the aforementioned recent literature that estimates MPCs out of income using household-level data (the average expenditure-to-income ratio in the sample is 0.66 implying a MPC around 0.18). In addition, the effects of the change in the state-level unemployment rate and real (national) GDP growth on expenditure growth have the expected signs but are not statistically significant.

In terms of our variable of interest, we find that a 1 p.p. decline in the 30-year fixed-rate mortgage leads to 2.8 p.p. higher expenditure growth. This effect is larger than the corresponding effect in Spain. (Also, this is a nine-month effect compared to the 12-month effect for Spain.) The difference in the magnitude of the effects of mortgage rate changes in the two countries could indicate a general greater sensitivity of expenditure to interest rate changes in the United States than in Spain due to a stronger IES effect. Alternatively, the larger effect may capture the fact that mortgage rates do not reset automatically in

[23] The effect of changes in inflation expectations themselves on expenditure growth are only significant for mortgagors and are roughly the same magnitude in absolute value as those for nominal rate changes (not shown).

the United States the way they do in Spain. Instead, consumers must actively refinance their loans to reap the benefits of lower rates. Consumers who choose to do so may either be more cognizant of their potential cash flow changes or wish to alter their spending; therefore, they exhibit a bigger spending response when rates change. The IV estimates using monetary policy shocks as an instrument (column [2]) are similar to the OLS estimates, although the rate change effect is somewhat smaller and not statistically significant. The lack of precision—especially compared to the Spanish data—is likely due to a weaker first stage prediction equation (F-statistic of the excluded instrument is 26.6 compared with 1190 in the Spanish data). Indeed, as we will discuss shortly, our instrument lacks power to simultaneously distinguish positive versus negative mortgage rate changes in the United States data.

The remaining columns in Table 6 mimic those in Table 2 and divide households by housing tenure and mortgage status. There is a negative relationship between mortgage rate change and expenditure growth for all household types. Somewhat surprisingly, the effect is largest for renters. This finding contrasts with the smaller and insignificant estimated mortgage rate effect for renters in Spain. The different effect across countries could be due to the fact that there are fewer renters in Spain in general and/or more renters in the United States intend to purchase a home in the future compared with renters in Spain. Changing mortgage rates affect future owners' home financing costs, especially in an environment like the United States, where mortgages are long-term and mortgage rates do not automatically reset; thus, renters in the United States may adjust their current expenditure in anticipation of increased (decreased) future housing costs. Also, renters in the United States could have more debt than renters in Spain. Within the United States, the larger response of renters relative to outright homeowners could be partly due to larger cash flow changes related to nonhousing debt. All interest rates move together to some extent and United States renters tend to have more nonhousing debt as a fraction of income relative to outright homeowners.[24] In addition, the estimated mortgage rate effects for homeowners are similar whether or not they have a mortgage. However, only the estimated effect for mortgagors is precisely estimated. As one would expect, the relationship between mortgage rate changes and expenditure growth among homeowners is most precisely estimated for mortgagors because

[24]Over our sample period, renters' average nonhousing debt relative to income in the United States ranges from 25 to 30 percent based on household wealth data from the Panel Study of Income Dynamics (PSID). Nonhousing debt for outright homeowners is a noticeably lower, ranging from 15 to 17 percent of their income.

they have the most to gain directly from a decline in mortgage rates, given that they can potentially refinance to lower their housing costs. As with the Spanish data, the sensitivity of expenditure growth to mortgage rate changes for outright homeowners is likely driven by a combination of IES and nonhousing cash flow effects.

Rate increases versus Rate Declines

The next set of results investigates whether the effect of mortgage rate changes on expenditure growth in the United States is symmetric. Although increases in interest rates potentially benefit net savers, these increases have less impact on households' mortgage cash flows because mortgage contracts are long-term and payments do not increase when mortgage rates rise. In comparison, households can reduce their interest costs and mortgage payments when interest rates decline by choosing to refinance their mortgages. While there are transaction costs associated with refinancing, a large enough decline in rates typically makes refinancing cash flow positive for households with large enough remaining mortgage balances and duration. Fluctuating (long-term) interest rates also likely affect the cost of other forms of consumer debt that can be used to finance expenditure, but not necessarily in an asymmetric way as with mortgage rates. Therefore, a priori, one would expect interest rate declines in the United States to have more of an effect on expenditure than interest rate increases.

Table 7 shows results where we estimate the effects of positive versus negative rate changes on expenditures separately for all consumers in our sample. As expected, a decrease in rates has a much larger effect on expenditure than an increase in rates. In particular, expenditure growth rises by 3.7 p.p. when rates decline by 1 p.p.—an effect that is very precisely estimated (column [1]). In comparison, expenditure growth falls when rates increase, but the effect is half the size in absolute value and statistically insignificant. Column (2) shows the corresponding IV results; the instruments are weak and we cannot pin down the effect of positive versus negative rate changes when they are included together in the regression. In reality, as the results in column (4) show, we lack power just for pinning down the effect of positive rate changes. When we include interest rate decreases alone, column (6), the first-stage is relatively strong and the IV estimates are quite similar to the OLS estimates. Indeed, the F-statistic for the excluded instrument for interest rate decreases (column [6]) is nearly double the F-statistics in Table 6, where we do not separate positive versus negative rate changes. When we estimate the effect of positive versus negative rate changes separately with OLS (columns [3] and [5]), we continue to see evidence of asymmetric effects,

with interest rate declines having a larger, more precisely estimated, impact on expenditure (in absolute value).[25]

We focus the remainder of our analysis on the relationship between falling interest rates and mortgagors' expenditure. We make this choice because it allows us to investigate and isolate the mechanism behind the mortgage cash flow channel of monetary policy that in the United States typically works through encouraging (or discouraging) mortgage refinancing. Our instrument also does a better job of identifying the impact of interest rate declines. Nevertheless, the question of why the expenditure of renters and outright homeowners responds to changes in longer-term interest rates is important. We leave this question primarily to future work but briefly note that younger renters (those 45 years old or younger) tend to respond more to interest rate changes than older renters. Furthermore, the interest rate effects (estimated with OLS) are generally the largest for younger renters who are single or have a college education (see Table A.8 in the Appendix). Young renters are likely net borrowers and in general may benefit from lower interest rates to finance their expenditures. Moreover, young renters who are single or have higher income may be planning to purchase a home in the future and may face reduced financing costs with lower rates.

Heterogeneity across Mortgagors

In the United States, the transaction costs associated with mortgage refinancing are relatively large, so not all mortgagors benefit from lower interest rates—especially small declines. Mortgage holders who have refinanced recently and/or mortgagors with small remaining balances may not find it cost-effective to pay the transaction costs needed to refinance when mortgage rates decline. Others may have insufficient equity in their homes (or have negative equity) to take out a new mortgage.

While the CEX does not contain a direct indicator of whether or not households refinance their mortgage loans, we employ a series of indicators to try to identify consumers who have potentially refinanced recently or who would likely benefit the most from doing so, and to analyze whether the sensitivity of their expenditure growth to interest rate declines is higher than for other mortgagors.

[25]The evidence on asymmetric interest rate change effects is more mixed when we consider results broken down by housing tenure (see Tables A.6 and A.7 in the appendix). Interest rate declines raise expenditure for all household types, but the effects for interest rate increases are slightly larger than for decreases for renters and mortgagors (although the differences are not statistically significant). These findings highlight that there are other channels affecting consumption beyond the mortgage cash flow channel when interest rates fluctuate.

First, we group mortgagors based on the share of their income that is devoted to mortgage interest payments. Ideally, we would use a measure of total mortgage payments including principal, but these data are not available in the CEX. However, interest payments tend to make up the majority of mortgage costs, especially early in the life of an amortized 30-year fixed-rate loan. We use the mortgage interest payments to income (Mpay) ratio as a proxy for the amount of a household's cash flow that is tied up in housing costs. In particular, we divide households into three groups: those in the bottom quartile of the Mpay distribution, those in the middle two quartliles (25th to 75th percentiles), and those in the top quartile. (We calculate Mpay as of the initial period of observed household expenditures.) Nonhousing expenditure should be more sensitive to interest rate declines for households with more of their income devoted to mortgage-related interest costs, as long as they have the desire and ability to refinance.

We find that the spending response to interest rate *declines* is driven by mortgagors in the middle part of the Mpay distribution as shown in Panel A of Table 8. A 1 p.p. drop in interest rates raises expenditure growth for these households by 7 to 9 p.p., depending on whether we focus on the OLS or IV estimates (see columns [5] and [6]). This effect is more than double what we observe overall for mortgagors (columns [1] and [2]). In contrast, household expenditure growth for those at the top and bottom of the MPay distribution exhibits little response to interest rate declines—a finding that is not necessarily surprising. Indeed, the cash flow benefits from refinancing are likely low for mortgagors with low Mpay ratios, while mortgagors with high Mpay ratios may have refinanced recently and taken out a larger mortgage or have lower credit scores or high debt relative to income (or limited housing equity), and may therefore be more constrained in their ability to obtain a new mortgage. Overall, the results in Table 8 are consistent with refinancing driving the mortgage cash flow effect by determining the sensitivity of mortgagors' expenditure growth to interest rate declines.

The estimates in Panel B of Table 8 further divide mortgagors based on whether they report a fixed- or variable-rate mortgage. In the United States interest rates on ARMs are fixed for an extended period of time at the outset of the loan before they reset, so a household would need to be nearing the end of the initial rate lock horizon for its variable-rate loan to reset automatically. Still, households with variable-rate mortgages may be more attuned to interest rate fluctuations and more inclined to refinance to lock in more favorable terms when interest rates go down. We find that expenditure growth is particularly sensitive to interest rate declines for US mortgagors with ARMs. This difference in interest rate sensitivity is

driven primarily by households with variable-rate mortgages in the top and middle parts of the Mpay distribution (see Table 8, columns [3] to [6]). That high Mpay ratios matter for the interest rate sensitivity of households with variable-rate mortgages, in contrast to the results in Panel A of Table 8, is not necessarily surprising. Even if households with ARMs and high Mpay ratios have limited equity in their homes or high debt relative to income, they can still benefit from lower rates via their loans resetting automatically without them having to go through a new mortgage underwriting process. In addition, as noted earlier, households with variable-rate mortgages over our sample period are likely more financially savvy and wealthy; thus, some may be less constrained in their ability to refinance than the average household with a high MPay ratio.

When we consider additional indicators of potential refinancing, we find further evidence consistent with mortgage refinancing driving the relationship between mortgagors' expenditure growth and interest rates in the United States. In particular, we find a higher sensitivity of expenditure growth to interest rate declines for mortgagors that experience large declines in interest rates (100 basis point or more drop over the previous 14 months) as well as for mortgagors with large reported declines in mortgage interest payments over the expenditure growth period. We further find that the interest sensitivity of expenditure growth is largest for mortgagors in the middle of the Mpay distribution—those likely most able to refinance and with the most to gain from doing so—who either report a large decline in their mortgage interest payments or who have recently experienced a large drop in interest rates (see Table 9). In sum, these results show that the most likely mortgage refinancers have the largest expenditure response to interest rate decreases.

Robustness

Table 10 explores the robustness of our baseline results to some alternative specifications. We focus on overall mortgage rate changes rather than mortgage rate declines to be consistent with the estimates for Spain. First, we add the change in (five-year-ahead) consumer inflation expectations as an additional control to our main specification.[26] We use nominal rate changes in our main analysis because consumers observe nominal rates and changes these rates are what is relevant for a household in determining whether or not to refinance. The results (second row) show that the sensitivity of expenditure to (nominal) mortgage rate

[26]We use data on monthly consumer inflation expectations from the Federal Reserve Bank of Cleveland (see https://www.clevelandfed.org/our-research/indicators-and-data/inflation-expectations.aspx for more details on these data). We focus on the 5-year horizon because it is close to the average duration of mortgages in the United States.

changes is little changed relative to our baseline findings (first row) when controlling for inflation expectations. We also consider the relationship between expenditure growth and real interest rate changes directly, where we define the real rate change as the nominal rate change less the change in five-year-ahead inflation expectations. These results (third row) are once again quite similar to our baseline results, which could be due in part to the fact that inflation expectations were quite stable over our sample period. If anything, the sensitivity of expenditure growth to real rate changes is somewhat larger (in absolute value) than our baseline estimates with nominal rates, especially for mortgagors and renters.

The next two specifications include additional control variables (with nominal interest rate changes). First, we add (state-level) house price growth over the expenditure period, which serves as a proxy for changes in household wealth—another channel through which monetary policy impacts expenditure. Adding house price growth, however, has limited impact on our interest rate sensitivity estimates (row 4).[27] We also try to include year fixed effects rather than controlling for GDP growth (or house-price growth). Year fixed effects are designed to pick up broad macroeconomic trends over our sample period and control for systematic macroeconomic factors evolving over time that could impact household-level expenditure growth but not be well approximated by real GDP growth. With year fixed effects, the OLS estimates are generally smaller and less precisely estimated than our baseline effects, while the IV estimates are somewhat larger and a bit more precisely estimated (row 5). Overall, though, the results are qualitatively similar.

Finally, we divide total nonhousing expenditures into its components—durables and nondurables/services—to check how the interest rate sensitivity varies across expenditure categories. Like with the Spanish data, we find that the interest rate effects are larger for durables. Not only are households more likely to use the proceeds of refinancing for more costly (and infrequent) durables purchases, but even without refinancing, durables spending may respond to interest rates changes as many durable purchases are financed through other forms of credit. As with our results for Spain, our US findings are overall quite robust.

4.3 Discussion

Our analysis points to a healthy transmission of monetary policy to household consumption in both the United States and Spain from 2007 to 2018—a period dominated by interest rate declines. (Since we control for household income changes in our regressions, the effects that

[27]The coefficient on house-price growth itself (not shown) is fairly precisely estimated—especially for mortgagors—but has the wrong sign, as it is highly collinear with our other macroeconomic controls.

we document go beyond the general equilibrium effects of interest rate changes on income.) Our prior was that monetary policy transmission would be stronger in Spain because of the dominance of *true* ARMs in that country. The reality proved to be more complicated.

Indeed, we have highlighted that monetary policy affects household expenditure via multiple channels, not only the mortgage cash flow channel. The IES effect seems strong in both countries, as outright homeowners, who are likely net savers with low MPCs, increase their expenditure as rates decline (for outright homeowners, the mortgage cash flow effect is zero and other cash flow effects are likely falling assuming that they are net savers). In the United States, renters are the group most sensitive to mortgage rate changes, likely pointing to a nonhousing cash flow channel (and possibly higher MPCs for these households). In Spain, renters display little expenditure sensitivity to mortgage rate changes on average, consistent with them generally being poorer and exhibiting hand-to-mouth spending behavior. However, highly educated and high-income renters (see Table A.5 in the appendix) do react to mortgage rate changes. With mortgagors, the estimated effect is larger in the United States than in Spain—even though mortgage refinancing is necessary in the United States to take advantage of the mortgage cash flow channel. There are at least two reasons that could drive this result. First, households that refinance might have higher MPCs, and if not, refinancing can potentially free up more cash than the (frequent) automatic rate resets in Spain. Second, refinancing locks in a new rate for the duration of the loan, while mortgage cash flow effects of automatic resets might be perceived by Spanish households as transitory. Typically, the MPC out of transitory (resource) changes is lower than the MPC out of permanent changes.[28]

Another fact worth highlighting is the very different proportions of households in each housing tenure category. Mortgagors, outright owners, and renters represent 44, 40, and 16 percent of households in Spain in our sample. In the United States, the corresponding numbers are 50, 20, and 30 percent. In other words, within the 18-to-64 age group, homeownership is more prevalent in Spain (84 percent versus 70 percent), and homeowners in Spain are more likely to fully pay off their balances and own their homes outright, which is not surprising given the swift penalties from late mortgage payments and default in Spain during our sample period. Our overall estimated interest rate effects are a weighted average of the effects for different groups, so even if mortgagors in Spain exhibited higher sensitivity

[28] Jappelli and Scognamiglio (2018) show that following a reduction in mortgage payments in Italy in 2008, consumption of ARM holders increased relative to FRM. However, the implied MPC was not statistically different from zero, partially because borrowers expected that the income shock was short-lasting and interest rates would likely increase in the future.

to rate changes than mortgagors in the United States, the overall effect in Spain could be smaller depending on the behavior of other households.

In addition, the mortgage cash flow effect is much more homogeneous across Spanish mortgagors than United States mortgagors. So while the nature of mortgages might not matter much for the average effect of monetary policy, it might still matter in terms of how monetary policy (indirectly) impacts inequality. Indeed, the United States mortgagors that benefit from lower interest rates are the ones with the ability and desire to refinance—households that overall are likely wealthier and more financially savvy. Indeed, recent research by Agarwal et al. (2021) documents that homeowners in the top quintile of the income distribution were much more likely to refinance than homeowners in the bottom quintile during the pandemic. Similarly, Gerardi, Lambie-Hanson, and Willen (2021) find that nonwhite borrowers are much less likely to refinance than white borrowers. In general, refinancing incurs relatively high transaction costs—around $5,000 on average according to Freddie Mac[29]—an amount that may be prohibitive for less affluent borrowers even if the longer-term savings from refinancing outweigh the initial costs. In a mortgage market dominated by ARMs with frequent resets, borrowers are effectively able to refinance when rates decline without having to paying an upfront fixed cost, so the benefits of decreasing rates with expansionary monetary policy are spread more evenly across mortgagors. In addition, monetary policy might be more powerful in slowing the economy in Spain than in the United States, given that mortgage rates can reset higher automatically on a yearly basis. However, more work is certainly needed in this respect, as our sample period is dominated by rate declines and our estimates of the interest rate sensitivity of expenditure growth are quite noisy in the United States for rate increases.

Finally, Figure 3 depicts the implied partial equilibrium mortgage rate effects on household expenditure growth, over our sample period, for all households and for mortgagors in Spain and the United States. It is important to note not only that monetary policy took different paths in Europe and the United States over our sample period but also that mortgage rates in Spain follow the short-term policy rate more closely, while mortgage rates in the United States typically track longer-term rates. In any case, the figure highlights that monetary policy clearly affects household expenditure growth in both countries, with the effects in Spain much more precisely estimated, likely because the effects across Spanish households, particularly mortgagors, are more homogeneous.

[29]For more details, see https://www.wsj.com/articles/millions-of-americans-refinanced-last-year-but-fewer-black-and-latino-homeowners-did-11624440601

5 Conclusion

In this paper, we compare the transmission of monetary policy to consumption in two countries with very different mortgage market institutions—Spain and the United States. The Spanish mortgage market is made up mostly of true ARMs with annual rate resets, while the US market is dominated by long duration FRMs where homeowners' mortgage rate changes occur only if they actively refinance or move to a new home. The focus of our analysis is on the direct effect of monetary policy transmission, particularly the mortgage cash flow effect. We show that within Spain, due to the automatic resetting of the mortgage rate, the mortgage cash flow effect is more or less symmetric (of similar magnitude for rate increases and declines) and homogeneous across households. Within the United States, the mortgage cash flow effect is larger for rate declines and also heterogeneous among mortgagors, with the most likely refinancers showing the largest effects.

Our cross-country comparison reveals that the overall effect of mortgage rate changes is larger in the United States than in Spain, and this holds for all three housing tenure groups. While this result counters our prior that monetary policy transmission (especially among mortgagors) should be stronger in Spain because of the dominance of ARMs relative to the United States, we show that the result is explained by at least two factors. One, there are two other direct channels of monetary policy transmission: an intertemporal substitution effect and a nonmortgage cash flow effect, both of which are hard to disentangle from the mortgage cash flow effect due to the comovement of interest rates in the economy. While these channels are not the focus of our analysis, we find some evidence for these effects being operative in the data given the response of non-mortgagors' consumption to mortgage rate changes.

Two, US households can refinance to lock in a new lower rate for the duration of the loan when aggregate mortgage rates decline (as they did during most of our sample period) and refinancing is typically undertaken by those who have the most to gain from it. A third potential reason could be that refinancing locks in a new lower mortgage rate for the duration of the new FRM contract. In contrast, ARM rate changes can be temporary, lasting only until the next mortgage rate reset (if rates change again). We leave a deeper exploration of this reason for future research.

Overall, our results provide new evidence on the mortgage cash flow effect of monetary policy transmission. We show that the institutional structure of mortgages matters for the average effect of monetary policy on consumption in an unexpected way. Also, this structure

has indirect consequences for inequality given the automatic transmission of rate changes under ARMs versus the selective transmission under FRMs based on who refinances.

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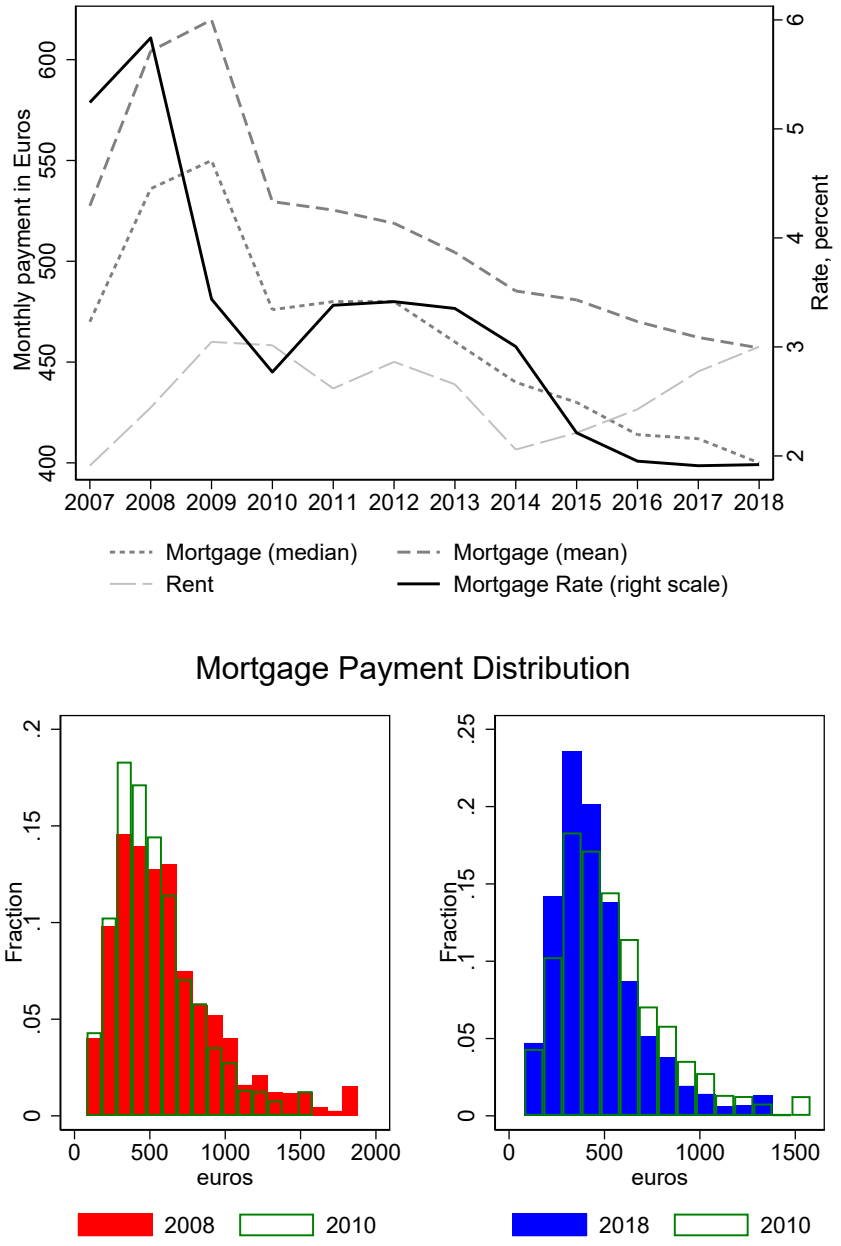
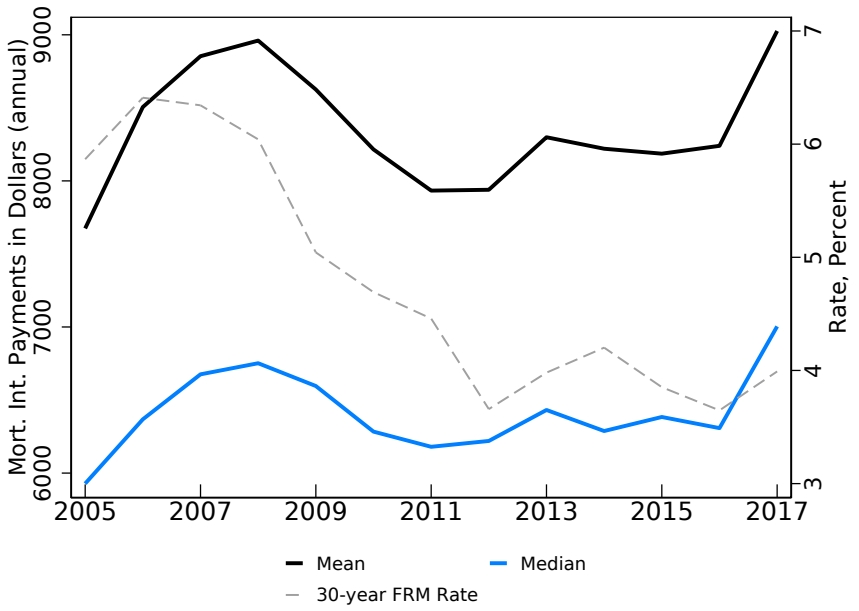
Figure 1. Mortgage and Rental Payments over Time in Spain



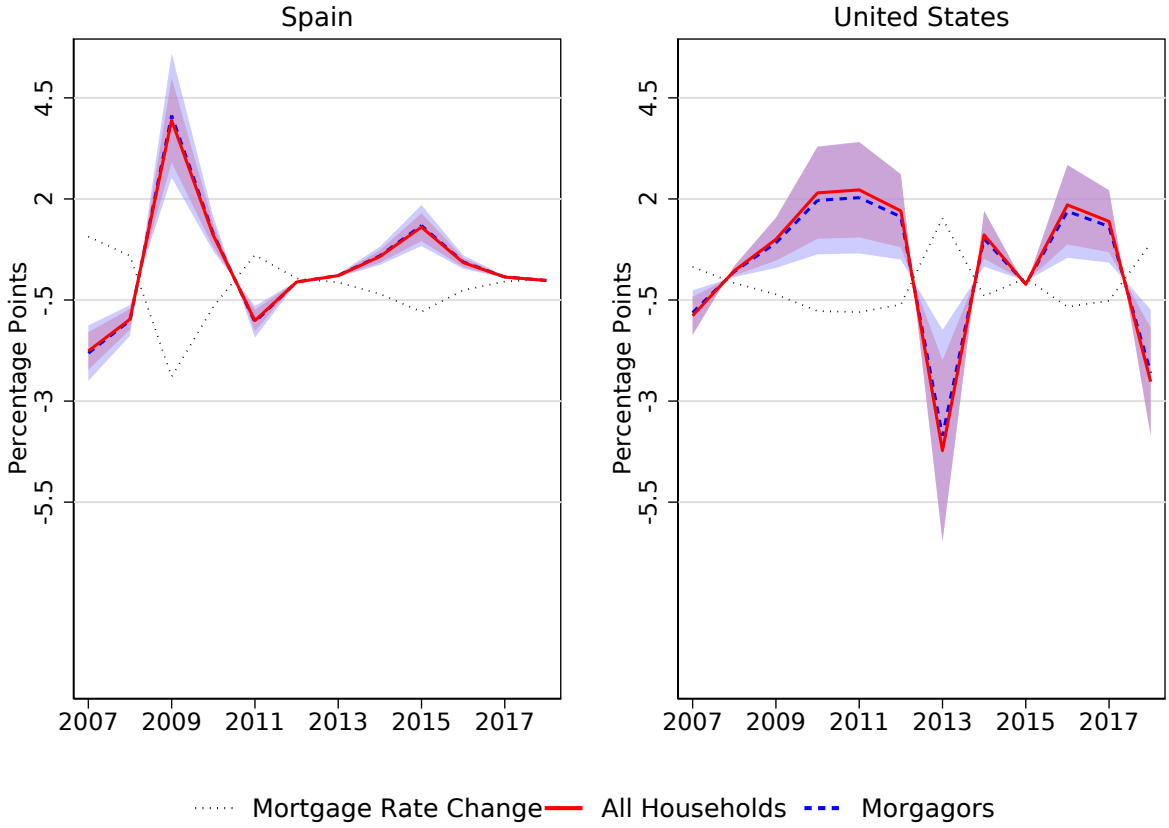
Source: Authors' calculations using the *Encuesta de Condiciones de Vida* (ECV) and data from the Bank of Spain on mortgage rates.

Figure 2. Mortgage Interest Payments over Time in the US



Source: Authors' calculations using the Consumer Expenditure Survey Data and mortgage rate data from the Federal Home Loan Mortgage Corporation.

Figure 3. Interest Rate Effects on Household Consumption over Time



Source: Authors' calculations using the OLS estimates of Table 2 for Spain and Table 6 for the US, along with the actual rate changes during the period. US estimates are scaled up by a 4/3 factor to account for the fact that US estimates refer to changes over a 9-month period instead of 12 months in Spain.

Table 1. Mortgage Interest Rate Payments over Time

Year	(1) Mortg. Rate	(2) Mortg. Rate Chg.	(3) Interest Paid over Income	(4) Households with Interest Declines	(5)	(6)
				Fraction	Chg., Euros	Chg. rel. Inc.
2008	5.83	0.59	0.137	0.58	–1247	–0.044
2009	3.44	–2.40	0.102	0.78	–1970	–0.068
2010	2.77	–0.67	0.099	0.62	–1157	–0.044
2011	3.38	0.61	0.108	0.48	–1130	–0.044
2012	3.42	0.03	0.093	0.66	–1133	–0.045
2013	3.35	–0.06	0.083	0.69	–980	–0.038
2014	3.00	–0.35	0.084	0.64	–720	–0.030
2015	2.21	–0.79	0.069	0.71	–751	–0.030
2016	1.95	–0.26	0.057	0.66	–689	–0.028
2017	1.91	–0.04	0.046	0.60	–761	–0.028
2018	1.92	0.01	0.046	0.57	–670	–0.024

Notes: Data from the longitudinal component of the ECV. The sample includes households reporting mortgage payments in two consecutive years. The survey reports the annual amount of interest paid by households holding mortgages, but principal payments are not included. We do not know when a consumer moves or takes a new loan. Columns (1) and (2) report the reference mortgage rate published by the Bank of Spain and its change. Column (4) is the fraction of households with interest payment declines in a given year. Columns (3), (5), and (6) are averages across households in a give year. The last two columns report averages conditional on having experienced an interest rate decline.

Table 2. Consumption Growth and Mortgage Rate Changes in Spain

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All		Owners/Mortgage		Owners/No Mortg.		Renters	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Rate chg.	–1.65***	–1.48***	–1.70***	–1.57***	–1.92***	–1.83***	–0.74	–0.26
	(0.22)	(0.24)	(0.33)	(0.35)	(0.29)	(0.32)	(0.55)	(0.55)
Household Income Growth	0.18***	0.18***	0.18***	0.18***	0.15***	0.15***	0.22***	0.22***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Regional Unemp. Change	–0.90***	–0.90***	–0.95***	–0.95***	–0.66***	–0.66***	–1.23***	–1.23***
	(0.11)	(0.11)	(0.16)	(0.16)	(0.15)	(0.15)	(0.29)	(0.29)
National GDP Growth	0.53***	0.51***	0.65***	0.64***	0.51***	0.50***	0.30	0.27
	(0.14)	(0.14)	(0.19)	(0.19)	(0.18)	(0.18)	(0.34)	(0.35)
Cons. growth mean	–1.8	–1.8	–2.4	–2.4	–1.7	–1.7	–0.4	–0.4
SD	47.8	47.8	46.8	46.8	46.7	46.7	51.5	51.5
Rate chg. mean	–0.2	–0.2	–0.2	–0.2	–0.2	–0.2	–0.2	–0.2
SD	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.8
R-squared	0.05	0.05	0.05	0.04	0.05	0.04	0.08	0.06
Observations	69,516	69,516	30,479	30,479	27,720	27,720	11,311	11,311
F exc. instrument		1190		1164		1194		1198

Notes: The LHS is log consumption growth excluding housing-related expenditures (mainly utilities, maintenance spending, and condo fees). The rate included in the regressions is the 12-month change in the reference rate for mortgages from the Bank of Spain, lagged one month relative to the date of the household interview. The unemployment change and GDP growth are also relative to 12 months before the date of the interview. Note, however, that the frequency of the unemployment rate and GDP growth is quarterly. Additional controls: region fixed effects; two-week period of the interview fixed effects; household size; number of earners in the household; age, gender, education level, labor market status, and nationality of the head; change in labor force status; change in household size; change in marital status; presence of children; and an indicator for job loss. Standard errors clustered by two-week period × year, the level of variation of the mortgage rate. Sample: all households with heads 18 to 64 years old, years 2007 to 2018. Instrument: Euribor three-month shock aggregated over a year, lagged one month.

Table 3. Consumption Growth and Mortgage Rate Changes (Spain)
Rate Increases versus Rate Decreases

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All		Owners/Mortgage		Owners/No Mortg.		Renters	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Increase × Rate chg.	–2.77***	–3.82***	–2.38**	–4.02***	–3.35***	–3.77***	–1.98	–2.98
	(0.66)	(0.73)	(0.96)	(1.13)	(0.85)	(0.97)	(1.64)	(1.94)
Decrease × Rate chg.	–1.24***	–0.58	–1.45***	–0.64	–1.39***	–1.07**	–0.28	0.82
	(0.32)	(0.42)	(0.47)	(0.57)	(0.40)	(0.50)	(0.77)	(0.91)
Income Growth	0.18***	0.18***	0.18***	0.18***	0.15***	0.15***	0.22***	0.22***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Unemp. Change	–0.80***	–0.69***	–0.90***	–0.74***	–0.54***	–0.49***	–1.14***	–1.02***
	(0.12)	(0.13)	(0.18)	(0.19)	(0.17)	(0.17)	(0.32)	(0.33)
GDP Growth	0.59***	0.64***	0.69***	0.78***	0.60***	0.61***	0.35	0.38
	(0.14)	(0.14)	(0.20)	(0.20)	(0.19)	(0.19)	(0.35)	(0.36)
Diff p-value	0.07	0.00	0.46	0.03	0.07	0.04	0.42	0.14
R-squared	0.05	0.05	0.05	0.04	0.05	0.04	0.08	0.06
Observations	69,516	69,516	30,479	30,479	27,720	27,720	11,311	11,311
F exc. instrument		396		391		403		362

Notes: The LHS is log consumption growth excluding housing-related expenditures (mainly utilities, maintenance spending, and condo fees). The rate included in the regressions is the 12-month change in the reference rate for mortgages from the Bank of Spain, lagged one month relative to the date of the household interview. The unemployment change and GDP growth are also relative to 12 months before the date of the interview. Note, however, that the frequency of the unemployment rate and GDP growth is quarterly. Additional controls: region fixed effects; two-week period of the interview fixed effects; household size; number of earners in the household; age, gender, education level, labor market status, and nationality of the head; change in labor force status; change in household size; change in marital status; presence of children; and an indicator for job loss. Standard errors clustered by two-week period× year, the level of variation of the mortgage rate. Sample: all households with heads 18 to 64 years old, years 2007 to 2018. Instrument: Euribor three-month shock aggregated over a year, lagged one month.

Table 4. Consumption Growth and Mortgage Rate Changes (Spain). Splits of Mortgage Holders

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Younger than 45		High Education		High Income		Large House		Large Inc. Drop		Working		House-Price Apprec.	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Yes × Rate chg.	–2.06***	–2.07***	–1.88***	–2.22***	–2.11***	–2.28***	–2.22***	–2.00***	–2.23***	–2.19***	–1.94***	–2.03***	–2.94***	–2.88***
	(0.41)	(0.45)	(0.50)	(0.52)	(0.49)	(0.49)	(0.49)	(0.54)	(0.64)	(0.73)	(0.35)	(0.38)	(0.68)	(0.85)
No × Rate chg.	–1.50***	–1.61***	–1.78***	–1.64***	–1.61***	–1.58***	–1.62***	–1.81***	–1.67***	–1.76***	–1.09	–0.92	–1.42***	–1.53***
	(0.43)	(0.45)	(0.41)	(0.47)	(0.39)	(0.44)	(0.39)	(0.44)	(0.33)	(0.37)	(0.76)	(0.89)	(0.39)	(0.45)
Pct. Yes	0.56	0.56	0.43	0.43	0.39	0.39	0.33	0.33	0.26	0.26	0.86	0.86	0.53	0.53
p-value diff	0.30	0.44	0.87	0.42	0.42	0.28	0.32	0.79	0.40	0.59	0.31	0.26	0.06	0.21
R-squared	0.05	0.04	0.05	0.04	0.05	0.04	0.05	0.04	0.05	0.04	0.05	0.04	0.05	0.04
Observations	30,479	30,479	30,479	30,479	30,479	30,479	30,479	30,479	30,479	30,479	30,479	30,479	30,479	30,479
F exc. instrum.		378		380		359		349		372		418		414

Notes: The LHS is log consumption growth excluding housing-related expenditures (mainly utilities, maintenance spending, and condo fees). The rate included in the regressions is the 12-month change in the reference rate for mortgages from the Bank of Spain, lagged one month relative to the date of the household interview. All controls as in Table 2, not reported for brevity. Standard errors clustered by two-week period × year, the level of variation of the mortgage rate. Sample: all households with heads 18 to 64 years old, years 2007 to 2018. Instrument: Euribor three-month shock aggregated over a year, lagged one month. 'Yes'/'No' indicates the consumer is/is not in the group indicated by the column heading.

Table 5. Consumption Growth and Mortgage Rate Changes (Spain)
Robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All		Owners/Mortgage		Owners/No Mortg.		Renters	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Baseline								
Rate chg.	–1.65***	–1.48***	–1.70***	–1.57***	–1.92***	–1.83***	–0.74	–0.26
	(0.22)	(0.24)	(0.33)	(0.35)	(0.29)	(0.32)	(0.55)	(0.55)
Controlling for Changes in Expected Inflation								
Rate chg.	–1.73***	–1.57***	–1.89***	–1.78***	–1.90***	–1.79***	–0.83	–0.33
	(0.23)	(0.25)	(0.34)	(0.36)	(0.30)	(0.33)	(0.56)	(0.57)
Real Rate instead of Nominal Rate								
Rate chg.	–1.69***	–1.67***	–1.89***	–1.77***	–1.79***	–2.05***	–0.84	–0.29
	(0.22)	(0.28)	(0.33)	(0.40)	(0.31)	(0.37)	(0.55)	(0.63)
Controlling for House Price Changes								
Rate chg.	–1.73***	–1.68***	–1.82***	–1.87***	–1.98***	–1.98***	–0.78	–0.39
	(0.21)	(0.23)	(0.32)	(0.34)	(0.28)	(0.32)	(0.54)	(0.54)
Including Year Fixed Effects								
Rate chg.	–1.03**	–0.73	–1.15**	–0.96	–1.70***	–1.37**	0.98	1.57
	(0.40)	(0.47)	(0.56)	(0.65)	(0.48)	(0.53)	(1.30)	(1.49)
Nondurables and Services								
Rate chg.	–1.07***	–0.93***	–1.07***	–1.01***	–1.23***	–1.12***	–0.54	–0.04
	(0.19)	(0.22)	(0.29)	(0.31)	(0.25)	(0.29)	(0.48)	(0.50)
Durables								
Rate chg.	–3.66***	–3.47***	–3.86***	–3.60***	–3.80***	–3.63***	–2.62**	–2.65*
	(0.56)	(0.58)	(0.86)	(0.89)	(0.77)	(0.81)	(1.31)	(1.44)

Notes: The LHS is log consumption growth excluding housing related expenditures (mainly utilities, maintenance spending, and condo fees). The rate included in the regressions is the 12-month change in the reference rate for mortgages from the Bank of Spain, lagged one month relative to the date of the household interview. All controls as in Table 2, not reported for brevity. Standard errors clustered by two-week period × year, the level of variation of the mortgage rate. Sample: all households with heads 18 to 64 years old, years 2007 to 2018. Instrument: Euribor three-month shock aggregated over a year, lagged one month. Alternative specifications as indicated by the panel heading in the table.

Table 6. Consumption Growth and Mortgage Rate Changes in the United States

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All		Owners/Mortgage		Owners/No Mortg.		Renters	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Chg. Rate	–2.78***	–1.98	–2.54***	–1.71	–2.33	–0.14	–3.50***	–4.47
	(0.75)	(1.73)	(0.88)	(2.07)	(1.57)	(3.07)	(0.95)	(2.86)
Income Growth	0.12***	0.12***	0.13***	0.13***	0.12***	0.12***	0.11***	0.11***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Unemp. Change	–0.43	–0.34	–0.73	–0.64	–0.29	–0.04	–0.16	–0.27
	(0.48)	(0.52)	(0.64)	(0.69)	(1.11)	(1.17)	(0.73)	(0.81)
Real GDP growth	0.42	0.39	0.46	0.43	0.27	0.19	0.41	0.44
	(0.30)	(0.30)	(0.40)	(0.41)	(0.63)	(0.62)	(0.47)	(0.49)
Cons. growth mean	–2.9	–2.9	–2.3	–2.3	–3.2	–3.2	–3.6	–3.6
SD	59.7	59.7	59.2	59.2	61.0	61.0	59.8	59.8
Rate chg. mean	–0.2	–0.2	–0.2	–0.2	–0.1	–0.1	–0.1	–0.1
SD	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
R-squared	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
Observations	40,998	40,998	20,512	20,512	8,066	8,066	12,356	12,356
F exc. instrument		26.6		29.2		25.7		22.8

Notes: The LHS is real log consumption growth excluding shelter-related expenses (rent, maintenance, utilities, etc.) and retirement benefit contributions. The interest rate included in the regressions is the nine-month change in the 30-year fixed rate mortgage lagged three months relative to the end of a household's reported consumption period. The change in the unemployment rate is measured at the state level over the same nine-month period as household expenditures, while real GDP growth is quarterly and captures the 12-month growth in output as of the quarter that encompasses the majority of the expenditure months covered by a household's final interview. Additional controls: age, household size, change in household size, change in marital status, number of earners in household, education, quarter fixed effects, state fixed effects, and an indicator for missing household income growth. Standard errors (in parentheses) are clustered by month × year, which is the level of variation in the mortgage rate. Sample: all households with heads 18 to 64 years old who are in the survey between 2007 and 2018. Instrument: Shocks to the 10-year Treasury aggregated over the five-month period leading up a household's final three expenditure months.

Table 7. Consumption Growth and Mortgage Rate Changes (US)
Rate Increases versus Rate Decreases. All Households

	(1)	(2)	(3)	(4)	(5)	(6)
	Both		Rate Increases		Rate Decreases	
	OLS	IV	OLS	IV	OLS	IV
Decrease x Rate Chg.	–3.69***	8.62			–4.29***	–4.17**
	(1.08)	(44.34)			(1.05)	(1.74)
Increase x Rate Chg.	–1.62	–157.31	–3.58**	51.54		
	(1.60)	(513.89)	(1.61)	(240.03)		
Income Growth	0.12***	0.11***	0.12***	0.12***	0.12***	0.12***
	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)	(0.01)
Unemp. Change	–0.42	–8.13	–0.32	2.66	–0.37	–0.36
	(0.49)	(24.87)	(0.49)	(13.78)	(0.49)	(0.49)
Real GDP growth	0.47	–1.20	0.29	0.69	0.51	0.50
	(0.31)	(5.75)	(0.29)	(2.17)	(0.31)	(0.32)
Cons. growth mean	–2.9	–2.9	–2.9	–2.9	–2.9	–2.9
SD	59.7	59.7	59.7	59.7	59.7	59.7
Rate chg. mean	–0.2	–0.2	–0.2	–0.2	–0.2	–0.2
SD	0.5	0.5	0.5	0.5	0.5	0.5
R-squared	0.02	–0.39	0.02	–0.04	0.02	0.01
Observations	40,998	40,998	40,998	40,998	40,998	40,998
F exc. instrument		0.0		0.1		59.1

Notes: The LHS is real log consumption growth excluding shelter-related expenses (rent, maintenance, utilities, etc.) and retirement benefit contributions. The interest rate included in the regressions is the nine-month change in the 30-year fixed rate mortgage, lagged three months relative to the end of a household's reported consumption period. The change in the unemployment rate is measured at the state level over the same nine-month period as household expenditures, while real GDP growth is quarterly and captures the 12-month growth in output as of the quarter that encompasses the majority of the expenditure months covered by a household's final interview. Additional controls: age, household size, change in household size, change in marital status, number of earners in household, education, quarter fixed effects, state fixed effects and an indicator for missing household income growth. Standard errors (in parentheses) are clustered by month × year, which is the level of variation in the mortgage rate. Sample: all households with heads 18 to 64 years old who are in the survey between 2007 and 2018. Instrument: Shocks to the 10-year Treasury aggregated over the five-month period leading up a household's final three expenditure months.

Table 8. Consumption Growth and Mortgage-Rate Decreases (US)
Splits based on Mortgage-Interest-Payment-to-Income Ratios. Mortgage Holders

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All w/ Mortgages		High MPay		Middle MPay		Low Mpay	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	Panel A							
Rate Chg.	–3.53***	–3.67*	0.31	2.72	–7.37***	–8.93***	0.52	–0.65
	(1.28)	(2.08)	(2.41)	(4.37)	(1.68)	(2.73)	(2.54)	(4.10)
R-squared	0.02	0.01	0.02	0.00	0.02	0.01	0.03	0.01
Observations	20,419	20,419	5,103	5,103	10,210	10,210	5,104	5,104
F exc. instrument		59.1		53.7		61.1		60.7
	Panel B							
Fixed Rate × Rate Chg.	–3.04**	–3.22	–1.00	2.73	–5.29***	–7.89***	–0.24	–0.22
	(1.30)	(2.14)	(2.31)	(4.04)	(1.69)	(2.79)	(2.74)	(4.35)
Var. Rate × Rate Chg.	–11.57***	–11.13**	–11.33*	–12.67	–11.73**	–7.38	–6.17	–5.53
	(3.45)	(4.85)	(6.02)	(8.09)	(5.89)	(8.40)	(7.75)	(9.14)
p-value diff	0.01	0.11	0.11	0.10	0.27	0.95	0.44	0.55
Percent Var. Rate	5.4	5.4	7.6	7.6	4.1	4.1	5.6	5.6
R-squared	0.02	0.01	0.02	0.00	0.02	0.01	0.03	0.01
Observations	20,419	20,419	5,260	5,260	10,294	10,294	4,863	4,863
F exc. instrument		29.5		28.8		28.5		33.2

Notes: The LHS is real log consumption growth excluding shelter-related expenses (rent, maintenance, utilities, etc.) and retirement benefit contributions. The interest rate included in the regressions is the nine-month change in the 30-year fixed rate mortgage, lagged three months relative to the end of a household's reported consumption period. All controls as in Table 6, not reported for brevity. Standard errors (in parentheses) are clustered by month × year, which is the level of variation in the mortgage rate. Sample: all households with heads 18 to 64 years old who are in the survey between 2007 and 2018. Instrument: Shocks to the 10-year Treasury aggregated over the five-month period leading up a household's final three expenditure months. Splits based on distribution of mortgage interest payment ratios for homeowners with mortgages as indicated by the column heading. High: top quartile; Middle: middle two quartiles; Low: bottom quartile.

Table 9. Consumption Growth and Mortgage Rate Decreases (US)
Splits based on Large Rate Changes and Mortgage Interest Expenditures. Mortgage Holders

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Lg. Rate Chg.		Lg. Mpay Decl.					
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
No x Rate Chg.	–3.56**	–2.50	–3.77**	–1.68				
	(1.64)	(2.46)	(1.52)	(2.30)				
Yes x Rate Chg.	–4.78**	–3.01	–4.77*	–6.01*				
	(2.12)	(2.17)	(2.69)	(3.41)				
Not mid-Mpay x Not Lg. Mpay Decl. [A]					–1.38	2.55		
					(1.84)	(2.63)		
Not mid-Mpay x Lg. Mpay Decl.[B]					–3.67	–4.95		
					(3.20)	(4.37)		
Mid-Mpay x Not Lg. Mpay Decl. [C]					–5.91***	–5.09**		
					(1.77)	(2.43)		
Mid-Mpay x Lg. Mpay Decl. [D]					–6.95*	–7.86*		
					(3.66)	(4.55)		
Not mid-Mpay x No Lg. Rate Decl [A]							–2.01	0.30
							(2.04)	(2.93)
Not mid-Mpay x Lg. Rate Decl [B]							–1.86	0.85
							(2.73)	(1.73)
Mid-Mpay x No Lg. Rate Decl [C]							–5.18***	–5.24**
							(1.75)	(2.47)
Mid-Mpay x Lg. Rate Decl [D]							–7.76***	–6.38**
							(2.55)	(3.04)
p-value diff	0.59	0.84	0.71	0.18				
p-value diff ([A] vs. [C])					0.02	0.08	0.11	0.02
p-value diff ([B] vs. [D])					0.44	0.58	0.06	0.00
p-value diff ([C] vs. [D])					0.50	0.97	0.36	0.73
R-squared	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
Observations	16,523	16,523	16,523	16,523	16,523	16,523	16,523	16,523
F exc. instrument		38.3		29.8		14.9		19.2

Notes: The LHS is real log consumption growth excluding shelter-related expenses (rent, maintenance, utilities, etc.) and retirement benefit contributions. The interest rate included in the regressions is the nine-month change in the 30-year fixed rate mortgage, lagged three months relative to the end of a household's reported consumption period. All controls as in Table 6, not reported for brevity. Standard errors (in parentheses) are clustered by month × year, which is the level of variation in the mortgage rate. Sample: all households with heads 18 to 64 years old who are in the survey between 2007 and 2018. Instrument: Shocks to the 10-year Treasury aggregated over the five-month period leading up a household's final three expenditure months. Lg. Rate Chg. indicates whether the household experiences an interest rate decrease over a 14-month period that is 100 basis points or more. Lg. Mpay Decl. indicates households that report the largest decline in mortgage interest payments over their expenditure period (households with a decline of roughly 10 percent or more.

Table 10. Consumption Growth and Mortgage Rate Changes (US)
Robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All		Owners/Mortgage		Owners/No Mortg.		Renters	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	Baseline							
Rate Chg.	–2.78***	–1.98	–2.54***	–1.71	–2.33	–0.14	–3.50***	–4.47
	(0.75)	(1.73)	(0.88)	(2.07)	(1.57)	(3.07)	(0.95)	(2.86)
	Controlling for Changes in Expected Inflation							
Rate Chg.	–3.00***	–1.21	–3.05**	–1.44	–2.01	4.15	–3.56***	–6.28
	(–3.08)	(–0.30)	(–2.44)	(–0.33)	(–0.97)	(0.46)	(–3.02)	(–0.84)
	Real Rate instead of Nominal Rate							
Rate Chg.	–3.25***	–3.99	–3.20**	–3.25	–2.32	–0.29	–4.01***	–9.62
	(1.00)	(3.36)	(1.25)	(3.83)	(2.08)	(6.63)	(1.21)	(6.37)
	Controlling for House Price Changes							
Rate Chg.	–2.61***	–3.18**	–2.38***	–3.01	–2.19	–1.16	–3.31***	–5.49**
	(0.73)	(1.57)	(0.87)	(1.89)	(1.55)	(2.88)	(0.93)	(2.57)
	Including Year Fixed Effects							
Rate Chg.	–1.49**	–2.98*	–1.40	–3.00	–2.28	–1.06	–1.83*	–4.85*
	(0.69)	(1.72)	(0.98)	(2.08)	(1.56)	(3.27)	(1.04)	(2.68)
	Nondurables and Services							
Chg. Rate	–1.73***	–1.20	–1.81***	–1.39	–0.67	0.85	–2.36***	–2.68
	(0.56)	(1.44)	(0.67)	(1.93)	(1.07)	(2.27)	(0.74)	(2.00)
	Durables							
Chg. Rate	–10.82**	–18.55	–10.22*	–20.35	–5.92	–6.94	–14.42**	–24.87
	(4.66)	(11.65)	(5.22)	(14.62)	(7.65)	(23.01)	(6.78)	(15.60)

Notes: The LHS is real log consumption growth excluding shelter-related expenses (rent, maintenance, utilities, etc.) and retirement benefit contributions. Except where indicated, the interest rate included in the regressions is the nine-month change in the nominal 30-year fixed rate mortgage, lagged three months relative to the end of a household's reported consumption period. Each specification also includes all controls as in Table 6, not reported for brevity. Standard errors are clustered by month x year, which is the level of variation in the mortgage rate. Sample: all households with heads 18 to 64 years old who are in the survey between 2007 and 2018. Instrument: Shocks to the 10-year Treasury aggregated over the five-month period leading up a household's final three expenditure months. Alternative specifications as indicated by the panel heading in the table.

A Appendix

A.1 Data

A.1.1 CEX Variable Construction Details

- *Total Spending Excluding Housing [CONSX]*: Our primary expenditure measure (CONSX) consists of all household spending excluding shelter. We exclude housing-related expenditures from overall spending to avoid any mechanical relationship between interest rates and the number of housing services that a household employs, which could potentially contaminate our results. The total expenditure data in the CEX also includes outlays for social security, pension, and other retirement benefits. We omit these outlays as well, since we do believe such payments should not be considered household consumption—if anything they represent a form of saving. More specifically, based on the CEX variable names from the FMLI files, we define CONSX as follows:

$$CONSX = TOTEXP - UTIL - SHELT - RETPEN$$

  Here we have only included the root of the variable name, but as discussed in the main text we combine the current quarter (CQ) and previous quarter (PQ) values (e.g. TOTEXP = TOTEXPPQ + TOTEXPCQ)

- *After-tax (Disposable) Income [YATAX]*: The BLS collects data on households' total disposable income over the past 12 months in a household's first and last interview.[30] The reported disposable income data have changed over time, with the biggest change occurring in 2005 when the BLS began imputing households' after-tax income when data are missing. Prior to that time, the BLS reported after-tax income whether or not they had complete income information from the household. (There is a level shift up in average after-tax income with the imputation procedure starting in 2005.) With the switch to imputed income measures, the BLS changed the relevant variable names (twice); we therefore combine data from three different series to construct YATAX as follows:

[30] The income series are populated for the second and third interviews, but the values from the first interview are just repeated.

$$YATAX = \begin{cases} \text{DPI12MO} & \text{if year} \leq 2005 \\ \text{fincatxm} & \text{if } 2005 \leq \text{year} \leq 2013 \\ \text{fincatxm} & \text{if year} > 2005 \end{cases}$$

where "year" refers to the survey year of a household's interview.

- *Fixed versus Variable Rate Mortgages*: The mortgage market in the United States is very different than in Spain in that the vast majority of consumers have fixed-rate mortgages where the mortgage rates and payments change only through refinancing. In addition, the adjustable-rate mortgages (ARMs) reset infrequently and are often used by consumers who are either financially savvy or do not intend to stay in their current residence for an extended period of time. These ARMs have a fixed interest rate for the first 5, 7, or 10 years and thus behave more like fixed-rate mortgages compared to the *true* ARMs in Spain that automatically reset for the most part yearly. Still, the CEX has data we can use to determine whether a household's mortgage on its primary residence is a fixed- or adjustable-rate loan, thus allowing us to examine whether households respond differently to interest rate changes based on their mortgage type.

  In particular, we use supplementary data from the "MOR" files that are part of the CEX detailed expenditure files. The MOR files are a subset of the supplementary data available on "Owned Living Quarters and Other Owned Real Estate," and contain data on homeowners' mortgages. Specifically, the files include a yes/no question on whether each mortgage-related loan outstanding for a household is a fixed-rate (FIXEDRTE), variable-rate (VARRTE), interest-only (INTONLY), or other (OTHRTE) type of mortgage loan. We identify households as having an ARM if they report that their primary mortgage is a variable rate loan (VARRTE = YES).

- *A Note on Sample Size and Other CEX Data Details:* To maintain sample size, we assign values to households with missing income growth or missing state of residence data. Households with missing income growth are assigned average income growth across all households in the CEX with nonmissing income growth data. We also include a dummy variable indicator for this imputation. In addition, state information is suppressed for some households living in less populous states in certain years for data confidentiality reasons. There are also years where a household is assigned to a group of generally small states. For instance, Vermont, New Hampshire, and Maine are grouped

together in some years. To avoid dropping households that we cannot identify as living in a particular state when controlling for state fixed effects, we create an arbitrary state group for all households without adequate state information (and also include a dummy variable indicating that their state information is missing). These households are further assigned the change in the national unemployment rate between their first and last interview instead of a state unemployment rate. Finally, to avoid undue influence from outliers, we winsorize the top and bottom 1 percent of the consumption growth and income growth distributions by year. Winsorizing the top and bottom 2 percent of the consumption and income growth distribution or the top and bottom 5 percent yields similar estimation results.

A.1.2 Construction of Monetary Policy Shocks

Treasury yield-based shocks for the United States

- Bloomberg data labels: *fcm1, fcm2, fcm3, fcm5, fcm7, fcm10, fcm20, fcm30*: fcm'j' represents the j-year Treasury bill/bond/note yield at constant maturity (in percent per annum).
- The surprise component is the difference in the relevant Treasury yield on the day of the meeting relative to the day before the meeting.

Euribor contract-based shocks for Spain

- Bloomberg data labels: *euribor01, euribor03, euribor06, euribor12*: euribor'j' represents the rate on the j-month EURIBOR contract.
- The surprise component is the difference in the relevant Treasury yield on the day of the meeting relative to the day before the meeting.

Other High-Frequency Shocks: United States

- Bloomberg data labels: *FF1Comdty*: current-month federal funds futures prices; *FF2Comdty*: next-month federal funds futures prices
- Using the description on Bloomberg:

$$\begin{aligned} FF1_{rate} &= 100 - FF1Comdty \\ &= \text{average of the effective FFR for the current month} \end{aligned}$$

- Using the definition above:

$$(FF1_{rate})_{t-\Delta t} = \frac{d1}{D1} r_0 + \frac{D1 - d1}{D1} E_{t-\Delta t} r_1,$$

where $d1$ is the day of the month when the FOMC meeting occurs, $D1$ is the total number of days in the meeting month, r_0 is the current FFR, and r_1 is the FFR announced at the next FOMC meeting.

- Our object of interest is the surprise component of the change in the FFR, which we call $MP1_t$, defined as:

$$MP1_t = r_1 - E_{t-\Delta t} r_1,$$

where t is the day of the FOMC meeting.

- We obtain this by solving forward the $FF1_{rate}$ equation to time t and taking the difference of the two:

$$\begin{aligned} E_{t-\Delta t} r_1 &= \left[(FF1_{rate})_{t-\Delta t} - \frac{d1}{D1} r_0 \right] \frac{D1}{D1 - d1}, \\ r_1 &= \left[(FF1_{rate})_t - \frac{d1}{D1} r_0 \right] \frac{D1}{D1 - d1}, \\ \implies MP1_t &= \left[(FF1_{rate})_t - (FF1_{rate})_{t-\Delta t} \right] \frac{D1}{D1 - d1} \end{aligned}$$

- Adjustments:
  - If the meeting was held on the first day of the month, then $E_{t-\Delta t} r_1$ will be captured by $FF2_{rate}$ on the last day of the previous month.
  - If the meeting was held in the last seven days of the month, then $MP1_t$ is the unweighted difference in the next-month's FFR rate, that is, $MP1_t = (FF2_{rate})_t - (FFR_{rate})_{t-\Delta t}$.

Other High-Frequency Shocks: Spain

- Bloomberg data labels: *EX1Comdty*: current month EONIA futures rate; *EX2Comdty*: next month EONIA futures rate.

- Since EONIA futures are the equivalent for FFF in the US, we can use the same steps as described for the US to define:

$$MP1_t = \left[(EX1Comdty_{rate})_t - (EX1Comdty_{rate})_{t-\Delta t}\right] \frac{D1}{D1 - d1}$$

- Adjustments:
  - If the meeting was held on the first day of the month, then $E_{t-\Delta t} r_1$ will be captured by $EX2Comdty_{rate}$ on the last day of the previous month.
  - If the meeting was held in the last seven days of the month, then $MP1_t$ is the unweighted difference in the next-month FFR rate, that is, $MP1_t = (EX2Comdty_{rate})_t - (EX2Comdty_{rate})_{t-\Delta t}$.

For the purposes of interpretation, all the surprise components are converted into "shocks" in basis points by multiplying them by (-100), so that a positive shock is expansionary while a negative shock is contractionary. These shocks are then used as dependent variables in our regressions.

A.2 Model

Recursive formulation of the household optimization problem:[31]

$$V(b, y; r) = \max_{c,b'} [u(c) + \beta V(b', y'; \bar{r})]$$

s.t.

$$b' = (1 + r) \times (b + y - c - p)$$
$$p = \frac{mr}{1 - (1 + r)^{-(T-t)}}$$

In the value function on the RHS, we set $r = \bar{r}$ because we want to consider the effect of a one-time change in the real interest rate r after which the rate goes back to its steady state. We will also be treating y as a constant throughout because we are ignoring any general equilbirum (GE) effects in our analysis.

Taking the FOC wrt either c or b' yields the Euler equation:

$$u_c = \beta(1 + r)V'_b$$

Totally differentiating the Euler equation:

$$\begin{aligned} u_{cc}dc = \beta V'_b dr + \beta(1 + r)V'_{bb}(b + y - c - p)dr - \beta(1 + r)V'_{bb}(1 + r)dc - \beta(1 + r)V'_{bb}(1 + r)dp \\ + \beta(1 + r)V'_{bb}(1 + r)db + \beta(1 + r)V'_{bb}(1 + r)dy \end{aligned}$$

Re-arranging terms:

$$\begin{aligned} dc \left[u_{cc} + \beta(1 + r)^2 V'_{bb}\right] = \beta V'_b dr + \beta(1 + r)V'_{bb}(b + y - c - p)dr - \beta(1 + r)^2 V'_{bb}dp \\ + \beta(1 + r)^2 V'_{bb}db + \beta(1 + r)^2 V'_{bb}dy \end{aligned}$$

Since b is predetermined and y is treated as a constant, the last two terms drop out:

$$dc \left[u_{cc} + \beta(1 + r)^2 V'_{bb}\right] = \beta V'_b dr + \beta(1 + r)V'_{bb}(b + y - c - p)dr - \beta(1 + r)^2 V'_{bb}dp$$

[31] Technically, there are two separate equations for the evolution of short-term versus long-term asset positions: $b' = (1 + r) * (b + y - c)$ and $m' = (1 + r^m) * (m - p)$. But assuming that $r^m = r + \nu$, where ν is a constant markup, we can combine the two equations into one: $b' + m' = (1 + r) * (b + y - c - p) + \nu * (m - p)$.

Combine with the Euler equation:

$$dc\left[u_{cc}+\beta(1+r)^2V'_{bb}\right]=\frac{u_c}{1+r}dr+\beta(1+r)V'_{bb}(b+y-c-p)dr-\beta(1+r)^2V'_{bb}dp$$

For ease of interpretation here let us try to rewrite this in terms of the marginal propensity to consume (MPC). For this, first note that even even though we are ignoring GE effects and setting $dy=0$ in our model, the MPC is still a well-defined concept. This is because for a general function $c=c(y)$, $dc=\frac{\partial c}{\partial y}dy$. For an even more general function $c=c(b,y), dc=\frac{\partial c}{\partial b}db+\frac{\partial c}{\partial y}dy$. This means that the MPC is given by the coefficient of dy.

Therefore, going back to the totally differentiated Euler equation and ignoring the terms without dc and dy (as these won't affect the coefficient of dy), we get:

$$u_{cc}dc=-\beta(1+r)^2V'_{bb}dc+\beta(1+r)^2V'_{bb}dy$$

$$MPC=\mu\equiv\frac{\partial c}{\partial y}=\frac{\beta(1+r)^2V'_{bb}}{u_{cc}+\beta(1+r)^2V'_{bb}}$$

From the above definition of MPC, we can rewrite the equation connecting dc to dr and dp:

$$dc\left[\frac{\beta(1+r)^2V'_{bb}}{\mu}\right]=\frac{u_c}{1+r}dr+\beta(1+r)V'_{bb}(b+y-c-p)dr-\beta(1+r)^2V'_{bb}dp$$

$$dc=\mu\frac{u_c}{\beta(1+r)^2V'_{bb}}\frac{dr}{1+r}+\mu(b+y-c-p)\frac{dr}{1+r}-\mu dp$$

We can manipulate the expression for μ as follows:

$$\mu\left[u_{cc}+\beta(1+r)^2V'_{bb}\right]=\beta(1+r)^2V'_{bb}$$

which implies:

$$\beta(1+r)^2V'_{bb}=\frac{\mu u_{cc}}{1-\mu}$$

This yields an equation linking dc to dr and dp:

$$dc=(1-\mu)\frac{u_c}{u_{cc}}\frac{dr}{1+r}+\mu(b+y-c-p)\frac{dr}{1+r}-\mu dp$$

For a small but positive r this reduces to:

$$dc = \underbrace{(1-\mu)\frac{u_c}{u_{cc}}dr}_{\text{IES effect}} + \underbrace{\mu(b+y-c-p)dr - \mu dp}_{\text{cash flow effect}}$$

Next we want to express dp as a function of dr to make clear why we include it as part of the cash flow effect.

The equation for p is:

$$p = \frac{mr}{1-(1+r)^{-(T-t)}}$$

Totally differentiating:

$$dp = \frac{r}{1-(1+r)^{-(T-t)}}dm + m\left[\frac{1-(1+r)^{-(T-t)} - r(T-t)(1+r)^{-(T-t)-1}}{\left(1-(1+r)^{-(T-t)}\right)^2}\right]dr$$

We can rewrite this as:

$$dp = \frac{p}{m}dm + m\left[\frac{1}{1-(1+r)^{-(T-t)}} - \frac{p}{m}\frac{(T-t)(1+r)^{-(T-t)-1}}{(1-(1+r)^{-(T-t)})}\right]dr$$

Setting dm to 0 as m is predetermined:

$$dp = m\left[\frac{1}{1-(1+r)^{-(T-t)}} - \frac{p}{m}\frac{(T-t)(1+r)^{-(T-t)-1}}{(1-(1+r)^{-(T-t)})}\right]dr$$

$$dp = m\left[\frac{p}{mr} - \frac{p}{m}(T-t)\frac{p}{mr}(1+r)^{-(T-t)-1}\right]dr$$

$$dp = \frac{p}{r}dr - (T-t)\frac{p^2}{mr}(1+r)^{-(T-t)-1}dr$$

$$dp = \frac{p}{r}\left[1-(T-t)\frac{p}{m}(1+r)^{-(T-t)-1}\right]dr$$

This means:

$$\frac{\partial p}{\partial r} = \frac{p}{r}\left[1-(T-t)\frac{p}{m}(1+r)^{-(T-t)-1}\right] > 0 \quad \text{for}$$

Note that for $r > 0$:

$$\frac{\partial p}{\partial r} > 0 \iff 1 > (T-t)\frac{p}{m}(1+r)^{-(T-t)-1} \iff \frac{m}{p}(1+r)^{T-t+1} > (T-t)$$

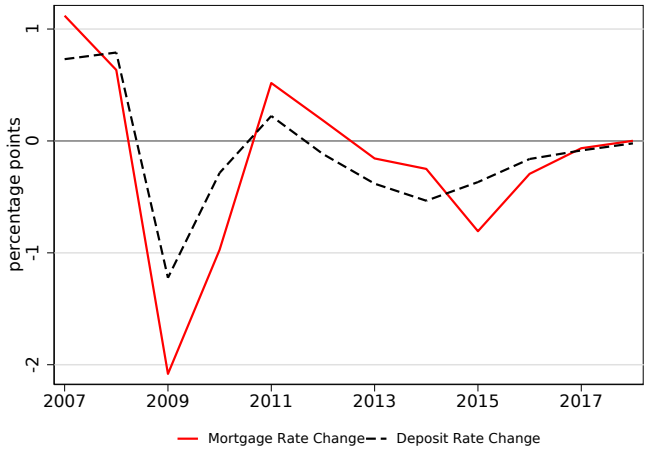
Therefore, we can rewrite the equation for dc as:

$$dc = (1-\mu)\frac{u_c}{u_{cc}}dr + \mu(b+y-c-p)dr - \mu\frac{\partial p}{\partial r}dr$$

$$\frac{dc}{dr} = (1-\mu)\underbrace{\frac{u_c}{u_{cc}}}_{\text{IES effect}} + \mu\left[\underbrace{(b+y-c-p)}_{\text{cash flow effect due to NIE of short-term positions}} - \underbrace{\frac{\partial p}{\partial r}}_{\text{mortgage cash flow effect}}\right]$$

A.3 Additional Supporting Tables and Figures

Figure A.1. Co-movement of Interest Rates over Time in Spain



Source: Authors' calculations using the data from the Bank of Spain on mortgage rates and certificates of deposit rates.

Table A.1. Summary Statistics from the ECPF-2006

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
Income	26537	15745	85	97278	69517
Consumption	23754	15640	1526	92623	69517
Consumption Growth	–1.76	47.78	–125.71	123.93	69517
Income Growth	0.99	33.45	–93.60	99.43	69517
Consumption/Income	0.99	0.56	0.19	3.38	69517
Owns Home	0.79	0.4	0	1	69517
Has Mortgage	0.44	0.5	0	1	69517
Head age	46.39	10.13	18	64	69517
Male head	0.74	0.44	0	1	69517
No. Earners in Household	1.7	0.74	0	7	69517
No. Household Members	2.89	1.26	1	16	69517
High-Education Head	0.36	0.48	0	1	69517
High-Income Household	0.32	0.47	0	1	69517
Large-House Household	0.3	0.46	0	1	69517
Large Inc. drop	0.26	0.44	0	1	69517
Head Working	0.78	0.41	0	1	69517
Local House Appreciation	0.54	0.5	0	1	69517
Mortgage Rate Change	–0.2	0.9	–3.4	1.35	69517
Monetary Policy Shock	1.06	6.91	–11.4	28.2	69517
Regional Unemp. Change	0.46	3.08	–6.26	11.24	69517
National GDP Growth	0.8	2.53	–4.36	4.16	69517
Regional Housing Apprec.	–1.05	7.33	–15.77	15.05	69517

Notes: Data from the *Encuesta Continua the Presupuestos Familiares, Base 2006.* Households with heads 18 to 64 years old from 2007 to 2018.

Table A.2. Summary Statistics by Housing Tenure (Spain)

Variable	Mean	Std. Dev.	Min.	Max.	N
Owners with a Mortgage					
Income	29014	15579	85	97278	30482
Consumption	25380	15533	1526	92623	30482
Consumption Growth	–2.44	46.83	–125.71	123.93	30482
Income Growth	0.78	30.85	–93.60	99.43	30482
Consumption/Income	0.95	0.52	0.19	3.38	30482
Mortgage Rate Change	–0.22	0.92	–3.4	1.35	30482
Regional Unemp. Change	0.53	3.09	–6.26	11.24	30482
National GDP Growth	0.74	2.54	–4.36	4.16	30482
Regional Housing Apprec.	–1.3	7.31	–15.77	15.05	30482
Head age	43.86	9.1	18	64	30482
Male head	0.76	0.43	0	1	30482
No. Earners in Household	1.73	0.69	0	6	30482
No. Household Members	2.98	1.21	1	16	30482
High–Education Head	0.43	0.49	0	1	30482
High–Income Household	0.39	0.49	0	1	30482
Large–House Household	0.33	0.47	0	1	30482
Large Inc. drop	0.26	0.44	0	1	30482
Head Working	0.86	0.35	0	1	30482
Local House Appreciation	0.53	0.5	0	1	30482
Owners without a Mortgage					
Income	27237	16344	354	97278	27723
Consumption	25335	16477	1526	92623	27723
Consumption Growth	–1.71	46.67	–125.71	123.93	27723
Income Growth	0.94	33.88	–93.60	99.43	27723
Consumption/Income	1.04	0.59	0.19	3.38	27723
Mortgage Rate Change	–0.18	0.91	–3.4	1.35	27723
Regional Unemp. Change	0.53	3.08	–6.26	11.24	27723
National GDP Growth	0.79	2.54	–4.36	4.16	27723
Regional Housing Apprec.	–1.04	7.28	–15.77	15.05	27723
Head age	52.23	8.49	18	64	27723
Male head	0.75	0.43	0	1	27723
No. Earners in Household	1.76	0.81	0	7	27723
No. Household Members	2.9	1.2	1	12	27723
High–Education Head	0.3	0.46	0	1	27723
High–Income Household	0.33	0.47	0	1	27723
Large–House Household	0.37	0.48	0	1	27723
Large Inc. drop	0.27	0.44	0	1	27723
Head Working	0.70	0.46	0	1	27723
Local House Appreciation	0.54	0.5	0	1	27723
Renters					
Income	20008	13021	298	97278	11312
Consumption	17541	12533	1526	92623	11312
Consumption Growth	–0.35	51.53	–125.71	123.93	11312
Income Growth	1.51	37.8	–93.60	99.43	11312
Consumption/Income	0.98	0.6	0.19	3.38	11312
Mortgage Rate Change	–0.21	0.83	–3.4	1.35	11312
Regional Unemp. Change	0.19	3.05	–6.26	11.24	11312
National GDP Growth	0.94	2.49	–4.36	4.16	11312
Regional Housing Apprec.	–0.54	7.44	–15.77	15.05	11312
Head age	41.82	10.21	18	64	11312
Male head	0.67	0.47	0	1	11312
No. Earners in Household	1.55	0.70	0	7	11312
No. Household Members	2.67	1.41	1	12	11312
High–Education Head	0.34	0.47	0	1	11312
High–Income Household	0.17	0.37	0	1	11312
Large–House Household	0.15	0.35	0	1	11312
Large Inc. drop	0.28	0.45	0	1	11312
Head Working	0.77	0.42	0	1	11312
Local House Appreciation	0.57	0.49	0	1	11312

Notes: Data from the ECPF–2006. Households with heads 18 to 64 years old. Sample: 2007–2018.

Table A.3. Summary Statistics from the CEX

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
Consumption	14770.01	18139.61	176.71	2080504.75	40998
Consumption Growth	-2.88	59.73	-198.59	186.19	40998
Income Growth	-0.48	62.3	-281.6	261.22	40998
Income	34950.24	29484.05	0	532298.38	40998
Consumption/Income	0.66	3.3	0.02	312.64	40996
Chg. Rate	-0.16	0.52	-1.62	1.14	40998
Unemp. Change	0.03	1.12	-2.83	5.23	40998
Real GDP growth	1.5	1.75	-4	4.06	40998
Head Age	45.5	11.47	18	64	40998
Family Size	2.85	1.56	1	15	40998
No. Earners in Hhld	1.55	0.89	0	8	40998
Chg Family Size (% w/)	12.32	32.87	0	100	40998
Chg Marital Stat (% w/)	1.95	13.82	0	100	40998
% Coll Degree	35.07	47.72	0	100	40998
% HS Only	23.11	42.15	0	100	40998
State House Appreciation	0.14	4.81	-24.6	16.64	40998

Notes: Data from the *Consumer Expenditure Survey* Households with heads 18 to 64 years old from 2007 to 2018.

Table A.4. Summary Statistics by Housing Tenure (US)

Variable	Mean	Std. Dev.	Min.	Max.	N
Owners with a Mortgage					
Consumption	17663.78	15643.03	593.2	366047.91	20512
Consumption Growth	-2.3	59.19	-198.59	186.19	20512
Income Growth	-1.31	54.17	-281.6	261.22	20512
Income	44582.59	31160.68	86.75	532298.38	20512
Consumption/Income	0.52	1.37	0.04	106.19	20512
Chg. Rate	-0.17	0.51	-1.62	1.14	20512
Unemp. Change	0.08	1.13	-2.83	5.23	20512
Real GDP growth	1.43	1.8	-4	4.06	20512
Head Age	45.89	10.32	18	64	20512
Family Size	3.07	1.52	1	14	20512
No. Earners in Hhld	1.75	0.85	0	8	20512
Chg Family Size (% w/)	12.48	33.05	0	100	20512
Chg Marital Stat (% w/)	1.46	12.01	0	100	20512
% Coll Degree	42.97	49.5	0	100	20512
% HS Only	19.81	39.86	0	100	20512
State House Appreciation	-0.07	4.77	-24.6	16.64	20512
Owners without a Mortgage					
Consumption	15612.85	29373.01	178.99	2080504.75	8066
Consumption Growth	-3.21	61.02	-198.59	186.19	8066
Income Growth	-2.38	68.17	-281.6	261.22	8066
Income	33207.85	29945.71	0	324400.66	8066
Consumption/Income	0.82	5.41	0.02	312.64	8065
Chg. Rate	-0.15	0.52	-1.62	1.14	8066
Unemp. Change	0.02	1.12	-2.77	5.23	8066
Real GDP growth	1.52	1.73	-4	4.06	8066
Head Age	51.78	10.3	18	64	8066
Family Size	2.61	1.47	1	15	8066
No. Earners in Hhld	1.42	0.96	0	7	8066
Chg Family Size (% w/)	11.49	31.9	0	100	8066
Chg Marital Stat (% w/)	1.83	13.42	0	100	8066
% Coll Degree	31.65	46.51	0	100	8066
% HS Only	26.77	44.28	0	100	8066
State House Appreciation	0.29	4.57	-24.6	12.91	8066
Renters					
Consumption	9414.63	8877.48	176.71	111278.35	12356
Consumption Growth	-3.57	59.81	-198.59	186.19	12356
Income Growth	2.17	70.31	-281.6	261.22	12356
Income	20058.72	17488.64	0	194260.03	12356
Consumption/Income	0.77	3.71	0.02	226.75	12355
Chg. Rate	-0.14	0.51	-1.62	1.14	12356
Unemp. Change	-0.04	1.08	-2.83	5.23	12356
Real GDP growth	1.6	1.68	-4	4.06	12356
Head Age	40.78	11.91	18	64	12356
Family Size	2.63	1.62	1	15	12356
No. Earners in Hhld	1.3	0.85	0	6	12356
Chg Family Size (% w/)	12.58	33.17	0	100	12356
Chg Marital Stat (% w/)	2.82	16.57	0	100	12356
% Coll Degree	24.12	42.78	0	100	12356
% HS Only	26.25	44	0	100	12356
State House Appreciation	0.41	5	-24.6	16.64	12356

Notes: Data from the CEX. Households with heads 18 to 64 years old. Sample: 2007–2018.

Table A.5. Consumption Growth and Mortgage Rate Changes. Splits for Outright Owners and Renters

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Younger than 45		High Education		High Income		Large House		Large Inc. Drop		Working		House-Price Apprec.	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Homeowners without Mortgages														
Yes × Rate chg.	–1.64**	–1.18	–0.85	–0.61	–2.30***	–2.09***	–2.37***	–2.55***	–2.32***	–2.03***	–1.69***	–1.72***	–2.37***	–2.61***
	(0.70)	(0.73)	(0.55)	(0.65)	(0.48)	(0.57)	(0.54)	(0.62)	(0.48)	(0.54)	(0.33)	(0.41)	(0.66)	(0.76)
No × Rate chg.	–2.06***	–2.16***	–2.39***	–2.47***	–1.81***	–1.92***	–1.74***	–1.63***	–1.85***	–1.95***	–2.72***	–2.62***	–1.83***	–1.74***
	(0.31)	(0.34)	(0.33)	(0.36)	(0.34)	(0.36)	(0.36)	(0.41)	(0.32)	(0.35)	(0.57)	(0.66)	(0.33)	(0.43)
Pct. Yes	0.19	0.19	0.30	0.30	0.33	0.33	0.37	0.37	0.27	0.27	0.70	0.70	0.54	0.54
p-value diff	0.59	0.22	0.02	0.01	0.39	0.79	0.36	0.25	0.37	0.90	0.13	0.28	0.48	0.37
R-squared	0.05	0.04	0.05	0.04	0.05	0.04	0.05	0.04	0.05	0.04	0.05	0.04	0.05	0.04
Observations	27,720	27,720	27,720	27,720	27,720	27,720	27,720	27,720	27,720	27,720	27,720	27,720	27,720	27,720
F exc. instrum.		406		392		395		400		408		406		410
Renters														
Yes × Rate chg.	–0.98	–0.84	–1.76*	–1.75	–2.87**	–3.12**	–2.14	–2.77*	0.57	0.52	–1.17**	–0.79	–3.25**	–1.10
	(0.71)	(0.72)	(1.01)	(1.13)	(1.24)	(1.32)	(1.33)	(1.46)	(0.93)	(1.06)	(0.59)	(0.61)	(1.26)	(1.56)
No × Rate chg.	–0.54	0.16	–0.46	0.05	–0.36	0.17	–0.50	0.09	–1.37**	–0.79	0.22	0.67	0.17	–0.13
	(0.86)	(0.91)	(0.65)	(0.64)	(0.58)	(0.60)	(0.66)	(0.64)	(0.68)	(0.71)	(1.07)	(1.18)	(0.73)	(0.74)
Pct. Yes	0.62	0.62	0.34	0.34	0.17	0.17	0.15	0.15	0.28	0.28	0.77	0.77	0.57	0.57
p-value diff	0.70	0.41	0.29	0.17	0.06	0.02	0.31	0.09	0.10	0.34	0.23	0.27	0.04	0.62
R-squared	0.08	0.06	0.08	0.06	0.08	0.06	0.08	0.06	0.08	0.06	0.08	0.06	0.08	0.06
Observations	11,311	11,311	11,311	11,311	11,311	11,311	11,311	11,311	11,311	11,311	11,311	11,311	11,311	11,311
F exc. instrum.		356		318		362		343		359		305		382

Notes: The LHS is log consumption growth excluding housing related expenditures (mainly utilities, maintenance spending, and condo fees). The rate included in the regressions is the 12-month change in the reference rate for mortgages from the Bank of Spain, lagged one month relative to the date of the household interview. All controls as in Table 2, not reported for brevity. Standard errors clustered by two-week period × year, the level of variation of the mortgage rate. Sample: all households with heads 18 to 64 years old; years 2007 to 2018. Instrument: Euribor three-month shock aggregated over a year, lagged one month. 'Yes'/'No' indicates the consumer is/is not in the group indicated by the column heading.

Table A.6. Consumption Growth and Mortgage Changes by Housing Tenure: Rate Decreases (US)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All		Owners/Mortgage		Owners/No Mortg.		Renters	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Rate Chg.	–4.29***	–4.17**	–3.43***	–3.52*	–5.60***	–2.21	–4.91***	–6.79***
	(1.05)	(1.74)	(1.28)	(2.09)	(1.94)	(3.01)	(1.54)	(2.57)
Income Growth	0.12***	0.12***	0.13***	0.13***	0.12***	0.12***	0.11***	0.11***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Unemp. Change	–0.37	–0.36	–0.65	–0.66	–0.34	–0.15	–0.05	–0.16
	(0.49)	(0.49)	(0.65)	(0.65)	(1.12)	(1.12)	(0.73)	(0.76)
Real GDP growth	0.51	0.50	0.52	0.52	0.45	0.29	0.50	0.58
	(0.31)	(0.32)	(0.40)	(0.42)	(0.65)	(0.63)	(0.49)	(0.51)
R-squared	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
Observations	40,998	40,998	20,512	20,512	8,066	8,066	12,356	12,356
F exc. instrument		59.1		59.1		59.7		59.0

Notes: The LHS is real log consumption growth excluding shelter-related expenses (rent, maintenance, utilities, etc.) and retirement benefit contributions. The interest rate included in the regressions is the nine-month change in the 30-year fixed rate mortgage lagged three months relative to the end of a household's reported consumption period. All controls as in Table 6, not reported for brevity. Standard errors are clustered by month x year, which is the level of variation in the mortgage rate. Sample: all households with heads 18 to 64 years old who are in the survey between 2007 and 2018. Instrument: Shocks to the 10-year Treasury aggregated over the five-month period leading up a household's final three expenditure months.

Table A.7. Consumption Growth and Mortgage Changes by Housing Tenure: Rate Increase (US)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All		Owners/Mortgage		Owners/No Mortg.		Renters	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Rate Chg.	–3.58**	51.54	–3.92**	17.85	–0.18	999.38	–5.36***	23.41
	(1.61)	(240.03)	(1.82)	(69.26)	(3.19)	(40075.09)	(1.77)	(859.60)
Income Growth	0.12***	0.12***	0.13***	0.13***	0.12***	0.15	0.11***	0.11***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(1.16)	(0.01)	(0.04)
Unemp. Change	–0.32	2.66	–0.66	0.46	–0.03	56.99	–0.06	1.56
	(0.49)	(13.78)	(0.65)	(4.00)	(1.10)	(2297.90)	(0.71)	(48.30)
Real GDP growth	0.29	0.69	0.34	0.48	0.18	8.33	0.25	0.49
	(0.29)	(2.17)	(0.40)	(0.77)	(0.62)	(331.10)	(0.45)	(7.02)
R-squared	0.02	–0.04	0.02	0.00	0.02	–18.12	0.02	–0.00
Observations	40,998	40,998	20,512	20,512	8,066	8,066	12,356	12,356
F exc. instrument		0.1		0.3		0.0		0.0

Notes: The LHS is real log consumption growth excluding shelter-related expenses (rent, maintenance, utilities, etc.) and retirement benefit contributions. The interest rate included in the regressions is the nine-month change in the 30-year fixed rate mortgage lagged three months relative to the end of a household's reported consumption period. All controls as in Table 6, not reported for brevity. Standard errors are clustered by month x year, which is the level of variation in the mortgage rate. Sample: all households with heads 18 to 64 years old who are in the survey between 2007 and 2018. Instrument: Shocks to the 10-year Treasury aggregated over the five-month period leading up a household's final three expenditure months.

Table A.8. Consumption Growth and Mortgage Rate Decreases (US)
Renters by Age and Type

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Baseline		College Ed		High Income		Single	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
45+ y.o. x Rate Chg.	–4.19*	–6.80						
	(–1.69)	(–1.19)						
Less 45 y.o. x Rate Chg.	–5.32***	–5.46						
	(–2.64)	(–1.29)						
45+ y.o x No x Rate Chg. [A]			–4.00	–9.11	–4.88*	–7.70	–5.40	–10.02
			(–1.55)	(–1.33)	(–1.80)	(–1.38)	(–1.48)	(–1.49)
45+ y.o x Yes x Rate Chg. [B]			–4.76	1.96	–1.92	–3.44	–2.51	–3.14
			(–1.05)	(0.16)	(–0.42)	(–0.35)	(–0.66)	(–0.46)
45+ y.o x No x Rate Chg. [C]			–3.93*	–6.87	–6.03**	–6.11	–4.77**	–4.04
			(–1.83)	(–1.40)	(–2.54)	(–1.37)	(–2.38)	(–0.93)
Less 45 y.o x Yes x Rate Chg. [D]			–9.23*	–1.08	–3.14	–3.48	–7.10*	–11.91
			(–1.95)	(–0.10)	(–1.07)	(–0.58)	(–1.82)	(–1.57)
p-value diff	0.73	0.84	0.00	0.00	0.00	0.00	0.00	0.00
p-value diff [A vs C]			0.98	0.75	0.75	0.82	0.87	0.39
p-value diff [B vs D]			0.47	0.76	0.79	1.00	0.38	0.35
p-value diff [A vs B]			0.31	0.65	0.42	0.65	0.54	0.28
p-value diff [C vs D]			0.87	0.45	0.54	0.61	0.60	0.35
R-squared	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
Observations	12,356	12,356	12,356	12,356	12,356	12,356	12,356	12,356
F exc. instrument		9.0		3.7		4.5		4.5

Notes: The LHS is real log consumption growth excluding shelter-related expenses (rent, maintenance, utilities, etc.) and retirement benefit contributions. The interest rate included in the regressions is the nine-month change in the 30-year fixed rate mortgage, lagged three months relative to the end of a household's reported consumption period. All controls as in Table 6, not reported for brevity. Standard errors are clustered by month x year, which is the level of variation in the mortgage rate. Sample: all households with heads 18 to 64 years old who are in the survey between 2007 and 2018. Instrument: Shocks to the 10-year Treasury aggregated over the five-month period leading up a household's final three expenditure months. 'Yes'/'No' indicates the household does/does not fall into the category indicated by the column heading.