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Monetary Policy when Households have Debt: New Evidence on the Transmission Mechanism

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Using household survey data for the U.S. and the U.K., we show that the aggregate response of consumption to interest rate changes is driven by households with a mortgage. Outright home-owners do not adjust expenditure at all while renters change their spending but by less than mortgagors. Income rises for all households as interest rate cuts directly affect firm investment and household consumption, boosting aggregate demand. A crucial difference between the housing tenure groups is the composition of their balance sheets: mortgagors hold sizable illiquid assets but little liquid wealth. Our results reveal that general equilibrium effects on household income coupled with balance-sheet-driven heterogeneity in the marginal propensity to consume play a key role in the transmission of monetary policy.

Key words: Monetary policy, Household balance sheets, Liquidity constraints.

JEL Codes: E21, E32, E52

1. INTRODUCTION

How monetary policy affects the real economy is one of the oldest and most intensively investigated topics in macroeconomics. In many standard macroeconomic theories, interest rate changes primarily affect household consumption through intertemporal substitution. The recent financial crisis, however, has sparked a lively debate about whether other mechanisms could be equally, or even more, important for the transmission of monetary policy.

A key part of this debate has focused on the financial positions of households. Mortgages make-up the vast majority of household debt in the U.S. and the U.K., and nearly half the population

The editor in charge of this paper was Nicola Gennaioli.

has a mortgage. As a result, there has been renewed interest in debt, household balance sheets, and the mortgage market—popularized by an influential set of papers highlighting the role of household debt in the amplification of macroeconomic shocks (Mian *et al.* 2013; Mian and Sufi, 2014). A growing body of theoretical work has been exploring how balance sheet differences across households may amplify the transmission of monetary policy (*e.g.*, Iacoviello (2005), Kaplan *et al.* (2018), Mitman *et al.* (2016), Bilbiie (2017) and Auclert (2019)). In these models, some households exhibit a high marginal propensity to consume out of temporary income shocks and this may vary with a household's financial position.

Despite the renewed interest in these issues, the literature is lacking a systematic empirical investigation of whether differences in household balance sheets affect the transmission mechanism of *conventional* interest rate changes to consumption. We use household survey data for the U.S. and the U.K. to fill this gap. Our contribution is to provide a new set of empirical findings about the heterogeneous effects of monetary policy and use these results to assess different theoretical channels of monetary transmission.

Few, if any, datasets contain information on household expenditure and income, together with assets and liabilities over a long period of time. This poses a significant challenge for studying the effects of monetary policy on households with different balance sheet positions. Instead, we use household survey data from the U.K. Living Costs and Food Survey and the U.S. Consumer Expenditure Survey, which have extensive expenditure and income coverage and have been run for many decades. These surveys are mostly cross-sectional and lack detailed balance sheet information, but our innovation is to use a household's housing tenure status—specifically whether they rent, own their home with a mortgage or own without a mortgage—as a predictor of their debt and asset positions, a fact that we document using lower frequency surveys. We construct pseudo-cohorts based on the three housing tenure groups and tackle the endogeneity of policy interest rates using identified monetary policy shocks for each country (Romer and Romer 2004; Cloyne and Huertgen, 2016). This strategy allows us to study the heterogeneous effects on consumption, explore the dynamics, and consider the general equilibrium effects on household income.

In the first part of the article, we show that the vast majority of the aggregate consumption response to a temporary unanticipated interest rate change is driven by households with a mortgage. When interest rates fall, households with a mortgage increase their spending considerably, while outright home-owners without mortgage debt do not change their expenditure at all. This heterogeneity exists over and above any heterogeneity coming from demographic factors. Renters also increase their spending, although by less than mortgagors.

In the second part of the article, we ask: what theoretical mechanism is most consistent with these results? We show that expansionary monetary policy leads to a significant increase in income for all groups as lower interest rates directly affect firm investment and household expenditure, boosting aggregate demand. But higher income only seems to translate into higher consumption for mortgagors and renters. To explore this, we use lower-frequency U.S. and U.K. wealth survey data and show that the three housing tenure groups differ markedly in their holdings of liquid and illiquid assets. Renters have little wealth and, being younger and poorer, fit the typical description of liquidity constrained households. Mortgagors tend to have little liquidity, despite owning sizable illiquid assets. Indeed, between 40% and 50% of households with mortgage debt have net liquid wealth that is less than half of their monthly income, consistent with a significant proportion of “wealthy” hand-to-mouth consumers (Kaplan and Violante, 2014).¹ In contrast, outright

1. The notion that debtors are liquidity constrained and exhibit high marginal propensities to consume can also be found in Eggertsson and Krugman (2012) and Iacoviello (2005).

home-owners have ample amounts of liquid and illiquid assets. Our housing tenure proxy is therefore capturing *two*, very different, types of hand-to-mouth households.

While our empirical strategy is not suited to establishing a causal link between consumption and income, the heterogeneity in the response of expenditure (relative to income) is consistent with theories where the marginal propensity to consume varies with the composition of household balance sheets. Since mortgagors are a large share of the population, our findings provide a new perspective on what drives the aggregate effects of monetary policy.

We also examine a range of other possible explanations for heterogeneity in the expenditure responses and show these struggle to explain all our results. In particular, we show that the differences across groups are not driven by heterogeneous changes in resources. The fall in mortgage payments is significantly larger in the U.K. than in the U.S.—as might be expected given the prevalence of variable rate mortgages in the U.K.—but the magnitudes are, on their own, too small to account for the magnitude of the increase in mortgagors' expenditure in either country. Rental payments also go up and, therefore, cannot explain the increase in renters' expenditure. Furthermore, since household income increases significantly for all groups, heterogeneity in the expenditure response does not seem to be explained by any heterogeneity in the response of income. We also show that our results cannot be explained easily, qualitatively or quantitatively, by differences across households in the elasticity of intertemporal substitution, the revaluation of nominal assets and liabilities via inflation and other financial wealth effects.

It is worth emphasizing that our evidence does not imply that the direct channels are necessarily unimportant. Rather, our contribution is to show that a large expenditure response of mortgagors—who hold sizable illiquid assets but little liquid wealth—seems to be of first-order importance in understanding the transmission of monetary policy. Furthermore, the general equilibrium effects on household income, together with MPC heterogeneity associated with heterogeneous balance sheet positions, is quantitatively more important than the direct effects alone, for example, via a change in cash-flows.

Two empirical issues are worth noting. First, households are not randomly assigned to be mortgagors, outright owners or renters. Mortgagors may respond more than outright owners not because of their balance sheet position, but because some other trait makes them more responsive to interest rate changes. At the very minimum, our balance sheet proxy (*i.e.* housing tenure) is still a strong predictor of the households most affected by monetary policy. But we also show that the heterogeneity we uncover exists over and above any effect from demographics. Furthermore, we show that other household characteristics are unlikely to explain our evidence. A second concern is the possibility of endogenous transitions from one tenure status to another over time. In addition to grouping by actual housing tenure, we therefore use a variant of the [Attanasio *et al.* \(2002\)](#) propensity score approach which explicitly addresses the issue of compositional change.

Related literature. This article relates to four strands of recent literature. First, we provide empirical support for theories that highlight the role of household balance sheet channels, credit constraints and market incompleteness in the transmission of monetary and fiscal policies. These include [Iacoviello \(2005\)](#), [Eggertsson and Krugman \(2012\)](#), [Kaplan *et al.* \(2018\)](#), [Mitman *et al.* \(2016\)](#), [Lueticke \(2018\)](#), [Auclert \(2019\)](#), [Greenwald \(2016\)](#), [Mitman \(2016\)](#), [Werning \(2015\)](#), [McKay *et al.* \(2016\)](#), and [Bilbiie \(2017\)](#).

Second, our article relates to a large body of empirical work, surveyed by [Jappelli and Pistaferri \(2010\)](#), estimating the response of consumption to exogenous income changes.² Examples include [Johnson and Parker \(2006\)](#), [Parker *et al.* \(2013\)](#), [Misra and Surico \(2014\)](#), [Jappelli and Pistaferri](#)

2. [Campbell and Mankiw \(1989\)](#) and [Attanasio and Weber \(1993\)](#) are early seminal contributions to this literature.

(2014), Baker (2018) and Cloyne and Surico (2017). Unlike this literature, we focus on the dynamic effects of changes in monetary policy in the U.S. and the U.K. and explore what we can learn about the monetary transmission mechanism.

Third, a growing research strand has studied how the structure of the mortgage market affects the transmission of monetary policy. Using aggregate data for selected OECD economies, Calza *et al.* (2013) show that countries with a higher debt to GDP ratio, an ability to extract housing equity and a higher share of adjustable rate mortgages tend to exhibit a larger average consumption response, although their empirical approach does not identify the marginal contribution of each of these features separately. Di Maggio *et al.* (2017) for the U.S., La Cava *et al.* (2016) for Australia, Jappelli and Scognamiglio (2018) for Italy and Floden *et al.* (2016) for Sweden, find evidence that the cash-flow channel via lower repayments on adjustable rate mortgages is active in these countries, although they do not evaluate other channels in the transmission mechanism. The theoretical model in Garriga *et al.* (2013) predicts that under adjustable mortgage rates the change in consumption is only slightly larger than under fixed rates when the monetary policy shock is temporary (as in this article). They show, however, that the difference can become much larger if the policy shock is very persistent (as in Di Maggio *et al.* (2017)).

Fourth, our findings complement evidence from an increasing number of studies that explore heterogeneity in the effects of monetary policy and income shocks. These include, Coibion *et al.* (2016), Wong (2018), Fagereng *et al.* (2016) and, on the more theoretical side, Gornemann *et al.* (2012) and Sterk and Tenreiro (2018).

While we also share an interest in mortgage debt, repayments and heterogeneity, relative to these studies, we focus on a broader set of household-level variables, including durable expenditure, mortgage and rental payments and gross and net income. Furthermore, we compare the evidence for the U.S.—a mortgage market in which access to housing equity is frequent *and* fixed rate deals are prevalent—with the results for the U.K.—a mortgage market in which access to housing equity is also frequent *but* fixed rate deals are less common. We show that considering all these dimensions of heterogeneity together, and across countries, is important for evaluating and disentangling different theoretical channels of monetary transmission.

Structure of the article. The rest of the article is structured as follows. Section 2 presents the datasets, discusses the identification of the monetary policy shocks, and sets out the empirical specification. The baseline estimates are reported in Section 3, together with two extensions that control for demographic factors and endogenous compositional changes. In Section 4, we assess which theoretical channels are most consistent with all our results. Section 5 briefly discusses what components of demand account for the increase in household income. Section 6 concludes. The [Supplementary Appendix](#) contains some further results and robustness exercises.

2. DATA AND EMPIRICAL FRAMEWORK

In this section, we describe our main sources of household survey data and the variables we use. We then lay out the strategy to group individual observations into pseudo-cohorts using housing tenure status to proxy a household's debt and asset position. We also discuss the identification of the monetary policy shocks. Finally, we present our empirical specification.

2.1. Household survey data

In order to investigate how different types of consumers change their expenditure in response to changes in monetary policy, we use household survey data with a rich coverage of expenditure

variables. For the U.K., we use the Living Costs and Food Survey (LCFS).³ For the U.S., we use the Consumer Expenditure Survey (CEX). Both surveys contain detailed information on weekly expenditures on non-durable goods and services, durable goods (excluding housing and rental-related costs) and household income. The latter is defined as labour income (wages and salaries) plus non-labour income (income from investments and social security payments), net of taxes paid by each household. In [Supplementary Appendix A](#), we provide a more detailed description of the variable definitions and the sample restrictions.

In addition, the survey provides information on two additional useful sets of variables (1) demographics, in particular household size and the year of birth of the household head, (2) mortgage payments for households with outstanding debt and rental payments for renters. The information on birth years will be used to verify that the heterogeneity we uncover across housing tenure groups does not reflect (omitted) differences in life-cycle positions (as opposed to genuine differences in debt positions over and above differences in demographics). The information on household size will allow us to conduct the analysis at the per capita level. The mortgage and rental payments data will be used to quantify the extent to which changes in cash flows can account for movements in expenditure.

We convert the data into a quarterly time series using the date of interview. The resulting series is then deflated by the Retail Prices Index (excluding mortgage interest payments) for the U.K. and the Consumer Price Index for the U.S. to convert the data into real series.⁴ Our sample covers 1975 to 2007 for the U.K. and 1981 to 2007 for the U.S. The key variables of interest are available in the FES from the mid-1970s, whereas the CEX begins in 1981. Our focus is on the effects of interest rate changes, so we deliberately stop just prior to the financial crisis, excluding the period of unconventional monetary policy.

2.2. *Grouping households into pseudo-cohorts*

The first empirical challenge we face is that, to our knowledge, no U.S. and U.K. datasets contain disaggregated information on *both* (1) wealth and household balance sheets and (2) a rich array of expenditure categories at the household level over a sufficiently long period of time. Unfortunately, the LCFS and the CEX are no exceptions but they do record detailed expenditure and income data as well as information on housing tenure status, namely whether a household lives in rented accommodation, is an owner-occupier with a mortgage or owns the property outright without a mortgage.

Housing tenure is a useful proxy for the balance sheet positions of households in both the U.S. and the U.K. Mortgagors, by definition, have sizable debt but also sizable wealth (which is typically tied-up in their house). Outright owners have sizable housing and other financial wealth. In contrast, renters tend to have low wealth. The housing tenure distinction therefore makes it possible to bypass the lack of household balance sheet information in surveys that feature rich

3. This survey was previously known as the Expenditure and Food Survey (EFS) and the Family Expenditure Survey (FES).

4. Previous research finds evidence consistent with possible trends in the under-reporting of expenditure for more affluent households. This can lead to a divergence between expenditure measures aggregated in the CEX and those from national statistics over time ([Aguiar and Bils, 2015](#)). To ensure consistency between the survey data and the national statistics, while allowing for different trends in under-reporting (and other characteristics) across groups, we do two things. First, we rescale expenditure for each cohort in the survey data by the ratio of the national statistics series to the corresponding series aggregated from the CEX/LCFS. The adjusted expenditure series for each cohort are reported in [Supplementary Appendix Figure B.2](#). Second, our cohort-specific regressions feature cohort-specific time trends. These time trends are meant to absorb low-frequency variation in both under-reporting and other characteristics that are specific to each group.

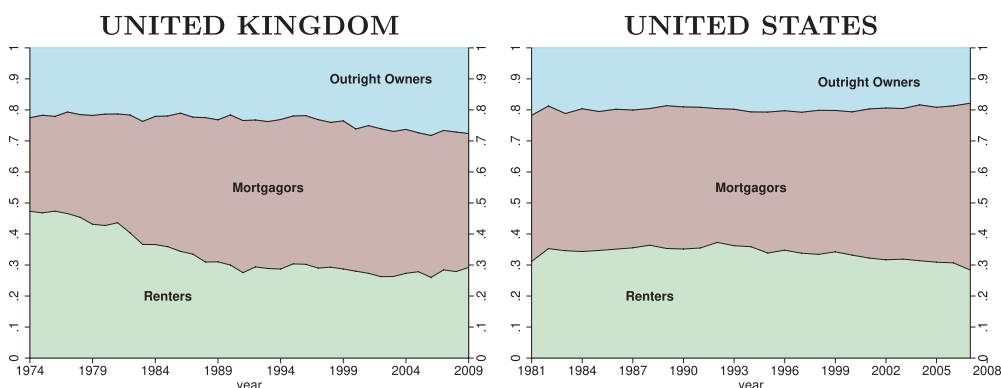


FIGURE 1

Share of mortgagors, outright home owners and renters in the U.K. (source: FES/LCFS, 1975–2009) and the U.S. (source: CEX, 1981–2009).

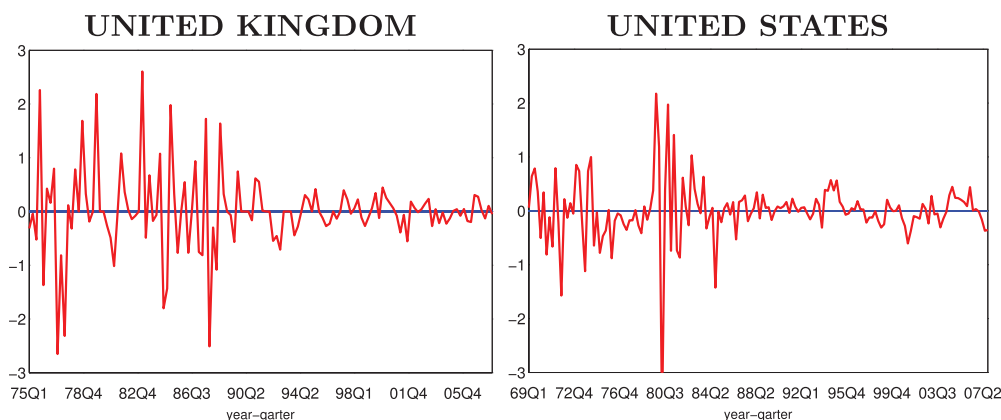


FIGURE 2

Monetary policy shocks series. U.K.: [Cloyne and Huertgen \(2016\)](#); U.S.: updated version of [Romer and Romer \(2004\)](#).

expenditure and income data.⁵ Accordingly, and in keeping with the tradition of [Browning *et al.* \(1985\)](#), we employ a grouping estimator to aggregate individual observations into pseudo-cohorts by housing tenure.

It is worth discussing two potential concerns about grouping households. The first concern is about endogenous changes in group composition. Specifically, a household may change housing tenure status in response to a monetary policy shock. The second concern is about selection. The assignments into the housing tenure groups are not random and some other characteristics may, potentially, be responsible for the heterogeneous responses we find.

In terms of compositional changes, the time series of the tenure shares in Figure 1 are clearly slow-moving. The variation in monetary policy we exploit, however, occurs at a much higher frequency (as can be seen from Figure 2). In Section 3, we provide formal evidence that compositional change is unlikely to be driving our results. Specifically, we show that the monetary policy shocks do not significantly affect the shares of households in each housing tenure group.

5. In Section 4.2, we examine the balance sheet composition of each of these housing tenure groups.

Furthermore, we show that our findings are not affected by using the propensity score method of [Attanasio *et al.* \(2002\)](#), which deals with possible endogenous compositional change.

Turning to the issue of selection, three factors seem to make this less severe in our context. First, we explicitly consider demographic and life cycle factors. In Section 3, we divide each housing tenure cohort into further sub-groups using the age of the household-head. We show that the expenditure response of middle-aged mortgagors is still significantly different from the response of middle-aged outright owners, despite the more stable age range. The heterogeneity we uncover based on housing tenure therefore exists over and above any possible heterogeneity purely due to demographic factors.⁶ Second, in Section 4, we explicitly consider which other characteristics might be driving our results and show that alternative mechanisms struggle to explain our empirical findings. The composition of household balance sheets therefore seems most likely to account for why some households respond strongly to interest rate changes while others do not. Finally, grouping households by housing tenure can be motivated from various theoretical frameworks. For example, the distinction between consumers with and without mortgage debt fits well with the predictions of a range of theoretical models that would imply heterogeneous expenditure responses to a monetary policy shock, including [Iacoviello \(2005\)](#), [Eggertsson and Krugman \(2012\)](#), and [Kaplan *et al.* \(2018\)](#).

2.3. *Identification of monetary policy shocks*

Our goal is to examine the effect of monetary policy on the spending and income of different *groups* of households. As such, we face the usual macroeconomic reverse causation problem: the economy responds to movements in monetary policy, but monetary policy also responds to developments in the macroeconomy. To identify unanticipated changes in the short-term interest rate, we need a monetary policy shock series that can be used for estimation.

There is a vast literature on the identification of monetary policy changes. Older approaches, mainly developed for the U.S., relied on timing restrictions and a Choleski decomposition of the variance–covariance matrix of the residuals from a Vector Autoregression, such as [Christiano *et al.* \(1996, 1999\)](#). But when applied to the U.K., this method produces a large rise in inflation following a monetary contraction, the so-called price puzzle, even after controlling for variables shown to ameliorate this issue for the U.S. ([Cloyne and Huertgen, 2016](#)).

Another popular approach for the U.S. was introduced by [Romer and Romer \(2004\)](#). This method first constructs a measure of the target policy rate (since the effective Federal Funds Rate is moved around by other factors than just policy decisions) and then regresses the change in the target rate around the policy decision on a proxy for the information set available to the policymaker just prior to that decision. This information set includes a range of real time indicators and forecasts to reflect the forward-looking nature of monetary policy. [Cloyne and Huertgen \(2016\)](#) construct a measure for the U.K. employing this methodology and show that it improves on conventional VAR methods. Hence, we use an updated version of the [Romer and Romer \(2004\)](#) shock series for the U.S. (whose original analysis ended in 1996) and the [Cloyne and Huertgen \(2016\)](#) shock series for the U.K.⁷ One particular advantage of using shocks based on the

6. Selected descriptive statistics for all housing tenure groups are reported in [Supplementary Appendix C](#). There are some small differences across the distributions of per-capita income and across the shares of post-compulsory educational attainment between mortgagors and outright owners. While the age difference between these two groups seems larger, (1) the age distributions for mortgagors and outright owners still overlap significantly and (2) as already noted, the heterogeneous responses across housing tenure groups are not overturned in the sensitivity analysis of Section 3.2 where we further control for demographics.

7. Unfortunately, the length and frequency of the sample we consider prevents us from using a high-frequency identification strategy as in [Gertler and Karadi \(2015\)](#).

Romer and Romer (2004) method is that we have two comparable series across the two countries we study.

The shock series match the micro-data sample periods, which are from 1975 to 2007 for the U.K. and 1981 to 2007 for the U.S. The shock series deliberately stop before the recent financial crisis, when the policy rate hit the zero bound in both countries.⁸ To boost the number of household observations used to generate the pseudo-cohorts at each point in time, we aggregate household survey variables to a quarterly frequency. The original shock series are monthly but, following Romer and Romer (2004) and Coibion (2012), we sum up the monthly innovations to obtain a quarterly series. The construction of the U.K. series also allows for a break in 1993 reflecting the adoption of the inflation targeting framework. The monetary policy shock series for the two countries are shown in Figure 2.

Cohort-specific Granger causality. The shock series we use should already be regarded as monetary innovations from a macroeconomic perspective. But there is still a concern that the monetary policymakers might have been reacting to the conditions in particular groups. While some of this should be captured in the policymakers' forecasts, *e.g.*, if they were concerned about developments in the housing market, it is useful for our purposes to test whether the U.S. and U.K. shock series can be predicted by movements in cohort level consumption and income. Finding that these shocks are unpredictable on the basis of cohort level concerns would therefore be reassuring. Specifically, we conduct Granger causality tests based on a VAR which contains consumption, expenditure and income per capita for each household group. We cannot reject the hypothesis that the cohort-specific time-series from household survey data (as well as the aggregate time-series from national statistics) do not Granger cause the monetary policy shocks in each country.

2.4. Empirical specification

Using the two monetary policy shock series, our empirical specification closely resembles Romer and Romer (2004). Accordingly, we regress the variable of interest on a distributed lag of the monetary policy shocks. As in Romer and Romer (2004), we also control for the lagged endogenous variable as is common in exercises with relatively short samples. Specifically, we estimate the following equation:

$$X_{i,t} = \alpha_0^i + \alpha_1^i \text{trend} + B^i(L)X_{i,t-1} + C^i(L)S_{t-1} + \sum_{q=2}^4 D_q^i Z_q + u_{i,t}, \quad (1)$$

where $X_{i,t}$ is real non-durable consumption, durable expenditure or income recorded by households interviewed at time t .⁹ The monetary policy shocks are denoted by S and Z is a vector of

8. Results using the Romer and Romer (2004) shocks might be sensitive to the period in the early 1980s when monetary policy was conducted somewhat differently (Coibion, 2012). This is also the period where the share of floating rate mortgages was unusually high in the U.S. Accordingly, in Supplementary Appendix D, we verify that our findings are not sensitive to starting the sample in 1985. This chimes with independent evidence from Wong (2018), who also provides support for a household balance sheet effect on non-durable consumption across U.S. households using the high-frequency identification in Gertler and Karadi (2015) over a shorter sample starting in 1993.

9. Households interviewed at time t are typically asked to report expenditure over the previous three months (with the exception of non-durable consumption in the LCFS which refers to the previous two weeks). To eliminate some of the noise inherent in survey data, $X_{i,t}$ is smoothed with a backward-looking (current and previous three quarters) moving average. In Supplementary Appendix E, we show that similar results are obtained without smoothing the data (although point estimates become more jagged and imprecise) or smoothing the impulse response function (in the spirit of Barnichon and Brownless (2017) and Tenreyro and Thwaites (2016)).

quarterly dummies. The α terms represent intercepts and coefficients on a time trend polynomial, with a break in 1993 for the U.K. (consistent with the time-series evidence in [Benati \(2006\)](#) and [Nelson \(2001\)](#)) and no break for the U.S. Finally, $i \in \text{Mortgagors}, \text{OutrightOwners}, \text{Renters}$ refers to the relevant housing tenure group. The orders of the lag polynomials are chosen using an optimal lag length criteria, namely the corrected AIC.¹⁰ Standard errors are bootstrapped using a recursive wild bootstrap following [Mertens and Ravn \(2013\)](#).¹¹

3. THE HETEROGENEOUS RESPONSE OF EXPENDITURE

This section reports strong heterogeneity across housing tenure groups in the response of expenditure to a monetary policy shock. Mortgagors respond the most, outright owners do not change expenditure at all, and the response of renters is closer to that of mortgagors. We first show results based on actual housing tenure status. We then consider a more sophisticated propensity score approach that tackles concerns about endogenous changes in group composition. Finally, we explore the role of demographics by restricting the age range within each housing tenure group. In all cases, we simulate the effects of a *temporary* 25 basis points (bp) cut in the policy rate. The gray areas on the charts show the 90% confidence intervals. For reference, in [Supplementary Appendix Figure B.1](#), we report the aggregate responses of expenditure to a monetary policy shock using national accounts data. We show that these are consistent with the disaggregated results using household survey micro-data.

3.1. Results based on housing tenure

In this section, we present the results from estimating our benchmark specification (1) using cohort-level data. Figures 3 and 4 present our baseline estimates for the response of non-durable consumption and durable expenditure across housing tenure groups. The left, middle and right-hand columns show the different responses for mortgagors, outright owners and renters, respectively.

Beginning with the response of non-durable consumption in Figure 3, the response of mortgagors tends to be larger than the adjustment made by outright owners. Specifically, the response of households with mortgage debt in the U.K. peaks at 0.3% after about 10 quarters but the response of outright owners without debt is never statistically different from zero. The response of non-durable expenditure for renters is similar to that of mortgagors at around 0.2%. This suggests that the behaviour of mortgagors and renters drives the aggregate results for non-durables in [Supplementary Appendix Figure B.1](#). For the U.S., the pattern is similar, with the peak effects for renters and mortgagors between 0.2% and 0.3%.

Clear evidence of heterogeneous effects across groups can also be seen in the response of durable expenditure in Figure 4. The heterogeneity between housing tenure groups is now starker. The response of U.K. mortgagors' expenditure peaks at around 1.2%, but the reaction of outright owners' durables is statistically indistinguishable from zero. The bottom row paints a similar picture for the U.S., with the significant and persistent response of households with debt peaking around 1.2%, and driving the aggregate durable response reported in [Supplementary Appendix Figure B.1](#). The results for renters' durable expenditures are, however, typically smaller

10. We have also explored a more general specification where X is a vector of variables, but with similar results. In addition, we have experimented with including the contemporaneous value of the shock and with assuming different types of trend. In all cases, our results are robust.

11. The wild bootstrap in [Mertens and Ravn \(2013\)](#) randomly multiplies draws of the residuals by -1 and 1 and is robust to heteroskedasticity.

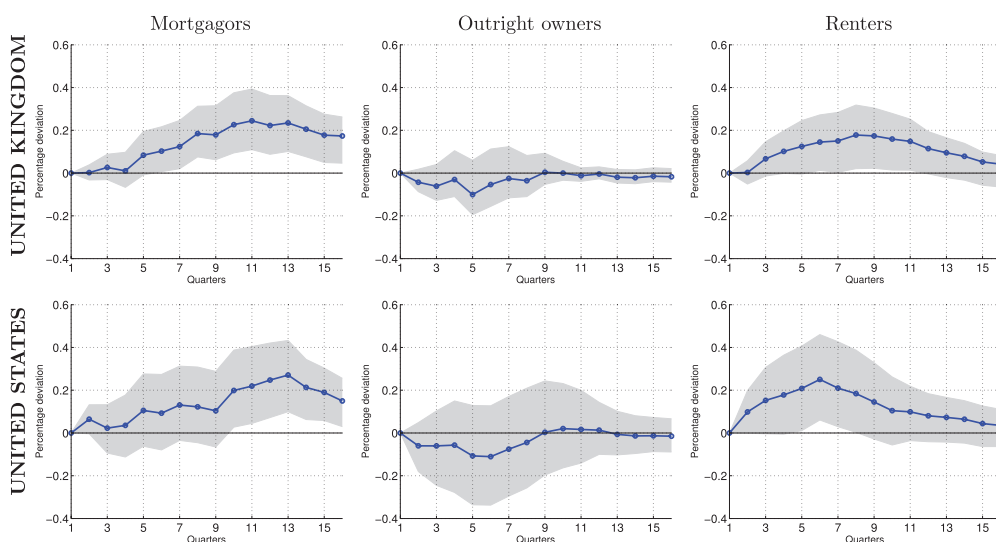


FIGURE 3

Dynamic effects of a 25 bp unanticipated interest rate cut on the consumption of non-durable goods and services by housing tenure group. Gray areas are bootstrapped 90% confidence bands. Top row: U.K. (FES/LCFS data). Bottom row: U.S. (CEX data).

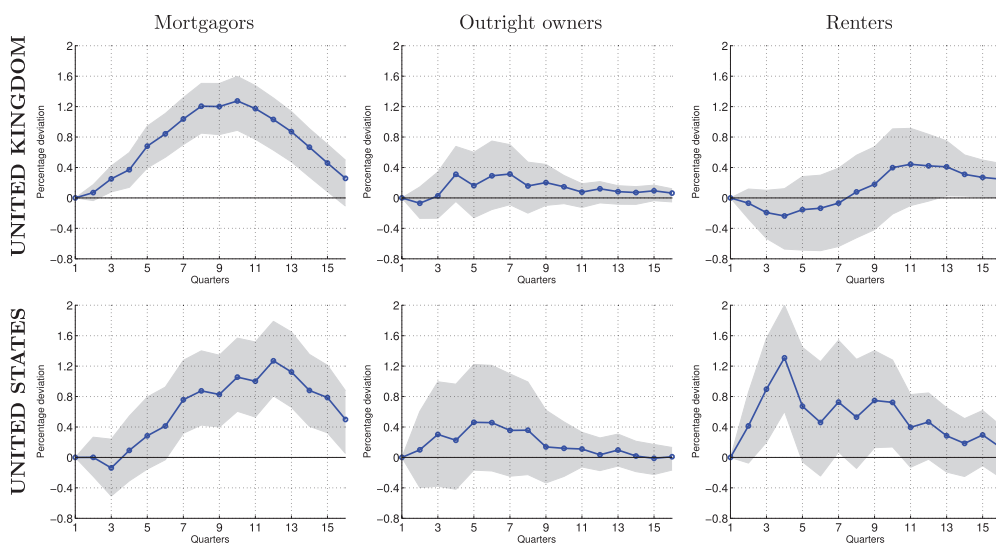


FIGURE 4

Dynamic effects of a 25 bp unanticipated interest rate cut on the expenditure of durable goods by housing tenure group. Gray areas are bootstrapped 90% confidence bands. Top row: U.K. (FES/LCFS data). Bottom row: U.S. (CEX data).

(especially in the U.K.) and less precisely estimated than for the other cohorts, possibly reflecting the heterogeneous composition of the renter group. Still, the durable expenditure of renters tends to increase, especially in the U.S.

Given that there are differences in the average levels of expenditure and income across housing tenure groups, it is useful to consider what these IRFs imply in dollar terms. This will also be

TABLE 1
Cumulative changes over four years in US\$

Panel A: U.K.				
	<i>Non-durable consumption</i>	<i>Durable expenditure</i>	<i>Mortgage or rental payments</i>	<i>After-tax income</i>
Mortgagors	308.3 [112.8, 516.1]	292.3 [189.2, 369.0]	−166.4 [−272.2, −41.7]	695.9 [186.5, 1105.1]
Outright owners	−62.6 [−148.2, 77.4]	46.5 [−24.6, 107.6]		451.7 [122.5, 797.2]
Renters	155.3 [17.9, 261.8]	19.0 [−36.5, 62.9]	64.7 [4.4, 118.7]	397.3 [94.2, 596.1]
Panel B: U.S.				
	<i>Non-durable consumption</i>	<i>Durable expenditure</i>	<i>Mortgage or rental payments</i>	<i>After-tax income</i>
Mortgagors	305.8 [58.3, 554.3]	229.3 [122.0, 350.8]	−56.3 [−112.8, −4.3]	757.3 [196.8, 1302.0]
Outright owners	−72.3 [−324.8, 186.0]	54.8 [−10.5, 127.8]		585.3 [83.3, 1012.8]
Renters	223.3 [32.3, 412.3]	123.5 [30.3, 213.8]	64.8 [9.8, 121.5]	439.3 [112.8, 699.8]

Notes: The table reports the overall dollar change in expenditure over the four-year period following a temporary 25 bp cut in monetary policy, together with the bootstrapped 90% confidence bands. The magnitudes are per household averages. To compute these numbers we cumulate the IRFs and divide by the average value of each variable for each cohort in each country (shown in [Supplementary Appendix Table C.1](#)). We use the U.S. price level in 2007 and the average exchange rate between pounds sterling and U.S. dollars in that year. Using the average exchange rate over the full sample would make the dollar changes for the U.K. some 10% lower but would not affect the fact that the estimated values in each column are of the same order of magnitude across the two countries.

useful later when we quantify the contribution of different transmission mechanisms. In Table 1, we convert the IRFs into an equivalent dollar change in expenditure over the four-year forecast period.¹² This can be seen as the overall dollar adjustment in the short-run as a result of the change in monetary policy.¹³ The overall effects on non-durable and durable expenditure in the two countries are shown in the first two columns of Table 1. The other columns will be discussed in Section 4.

The total dollar change in Table 1 for mortgagors' expenditure (non-durables and durables) is very similar across the two countries following an interest rate cut of the same size. For U.K. mortgagors, consumption over 48 months after a surprise interest rate cut increases by a total of \$600, or \$12.50/month. The figures for U.S. mortgagors tell a similar story: consumption increases by \$535 or \$11.15/month. The dollar changes for the other two housing tenure groups are also similar across countries and spending categories, with the possible exception of the response of durable expenditure for renters. But, overall, mortgagors display the largest and most significant overall dollar adjustment, whereas outright owners experience a small and insignificant change.¹⁴ This difference is not only economically meaningful but also statistically significant.

12. More details on the calculations can be found in the notes to Table 1.

13. The response of the policy rate to the monetary policy shock tends to be slightly more persistent in the U.S. than in the U.K., as can be seen in [Coibion \(2012\)](#) and [Cloyne and Huertgen \(2016\)](#). To make the magnitudes comparable, we rescale the U.K. numbers by the ratio of the cumulated response of the U.S. Federal Funds Rate and the cumulated response of the U.K. Bank Rate. This is like rescaling by the relative movement in the long-rate.

14. The absolute magnitudes of the numbers in Table 1 may seem small but we are considering a small and temporary change in interest rates (*i.e.* a change of 25 bp on impact, which then returns to zero after about four to eight quarters). The size of our monetary policy shock is therefore about twelve times smaller and more than six times less persistent than the shock analysed in [Di Maggio et al. \(2017\)](#).

In summary, in response to an interest rate drop, the expenditure rise tends to be large and significant for mortgagors but small and insignificant for outright owners, with the heterogeneity being more pronounced for durable goods. The response of renters tends to be closer to the response of mortgagors than outright owners', especially for non-durable goods and services. Since mortgagors represent around 40–50% of the population, their response accounts for the vast majority of the aggregate effect of monetary policy on consumption. More specifically, mortgagors appear to account for about 70% of the aggregate movement in consumption for the U.S. and around 80% for the U.K.¹⁵

3.2. *Controlling for demographics*

One possible concern is that the housing tenure distinction may simply be picking up (omitted) life-cycle effects. Although we can include demographic controls in our regressions, given the grouping strategy, this does not condition on demographics in the usual sense. Conditioning requires further splitting the groups by demographics. To explore this possibility, we follow the micro-econometric literature and construct birth cohorts.¹⁶ We regard households as “older” if the head was born before 1935, as “middle-aged” if the head was born in the interval [1935, 1949] and as “younger” if the head was born after 1949. This strategy therefore produces groups with a more stable age range than our baseline grouping strategy. For example, while the maximum possible age gap within the middle-aged group at each point in time is 14 years, it is important to note that the interquartile range is around 6 years.

Before reporting the results of this exercise, it is useful to consider the demographic composition of the housing tenure groups. As shown in [Supplementary Appendix Figure C.2](#), a greater share of mortgagors are younger and there is a prevalence of outright home-owners without mortgage debt among the older households. But, importantly, not all younger households are mortgagors and not all older households are outright home-owners. Furthermore, the middle-aged cohort is populated by even shares of all housing tenure groups.

Within each housing tenure group, we sub-divide households into birth cohorts. We then consider two separate experiments to explore whether age/life-cycle considerations could be driving our heterogeneous responses. First, we investigate whether the response of middle-aged mortgagors is similar to the response of middle-aged outright owners.¹⁷ Second, we examine whether excluding households with a retired head makes any difference to our results.

Comparing the first and the second columns in [Figures 5 and 6](#) reveals that the expenditure responses for middle-aged mortgagors are large and significant, while those for middle-aged outright owners are small and statistically indistinguishable from zero. This is true both in terms of the magnitude and in terms of the significance of the point estimates (both for non-durable consumption and durable expenditure). Consistent with the results in the previous section, middle-aged renters generally respond less than mortgagors but significantly more than outright owners. The heterogeneity across housing tenure groups therefore exists even for cohort groups with a more stable age range. In the [Supplementary Appendix Figures F.1 and F.2](#), we also consider

15. These calculations are based on the median of the expenditure response distribution for each group in [Table 1](#). Using the 25th and 75th percentiles, instead, the share of the aggregate response accounted for by mortgagors would range from 61% to 79% for the U.S. and from 77% to 90% for the U.K., respectively.

16. The objective in a pseudo-panel is to construct a group with relatively stable composition over time. Directly grouping by age does not satisfy this requirement as we would be constructing a representative household who never ages.

17. Unfortunately, there are neither enough mortgagors in the older birth cohort nor enough outright owners in the younger birth cohort for us to look at these two other sub-groups. Furthermore, we find little heterogeneity within the renter group.

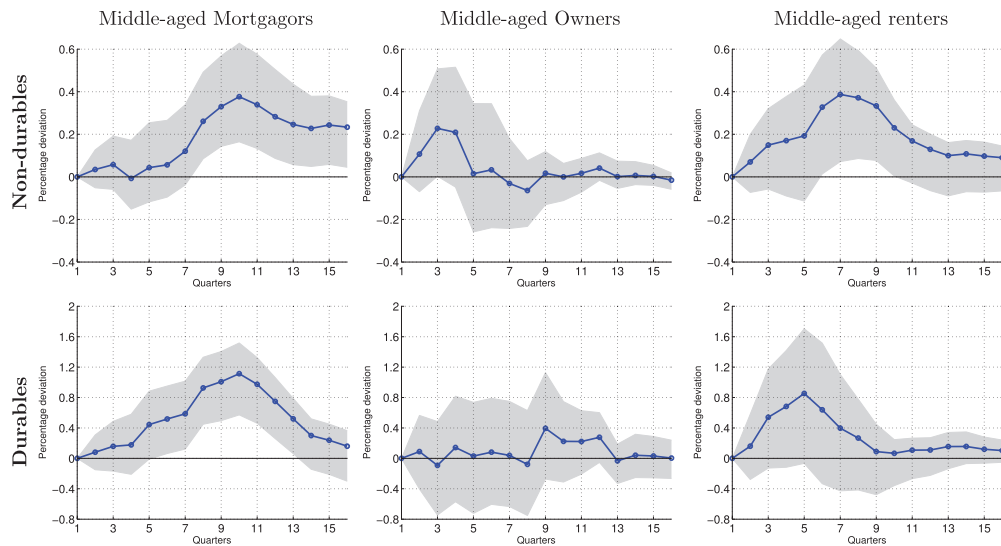


FIGURE 5

Dynamic effects of a 25 bp unanticipated interest rate cut on non-durable consumption (top) and durable expenditure (bottom) for mortgageors born after 1949 (left column), mortgageors born between 1935 and 1949 (middle column) and outright owners born before 1935 (right column). Gray areas are bootstrapped 90% confidence bands. U.K. data: FES/LCFS (1975–2007).

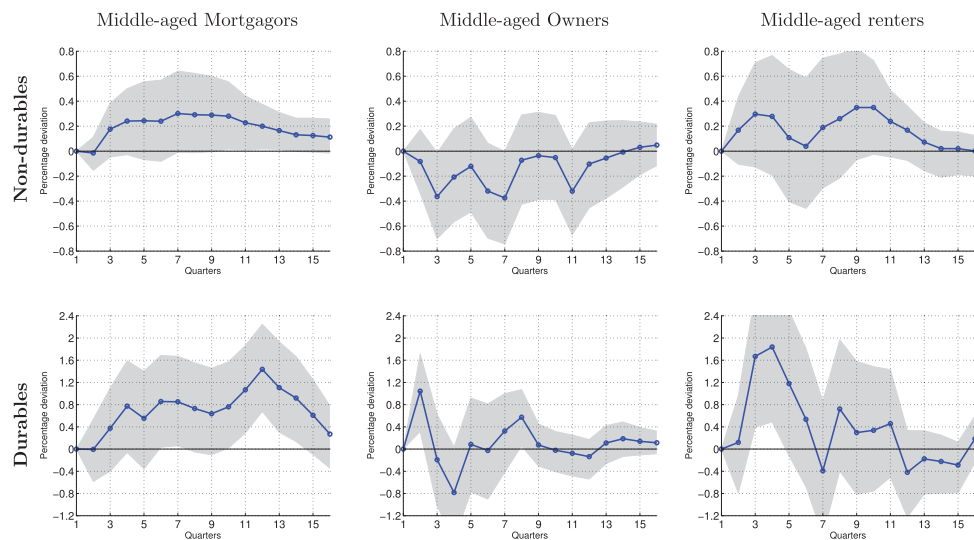


FIGURE 6

Dynamic effects of a 25 bp unanticipated interest rate cut on non-durable consumption (top) and durable expenditure (bottom) for mortgageors born after 1949 (left column), mortgageors born between 1935 and 1949 (middle column) and outright owners born before 1935 (right column). Gray areas are bootstrapped 90% confidence bands. U.S. data: CEX (1981–2007).

restricted samples from the LCFS and the CEX where we exclude households with a retired head. The results are very similar to our baseline findings above.

In summary, the estimates in the previous section are not overturned when considering the impact of demographics. In particular, the heterogeneous responses associated with housing tenure status appear to hold over and above any possible heterogeneity associated with age or birth cohort. These findings are also consistent with the results and the theoretical model in [Wong \(2018\)](#) who explores the role of demographics in the response of consumption to monetary policy in the U.S. after 1992 and concludes that younger households are more responsive to monetary policy because they are homeowners who refinance or take-out new loans when interest rates change.

3.3. *A propensity score approach*

By classifying households into particular groups, we are implicitly assuming that group transitions are not a significant concern. In particular, to interpret our estimates as the causal effect of monetary policy on the expenditure of mortgagors, we need that the policy change does not cause households to move from one housing tenure status to another. Note that this is likely to be more problematic, if anything, for the U.K. survey data which consist of repeated cross-sections, than for the U.S. survey data where, given the short panel dimension, we already consider only those households who have not changed housing tenure status between interviews. The risk of group transitions seems limited given the slow-moving housing tenure shares that we report in [Figure 1](#) and the small (25 bp) monetary policy change we consider. But, in this section, we assess formally the empirical relevance of possible changes in group composition.

One simple way to tackle this issue is to look at the response of the housing tenure group shares to an unanticipated cut in interest rates. In [Supplementary Appendix Figure G.1](#), we show that none of the group shares respond significantly, indicating that changes in monetary policy do not seem to trigger significant endogenous changes in the housing tenure status.¹⁸

A more formal approach is to apply the [Attanasio *et al.* \(2002\)](#) propensity score method. Rather than grouping households based on actual housing tenure, this approach groups households based on the probability of being a mortgagor using fully predictable household characteristics. Specifically, we run a probit regression over the full sample to generate individual predicted probabilities of having a mortgage based on a high order polynomial in age, education, a time trend and their interactions.¹⁹ For households observed in quarter t , we compute the probability that they had a mortgage in the previous quarter. For these two periods, we classify households as “likely” or “unlikely mortgagors” if the probability in the first of the two periods is larger or smaller than the share of mortgagors in the sample.²⁰ We then take the growth in consumption across these two quarters for each group, from which we can construct the implied consumption series for each of the groups that we then used for estimation.

The results of this exercise are shown in [Figures 7 and 8](#). As can be seen, the main findings of our earlier analysis are not overturned. The likely mortgagor group still exhibits stronger expenditure

18. While it may be theoretically possible that the inflows into one group might be offset by its outflows, it would seem difficult to think that *at the same time*, *e.g.*, some renters become mortgagors and other households with debt become renters following a monetary policy shock.

19. To maximize the number of households in each quarter and cohort, we place no restrictions on the birth year of the household head in this exercise but include age among the demographic variables in the probit regressions. To sharpen the comparison we do not include renters in the analysis in this section. While these restrictions do not affect the point estimates from the propensity score method significantly, they improve their accuracy.

20. As time variation in the probability of being a mortgagor may induce changes in the group composition, we use a constant threshold for determining the group of “likely” mortgagors.

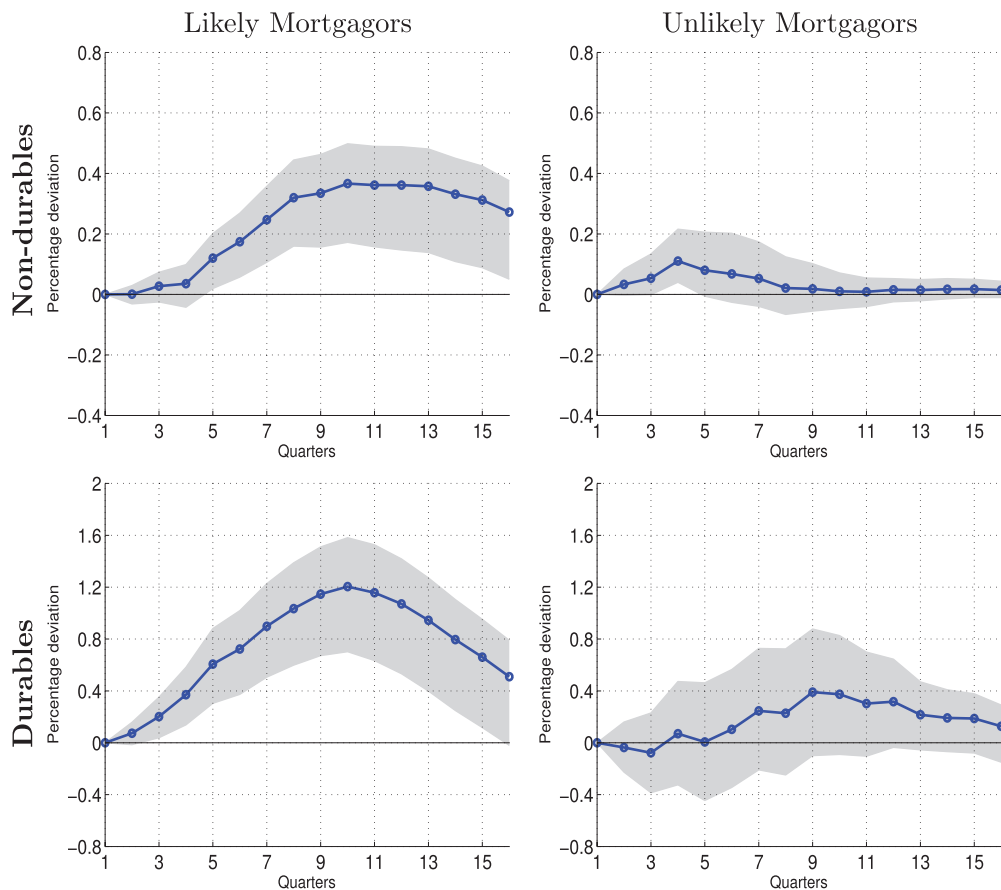


FIGURE 7

U.K. results for non-durable and durable expenditures for “likely” and “unlikely” mortgagors, excluding renters. Groups computed following Attanasio *et al.* (2002) propensity score approach using a fixed probability threshold. Gray areas are bootstrapped 90% confidence bands.

responses than the unlikely mortgagors, with the difference being particularly pronounced for durables and in line with the results on actual housing tenure. Changes in group composition are therefore unlikely to drive the heterogeneous expenditure responses we found above.

4. INSPECTING THE TRANSMISSION MECHANISM

In the previous section, we showed that there is significant heterogeneity in the response of expenditure to monetary policy shocks across housing tenure groups. Furthermore, this heterogeneity is not driven by heterogeneity in demographics. In this section, we explore which mechanism may be consistent with our results. To do so, we consider a rich set of household-specific variables in the micro-data as well as other, relevant, aggregate variables in the national statistics.

We show that our results are consistent with theories where the marginal propensity to consume varies with the composition of household balance sheets. In particular, some households may

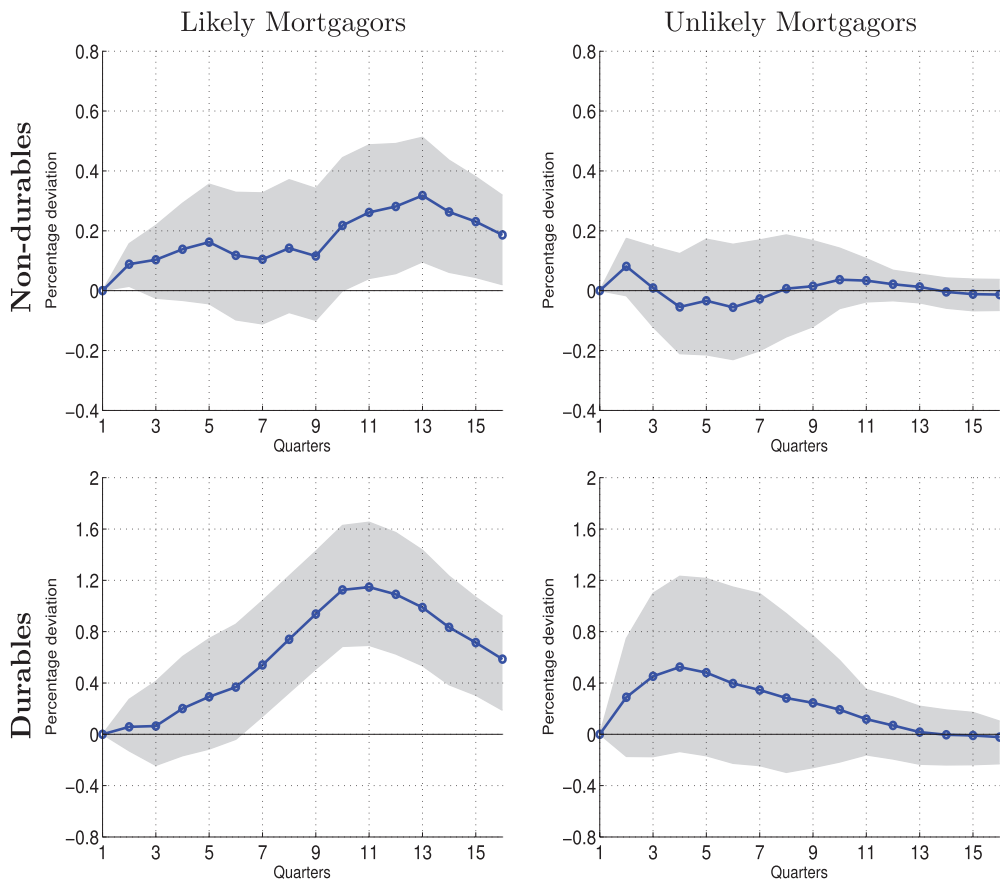


FIGURE 8

U.S. results for non-durable and durable expenditures for “likely” and “unlikely” mortgagors, excluding renters. Groups computed following Attanasio *et al.* (2002) propensity score approach using a fixed probability threshold. Gray areas are bootstrapped 90% confidence bands.

exhibit larger marginal propensities to consume if they have few liquid assets.²¹ By directly affecting investment and consumption decisions, interest rate cuts raise GDP and household income. For hand-to-mouth households, the increase in income leads to additional expenditure, which may stimulate aggregate demand further.²²

21. To be precise: heterogeneous marginal propensities to consume could interact with a range of other mechanisms. Our point is that, without this, other mechanisms are unlikely to be able to explain all our findings.

22. In theory, the mechanisms that generate heterogeneous MPCs—such as incomplete markets and credit constraints—may or may not amplify the effects of monetary policy on consumption. On the one hand, hand-to-mouth behaviour can attenuate the initial direct (partial equilibrium) effect of monetary policy on consumption (*e.g.*, by attenuating the degree of intertemporal substitution). On the other hand, these frictions can lead to a larger consumption response via general equilibrium effects: higher aggregate demand leads to more income, generating more consumption, etc. Important contributions to this theoretical debate are Werning (2015), McKay *et al.* (2016), Bilbiie (2017) and Kaplan *et al.* (2018). In particular, Kaplan *et al.* (2018) show that the presence of “wealthy hand to mouth” agents can amplify the effects of monetary policy, and that the indirect general equilibrium effects dominate the direct partial equilibrium effects. Our results are supportive of the dominance of the general equilibrium effect.

We explore this mechanism in two parts. First, we document a significant rise in income for all housing tenure groups and examine how expenditure responds relative to income—mortgagors exhibit the largest response of expenditure relative to income. Second, we analyse independent household survey data on wealth, and find that the balance sheets of the three housing tenure groups differ markedly in their composition of liquid and illiquid wealth. In particular, we show that our findings are consistent with *two*, very different, types of hand-to-mouth households: low wealth renters and wealthy mortgagors.

We also explore other channels that might account for our findings. For instance, the heterogeneous response of expenditure may simply reflect heterogeneity in the response of disposable income—either because mortgage and rental payments fall, or because monetary expansions increase earnings only for mortgagors and renters. In addition, a higher sensitivity of consumption to interest rates for some groups could reflect a higher elasticity of inter-temporal substitution. Finally, the effects may represent wealth redistribution across households from movements in goods and asset prices. All these mechanisms are likely to play a role in the transmission mechanism but we illustrate why, on their own, these explanations would struggle to explain the heterogeneity we find in the data.

4.1. *The response of income*

Household expenditure may respond directly to interest rate changes, *e.g.* through substitution effects. But the overall response of expenditure may also be affected by the general equilibrium effects that monetary policy has on GDP and household income. This section explores how income responds across groups and document two key results. First, we show that income responds for all household groups, consistent with a general equilibrium effect of monetary policy. Second, we show that the heterogeneity documented in the previous section does not reflect heterogeneity in the response of income. If the income of some groups is more sensitive to macroeconomic conditions, then the heterogeneity in resource windfalls associated with a monetary expansion may be the driver of heterogeneity in the expenditure responses across groups ([Gornemann *et al.*, 2012](#)).

In [Figure 9](#), we report the point estimates and confidence bands for the response of total household income net of taxes. We also report the point estimates for gross income.²³ Income net of taxes responds significantly for all three housing tenure groups and increases by a similar proportion across countries and cohorts. The peak effects are typically between 0.3% and 0.4%. It is useful to note that, despite the expenditure heterogeneity across groups, there is limited heterogeneity in the IRFs for income.²⁴ This is consistent with the notion that the increase in household resources triggered by the monetary policy shock is likely driven by an overall increase in aggregate demand. In other words, expenditure heterogeneity does not simply reflect earnings heterogeneity.

To compare these income effects to the change in expenditure, it is useful to convert the IRFs into a “windfall” in dollars. This is shown in [Table 1](#). Converting the percentage changes into dollar amounts reveals that the response of expenditure relative to income is still sizable for mortgagors and considerably smaller for outright owners. Furthermore, in both countries, the dollar increase in mortgagors’ income is of the same order of magnitude as the dollar change in

23. We report the point estimates for gross income purely for presentational convenience. The confidence bands for this measure largely overlap with those of net income.

24. In [Supplementary Appendix H](#), we show that similar results are obtained using labour income rather than total income.

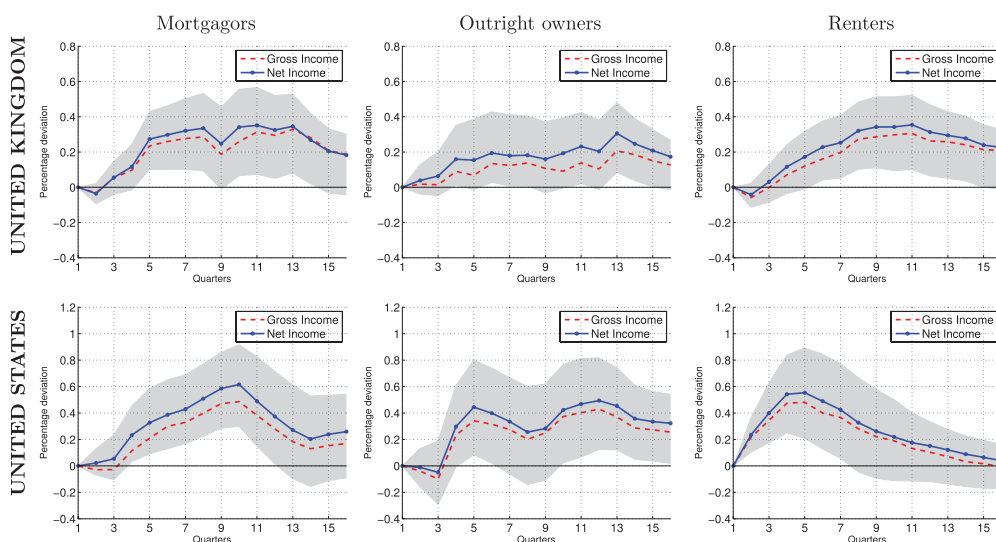


FIGURE 9

Dynamic effects of a 25 bp unanticipated interest rate cut on net income (blue) and gross income (red). Mortgagors (left), outright owners (centre), and renters (right). Gray areas are bootstrapped 90% confidence bands for net income. Top row: U.K. (FES/LCFS data). Bottom row: U.S. (CEX data).

mortgagors' total expenditure.²⁵ For U.K. mortgagors, expenditure over 48 months increases by \$600 (\$12.50/month), while income rises by \$696 (\$14.50/month). For the U.S., the expenditure of mortgagors increases by \$535 (\$11.15/month) and income goes up by \$757 (\$15.80/month).

Disposable income may also be affected by changes in taxes if fiscal policy responds to the fall in interest rates. This could be the case if, for instance, lower interest payments on government debt encourage tax cuts. But Figure 9 shows that the movements in gross and net income are very similar, with the difference being insignificant. The majority of the movement in net income is therefore driven by the response of gross income and not by movements in taxes.²⁶

To summarize, the increase in aggregate income is shared across all housing tenure groups, consistent with a general equilibrium effect of monetary policy on aggregate demand. Heterogeneity in the response of income therefore does not explain our results for expenditure. Table 1 also implies that higher income for all groups is associated with higher expenditure only for mortgagors and renters.

4.2. Liquidity shortages for the poor and the “wealthy”

In the previous section, we showed that income increases for all groups, but expenditure increases only for renters and mortgagors. Furthermore, the dollar change in expenditure for these two groups is of a similar order of magnitude to the dollar change in their income (Table 1). While renters seem to fit the traditional characterization of hand-to-mouth households, a strong

25. While we focus on the response of consumption and income separately here, in independent work on fiscal policy [Surico and Trezzi \(2018\)](#) show that Italian mortgagors have a higher marginal propensity to consume out of temporary property tax windfalls. This is also consistent with the MPC estimates in [Misra and Surico \(2014\)](#) based on the 2001 and 2008 U.S. income tax rebates.

26. Gross income responds slightly less than net income, consistent with [Mountford and Uhlig \(2009\)](#) who show that a monetary expansion is associated with a fall in net taxes receipts.

TABLE 2
Household financial and housing wealth for the U.K. and U.S.

	U.K. BHPS: 1995		U.S. SCF: 1995	
	Median	[p25 , p75]	Median	[p25 , p75]
Net financial wealth				
Outright owners	2,000	[0 , 10,000]	3,505	[165 , 18,455]
Mortgagors	150	[−753 , 3,450]	1,505	[−695 , 8,705]
Renters	0	[−25 , 559]	5	[−545 , 2,005]
Net housing wealth				
Outright owners	59,000	[42,000 , 80,000]	86,000	[52,000 , 142,000]
Mortgagors	28,000	[10,000 , 51,750]	43,500	[20,000 , 86,000]
Renters	0	0	0	0
<hr/>				
	U.K. BHPS: 2000		U.S. SCF: 2001	
	Median	[p25 , p75]	Median	[p25 , p75]
Net financial wealth				
Outright owners	3,300	[0 , 15,000]	8,305	[1,005 , 40,915]
Mortgagors	375	[−1,600 , 6,400]	4,605	[105 , 22,701]
Renters	0	[−68 , 1,000]	145	[−255 , 2,425]
Net housing wealth				
Outright owners	70,000	[47,000 , 110,000]	111,500	[65,000 , 203,500]
Mortgagors	36,000	[16,000 , 70,000]	62,000	[25,000 , 126,000]
Renters	0	0	0	0
<hr/>				
	U.K. BHPS: 2005		U.S. SCF: 2004	
	Median	[p25 , p75]	Median	[p25 , p75]
Net financial wealth				
Outright owners	3,050	[0 , 17,034]	5,580	[605 , 56,805]
Mortgagors	0	[−3,250 , 5,000]	2,500	[−95 , 25,505]
Renters	0	[−455 , 500]	70	[−345 , 2,305]
Net housing wealth				
Outright owners	150,000	[100,000 , 220,000]	145,000	[76,000 , 265,000]
Mortgagors	97,000	[56,250 , 152,000]	77,000	[32,000 , 168,000]
Renters	0	0	0	0

Notes: *Net financial wealth* (NLW): (1) from the BHPS, the value of savings and investments net of outstanding non-mortgage debt; (2) from the SCF, the value of checking, saving and MM accounts, directly held mutual funds, stocks, bonds and t-bills, net of outstanding unsecured debt. *Net housing wealth* is the household's estimate of the property value net of any outstanding mortgage and home equity lines of credit. Trimmed at the top 5 percentiles of the NLW distribution.

sensitivity of consumption to income for mortgagors is hard to reconcile with traditional one-asset models. A number of recent theories, however, emphasize the role of balance sheet composition in generating debtors who have relatively high MPC, and how these households shape the transmission of macroeconomic policy. In [Kaplan *et al.* \(2014, 2018\)](#), consumers can be wealthy but still spend a significant fraction of a temporary windfall if most of their wealth is tied-up in an illiquid asset (such as housing). In other words, mortgagors may become hand to mouth by purchasing a large housing asset. In [Iacoviello \(2005\)](#), homeowners with debt are sensitive to changes in monetary policy because the credit limit is tied to the collateral value of their home. The role of debtors with a high MPC is also important for understanding the effects of deleveraging shocks and the zero lower bound in [Eggertsson and Krugman \(2012\)](#).

Prima facie evidence that both renters and mortgagors may face liquidity shortages is provided by Table 2. At the one end of the spectrum, renters have little “cash on hand” and no housing wealth, consistent with the notion of poor hand to mouth consumers. At the other end, outright owners hold sizable financial and housing wealth, and therefore seem less likely to be constrained. In-between, mortgagors, in both countries, have little liquid assets despite having significant housing equity. As such, they appear to fit well the notion of “wealthy” hand-to-mouth (WHTM) households put

forward by [Kaplan and Violante \(2014\)](#), and further explored empirically by [Cloyne and Surico \(2017\)](#) in the context of U.K. tax changes.

To explore this hypothesis in more detail, we draw on independent evidence on household wealth from the British Household Panel Survey (BHPS) and the U.S. Survey of Consumer Finance (SCF) for the (multi-year) waves that correspond to our baseline samples.²⁷ Following [Kaplan and Violante \(2014\)](#), we define a household as “wealthy” hand-to-mouth if at any given point in time both (1) their net illiquid wealth is positive and (2) their net liquid wealth is less than half of their total monthly labor income.²⁸ In Figure 10, we report the share of “wealthy” hand-to-mouth mortgagors for pairs of temporally close waves in the BHPS and SCF. The message from this chart is that between 40% and 50% of households with debt hold a value of liquid assets below half of their monthly income and therefore are likely to face liquidity shortages. In the second panel of Figure 10, we also show that most WHTM agents in the sample do have a mortgage.

In summary, renters have low wealth and fit the typical description of liquidity constrained households. Their strong consumption response may not, therefore, be surprising. But, importantly, a significant share of mortgagors have low liquidity despite having high wealth. These balance sheet characteristics, coupled with the significant increase in after-tax income for all groups, suggest that heterogeneity in liquid asset holdings can account for the heterogeneity in expenditure documented earlier.²⁹ In [Supplementary Appendix J](#), we lay out a simple theoretical framework with collateral constraints, a renting/owning decision and durable expenditures that captures this idea. We show that this model can replicate our evidence on the heterogeneous responses of non-durable and durable expenditure across different households groups.

4.3. *Mortgage and rental payments*

A fall in interest rates can also affect the resources available to households by affecting interest payments and rents. These windfalls from lower interest or rental payments might then be spent on durables and non-durables in a way that could potentially rationalize the expenditure heterogeneity

27. These surveys do not contain wealth information at a sufficiently high frequency to be used for our main analysis and they lack rich consumption data over a long period of time. While there are more SCF waves than reported here, there are only three waves of the BHPS over our sample period (but we have confirmed that similar results emerge from the SCF waves that we have not reported).

28. When constructing the relevant household income and wealth measures, we select variables to make the concepts of net liquid and illiquid wealth as consistent as possible across the two datasets. The BHPS only reports quantities for overall investment and debts, whereas for specific assets it only records whether these are held or not. The SCF, in contrast, does provide quantities for particular assets and overall investment. Furthermore, the assets on which information is provided differ slightly between surveys. Accordingly, net liquid wealth in the U.K. is constructed as total amount of liquid savings and investments (National Savings Bank Accounts and Cash ISAs or TESSAs, Premium Bonds, Stocks and shares ISAs or PEPs) minus non-mortgage debt (Hire purchase agreements, Personal Loans, Credit and store cards, DWP Social Fund loans). Following [Kaplan and Violante \(2014\)](#), net liquid wealth in the U.S. is the value of checking, saving and MM accounts, directly held mutual funds, stocks, bonds and t-bills, net of outstanding unsecured debt. Net illiquid wealth in the U.K. is measured using a binary variable which takes value one if housing equity >0 or the household has positive investments in (relatively) illiquid instruments such as National Saving Certificates, NS/BS insurance bonds, private pensions, non-regular savings. Net illiquid wealth in the U.S. is the value of housing equity (housing value – mortgage debt) plus pension/retirement funds, life insurance, saving bonds, and certificate of deposits.

29. As emphasized by [Tobin \(1980\)](#) (p. 10), this hand to mouth behaviour by mortgagors could be entirely rational and optimal if, for instance, this group of households expect future income growth but find it difficult to borrow against this.

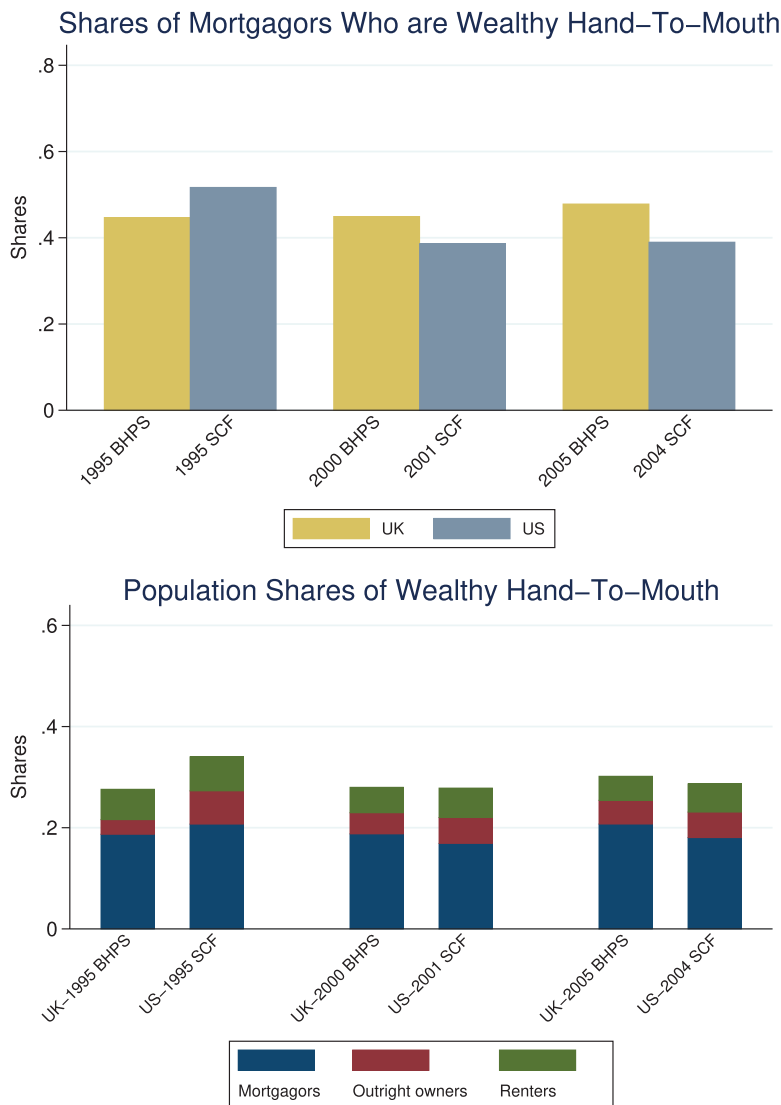


FIGURE 10

Shares of Wealthy Hand-To-Mouth (WHTM) mortgagors. U.K. (U.S.) data: 1995, 2000, 2005 waves of the British Household Panel Survey (Survey of Consumer Finances). A household is defined as WHTM if at any given point in time both (1) their net illiquid wealth is positive and (2) their net liquid wealth is less than half of their total monthly household labour income.

we documented in the previous section.³⁰ In our survey data, we observe both variables and we therefore explore how mortgage and rental payments react to monetary policy changes.

30. Note that financial income is already included in our measure of household income. Any cash-flow effect on savers is therefore already captured in our income responses. Since outright owners do not alter their expenditure, this section focuses on cash flows for mortgagors and renters.

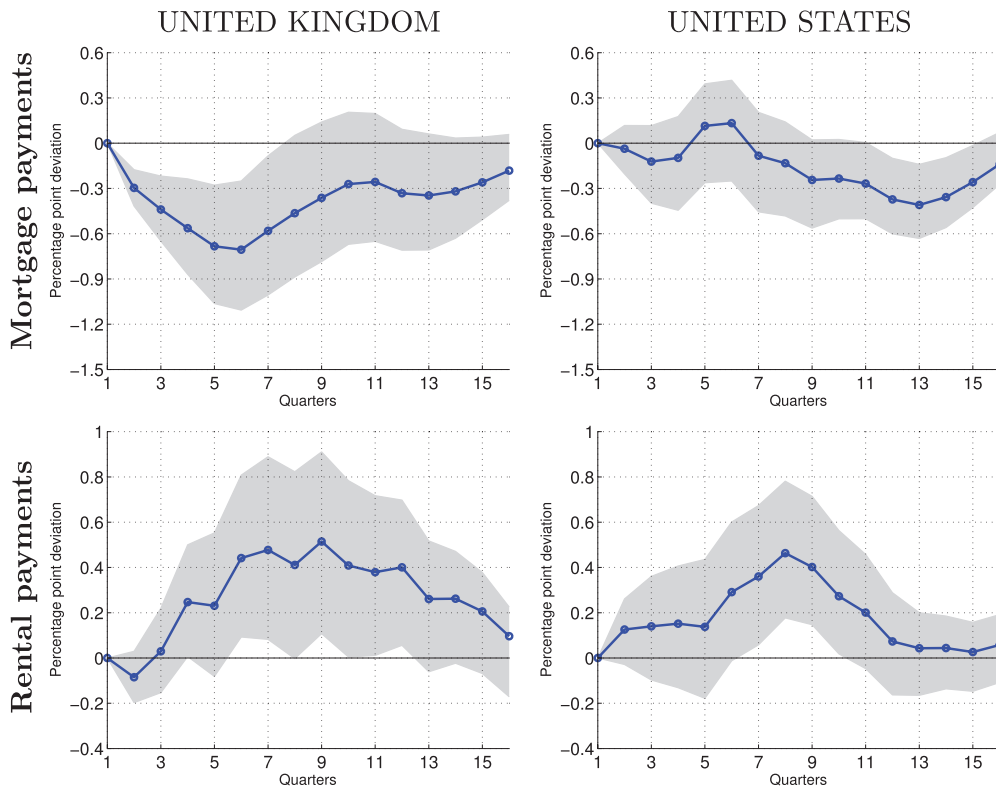


FIGURE 11

Dynamic effects of a 25 bp unanticipated interest rate cut on mortgage and rental payments. Gray areas are bootstrapped 90% confidence bands. Left: U.K. (FES/LCFS data). Right: U.S. (CEX data).

In Figure 11, we report the percentage change in mortgage payments (top row) and rents following a temporary interest rate cut of 25 bp. Mortgage payments fall significantly in both countries but the effect is considerably faster and larger in the U.K., peaking at around 0.7% versus 0.4% for the U.S.

As in the previous section, to compare these effects to the change in expenditure, it is useful to convert the IRFs into a ‘windfall’ in dollars. This is shown in the third column of Table 1. A few points are worth noting. First, the dollar benefit of this change for the average mortgagor is nearly three times larger in the U.K. than in the U.S. Interestingly, the absolute difference between the two point estimates is also consistent with the difference in total expenditure for mortgagors in the two countries (columns 1 and 2).³¹ The relative size and speed of the adjustment in mortgage payments is intuitive given the historic prevalence of adjustable rate mortgages in the U.K. market (Besley *et al.*, 2013). But secondly—and more importantly—the dollar fall

31. The size of the dollar change in the average mortgage payments is consistent with a back-of-the-envelope calculation using an *effective* mortgage duration of ten years, an *effective* loan to value ratio on outstanding debt of 0.5 and, for the U.K., the average house value from the Land Registry since 1995 (and from Halifax before then) as well as a share of mortgages on adjustable rates of 45%. This yields an average change in U.K. mortgage payments of 168 U.S. dollars. Replacing the U.K. share of mortgage contracts on adjustable rates with a share of 15% for the U.S., we obtain a value of 56 dollars. Note that our results are an average of the effect on loan rates for newly originated mortgages and the effect on existing adjustable and fixed rate loans.

associated with lower mortgage payments is considerably smaller than the dollar increase in total expenditure. For U.K. mortgagors, mortgage payments fall by only \$166 (\$3.50/month) while, as noted above, expenditure increases by \$600 (\$12.50/month) and household income rises by \$696 (\$14.50/month). For U.S. mortgagors, mortgage payments decrease by only \$56 (\$1.20/month) while expenditure increases by \$535 (\$11.15/month) and household income goes up by \$757 (\$15.80/month). The direct windfall from lower mortgage payments is therefore quantitatively too small to account for the magnitude of the rise in expenditure. In contrast, the general equilibrium response of household income seems to be crucial.

The response of rental payments tells a similar story. On the one hand, a monetary expansion lowers the user cost of housing. On the other hand, a fall in interest rates could lead to a rise in house prices—as we document in [Supplementary Appendix Figure I.1](#) for both countries—and therefore encourage the demand for renting relative to buying. The bottom row of Figure 11 shows that, in the data, the latter effect dominates and rental payments increase. Yet, renters increase their expenditure on both non-durable and durable goods.

In summary, mortgage payments move significantly more in the U.K. than in the U.S., but the magnitudes are much smaller than the overall dollar increase in expenditure. Furthermore, movements in rental payments do not free up extra resources because they actually increase following a monetary expansion. These cash flow effects are, *on their own*, unlikely to explain why mortgagors respond differently from outright owners.³² These effects also cannot explain why renters respond differently from other households without mortgage debt. Interestingly, our findings are consistent with the theoretical predictions in [Garriga et al. \(2013\)](#), who show that the distinction between adjustable and fixed rate mortgages implies a small difference in the consumption responses to a *temporary* monetary policy shock (as we consider here) but a large difference to a *very persistent* monetary shock (as considered in empirical work [Di Maggio et al. \(2017\)](#)).

4.4. Intertemporal substitution

Differences in the elasticity of intertemporal substitution (EIS) may also explain heterogeneity in the expenditure responses across housing tenure groups. There is a large literature estimating the EIS across households and several papers have argued that the EIS is likely to be increasing with wealth (see [Guvenen \(2006\)](#) and [Attanasio and Weber \(2010\)](#) for an overview). [Blundell et al. \(1994\)](#) report evidence that the EIS is larger for more affluent households and that wealth is a more important driver of EIS heterogeneity than demographics. More specifically, [Attanasio et al. \(2002\)](#) estimate that the EIS is around one for stock-holders—who are wealthier households—but only between 0.1 and 0.2 for households who do not participate in financial markets.

As shown in Table 2, outright owners tend to be richer than renters and have more financial assets than mortgagors. They also tend to be well-off households in general. Based on the empirical evidence above, one would therefore expect the outright owners to have a high EIS. But to explain our results, the outright owners would need to have a very low sensitivity of consumption to interest rates and thus a *very low* EIS. Similarly, mortgagors and renters would need to have a considerably higher EIS to be, even qualitatively, consistent with our results.³³ Since mortgagors do not, on average, have sizable net financial wealth (Table 2) and renters tend to be poorer, we conclude that heterogeneity in the intertemporal elasticity of substitution is unable to explain the heterogeneity in expenditure we find.

32. Of course, in the presence of heterogeneity in marginal propensities to consume, this cash flow channel could lead to additional consumption, further boosting aggregate demand.

33. [Best et al. \(2019\)](#) estimate a low EIS for mortgagors in the U.K.

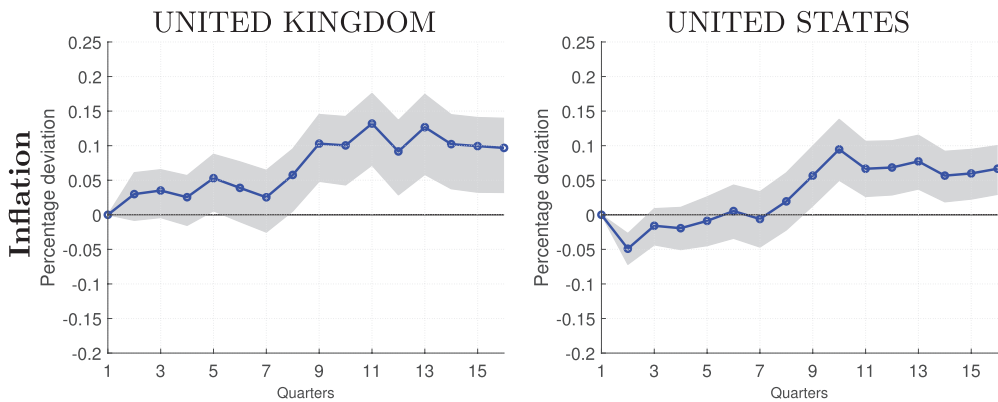


FIGURE 12

Dynamic effects of a 25 bp unanticipated interest rate cut on CPI inflation.

4.5. *Wealth redistribution and other wealth effects*

By raising inflation unexpectedly, expansionary monetary policy shocks may revalue both sides of the household balance sheet, leading to a redistribution of wealth from net savers to net borrowers. This mechanism has been studied by [Doepke and Schneider \(2006\)](#) for the case of a large and permanent change in inflation across sectors and groups of households in the U.S. We investigate it here in the context of a small and temporary change in interest rates across housing tenure groups in the U.S. and the U.K. As shown in Table 2, our grouping strategy identifies mortgagors as net borrowers and outright owners as net savers.

For this redistribution channel to drive the heterogeneous responses of expenditure reported in the previous section, the profile of the impulse response of inflation over the forecast period should look broadly similar to the the profile of the impulse response of debtors' expenditure. This is what we explore in Figure 12: consistent with the wider macro literature (*e.g.* [Romer and Romer \(2004\)](#) and [Christiano *et al.* \(1999\)](#)), an unanticipated interest rate cut leads to a rise in inflation, which in turn could potentially lead to a revaluation of household wealth. It is worth emphasizing, however, that the unexpected rise in inflation is statistically and economically very modest during the first two years after the shock and becomes significant only in the third year. In contrast, the response of mortgagors' expenditure is already sizable and significant within the first eight quarters after the shock. We conclude that while temporary monetary policy shocks may lead to some unexpected revaluation of nominal assets, both the timing and the magnitude of this redistribution channel do not seem to square easily with the response of mortgagors' expenditure.

Finally, a fall in interest rates is also likely to raise the price of financial assets, including housing, and this may lead to additional wealth effects. It seems unlikely, however, that these effects alone could explain the heterogeneity in expenditure we find. First, we consider a small (25 bp) and short-lived fall in the interest rate which is unwound within two years.³⁴ Furthermore, any effect on asset prices should be more beneficial for those with a larger amount of net financial assets. Since outright owners—the group holding the largest amount of net financial assets—do not adjust their expenditure at all, it is unlikely that these pure wealth effects could be, on their own, the main driver of our results.

34. See [Coibion \(2012\)](#) and [Cloyne and Huertgen \(2016\)](#).

5. WHAT IS BEHIND THE MOVEMENT IN INCOME?

In the previous sections, we have shown that heterogeneity in the access to liquidity combined with a sizable effect of monetary policy on household income can account for the evidence presented so far. Furthermore, in Table 1, we have also shown that the dollar changes in income are not only significant for all groups but are also larger than the dollar changes in expenditure. This implies that the overall increase in resources available across the three housing tenure groups is larger than the overall household expenditure increase in the economy. In other words, the change in interest rates must trigger a response in some other components of aggregate expenditure. In this section, we therefore explore the response of government spending, private investment, and net exports using aggregate data.

In the left column of Figure 13, we do not find evidence that government spending reacts to a monetary policy shock. In contrast, the middle column reveals that investment does respond strongly and significantly, which is consistent with the evidence in several empirical macro studies (e.g. Christiano *et al.* (1999)). This is important because it reveals that the extra demand driving the increase in household income comes from the private sector rather than from the government.

Finally, the boost to aggregate demand from monetary policy could work through net exports if the expenditure switching effect (from the exchange rate depreciation) increases exports *by more* than the rise in imports coming from increased household expenditure on both foreign and domestic goods. In the right column of Figure 13, we find that net exports actually fall in both countries. This suggests that the income effect (on expenditure) dominates the expenditure switching effect and thus net exports make a negative contribution to aggregate demand when monetary policy is expansionary.

In summary, the boost to household income following a cut in interest rates reflects increased demand from the domestic private sector rather than expenditure by the government or the rest of the world. Interestingly, this is consistent with the theoretical results in the supplementary note

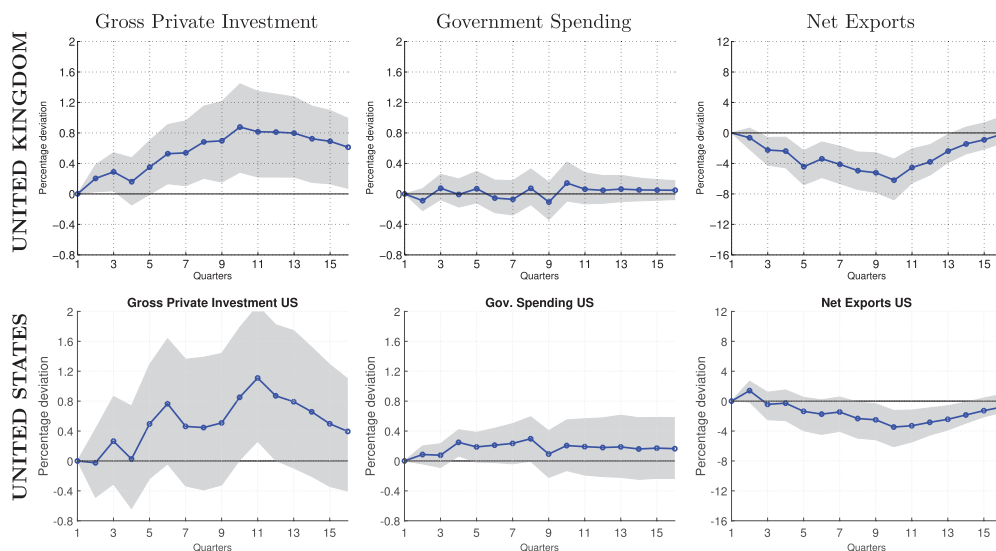


FIGURE 13

Dynamic effects of a 25 bp unanticipated interest rate cut on gross private investment (first column), government expenditures (consumption plus investment; second column), and net exports (X-M) (third column). Top row: U.K. (aggregate ONS data). Bottom row: U.S. (aggregate NIPA data).

by Kaplan *et al.* (2016) where household liquidity is provided by the private sector rather than by the government, as in their original paper (Kaplan *et al.*, 2018).

6. CONCLUSION

What features of household balance sheets, if any, matter for the transmission of monetary policy? Our analysis suggests that households with a mortgage tend to hold little liquid wealth and therefore exhibit hand-to-mouth behaviour despite owning sizable illiquid assets. Outright owners, in contrast, hold sufficient liquid assets and therefore hardly change their spending at all. Renters—whose financial circumstances are closer to the traditional characterization of liquidity constrained households in one-asset models—also exhibit behaviour consistent with a high marginal propensity to consume. We reach these conclusions by performing a detailed and extensive evaluation of the effects of temporary interest rate changes using household survey data for the U.S. and U.K.

While our empirical approach cannot shed light on the causal link between consumption and income, our evidence is consistent with the view that expansionary monetary policy has a direct effect on aggregate demand by stimulating firm investment and household expenditure. This, in turn, raises household income for all groups but translates into higher consumption only for households with low liquid wealth. Our key contribution is to show that (1) the response of mortgagors is consistent with a considerable share of this group having a high marginal propensity to consume and (2) MPC heterogeneity linked to balance sheet heterogeneity, together with a sizable general equilibrium effect on household income, is quantitatively more important than the direct effects alone, *e.g.*, via a change in cash-flows. Given that mortgagors are the largest housing tenure group in the population, their behaviour drives the aggregate response and has first-order implications for the transmission of monetary policy.

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Supplementary Data

Supplementary data are available at *Review of Economic Studies* online.

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