How do house prices affect consumption? Evidence from micro data

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Abstract

Housing wealth is a major component of households' wealth. Since house prices fluctuate considerably over time, an important question is how house price fluctuations affect households' consumption decisions. This may happen through at least two channels: (i) a wealth channel, or (ii) by relaxing or making borrowing constraints more severe. This paper investigates the response of household consumption to house prices using micro level data. We estimate a positive and the largest wealth effect on consumption of house prices for older households who are homewoners, and a zero and the smallest wealth effect for young households who are renters. These are the households that are more likely to be long and short housing, respectively. This heterogeneity is important since it predicts that as the population ages and becomes more concentrated in the old homeowners group, aggregate consumption will become more responsive to house prices.

1 Introduction

Housing is the dominant component of wealth for the typical household in the United States or the United Kingdom. Bertaut and Starr-McCluer (2002) show that residential property accounted for about one quarter of aggregate household wealth in the US in the late 1990's, while Banks and Tanner (2002) report that real estate accounted for 35% of aggregate household wealth in the UK in the mid 1990's. Housing wealth is particularly important for middle-class households: Tracy and Schneider (2001), for example, show that it accounts for almost two-thirds of the wealth of the median US household.

Houses are risky assets with volatile prices. Much of this volatility is local, but there is a common component to house prices that is visible in regional and even national house price indexes. National house price volatility is particularly striking in the UK, a relatively small country with a nationally integrated housing market. Figure 1 shows the evolution of house prices in the United Kingdom over the last thirteen years. During this period, annual changes in nominal house prices have ranged from -10% to 30%.

The magnitude and volatility of housing wealth have led many to suggest that house price changes have significant effects on aggregate consumption. Muellbauer and Murphy (1990), for example, argued that house price increases and financial liberalization stimulated a consumption boom in the UK in the late 1980's. More recently Case, Quigley, and Shiller (2003) find a strong correlation between aggregate house prices and aggregate consumption in a panel of developed countries from the late 1970's through the late 1990's. (See also Benjamin, Chinloy, and Jud 2004 and Bhatia 1987.)

It is tempting to attribute the correlation between house prices and consumption to a direct housing wealth effect: Increasing house prices increase housing wealth, which in turn increases consumption. There are, however, several reasons not to make this attribution without further analysis. First, the theoretical rationale for a large housing wealth effect is unclear. If we define financial wealth as the sum of liquid financial assets and the value of real estate minus debt outstanding, it is clear that an increase in house prices leads to an increase in homeowners' financial wealth. But this does not necessarily mean that their *real* wealth is also higher. Housing is a consumption good, and for homeowners who expect to live in their current house for a very long time, the higher house price simply compensates them for the higher implicit

rental cost of living in the house. In other words, as Sinai and Souleles (2003) point out, homeowners with a long expected tenure are perfectly hedged against fluctuations in rents and the corresponding fluctuations in house prices. These fluctuations, however large they may be, have no *real* wealth effect, and absent any substitution effects, should not affect consumption choices.

Second, there are alternative explanations for the correlation between house prices and consumption. House prices may affect consumption by relaxing or tightening borrowing constraints. Housing is an asset that can be used as collateral in a loan. For borrowing constrained homeowners, an increase in house prices relaxes borrowing constraints, even if there is no wealth effect associated with the house price increase. In other words, an increase in house prices may lead to an increase in consumption not because of a wealth effect, but because it allows borrowing constrained homeowners to smooth consumption over the life cycle (Ortalo-Magné and Rady 2001, Lustig and van Nieuwerburg 2004).

It is also possible that the correlation between house prices and consumption may be driven by an unobserved macroeconomic factor. For example house prices may respond to future income prospects, to which current consumption also responds provided that households are not borrowing constrained. In other words, when households become optimistic about the economy as a whole, the price of housing will tend to increase along with consumption (King 1990). Alternatively, financial liberalization may drive up house prices and stimulate consumption by relaxing borrowing constraints in the economy as a whole (Attanasio and Weber 1994, Muellbauer and Murphy 1997).

The objective of this paper is to use household level data to distinguish among these alternative explanations for the house price-consumption correlation. Micro data can be helpful in several ways. First, micro data allow us to identify those households for which the direct wealth effect of house prices should be particularly large or small. Most young households plan to increase house size later in life, say because of an expected increase in family size, and for this reason are short housing. On the other hand, many old households plan to move to a smaller house later in life, so that they are long housing. Without instruments that allow households to insure these short and long positions, there is a redistributive wealth effect of unexpected shocks to house prices. We expect to see older homeowning households increasing their consumption when house prices rise, while younger renting households should cut their consumption or leave it unchanged.

Second, micro data allow us to distinguish the effects of local and national movements in house prices. National income prospects and financial liberalization operate through national house prices, while regional income prospects, direct wealth effects, and collateral effects operate through local house prices.

In our analysis of household level data, we also distinguish between predictable and unpredictable movements in house prices and consumption. This approach, which we borrow from the literature testing the permanent income hypothesis (Hall 1978, Hall and Mishkin 1982, Flavin 1981, Campbell and Mankiw 1989, 1991, Zeldes 1989, Runkle 1991), enables us to distinguish wealth effects from collateral effects.

We use household level data from the UK Family Expenditure Survey (FES) to estimate the response of consumption to house prices. The FES is a continuous survey of households, in which each household is interviewed only once. Therefore we employ the methodology introduced in Browning, Deaton, and Irish (1985) and Deaton (1985) to construct panel data from a time-series of cross-sections, or a pseudo-panel. The use of household level data are important because we can estimate the response of consumption to house prices in the region where the household lives, and control for changes in household income, the degree of household leverage, and household demographics. We make use of the fact that households are heterogeneous along several dimensions, including age, homeownership status, and region of residence, to at least partially distinguish between aggregate, regional, and household specific effects of house prices on household consumption.

We find considerable heterogeneity in the response of household consumption to house prices. More precisely, we estimate a positive and the largest effect on consumption of house prices for old households who are homeowners, and a zero and the smallest effect for young households who are renters. These are the households who are more likely to be long and short housing, respectively. The estimated elasticity for the old homeowners group is as large as 1.7, controlling for interest rates, household income, and other demographic variables. This age heterogeneity is important since it suggests that as the population ages and becomes more concentrated in the old homeowners group, aggregate consumption will become more responsive to house prices. Previous estimates of the elasticity of consumption to house prices using aggregate data miss this important source of heterogeneity since they do not take into account the age structure of the population, and its slowly changing distribution.

We also find, controlling for economy-wide house prices and for regional income, that regional house prices are important for explaining household consumption. In

fact, the estimated elasticity of consumption to regional house prices is larger than the estimated elasticity of consumption to UK house prices when we include both in the regression together with regional income. This shows that it is important to consider regional heterogeneity when estimating the effects of house prices on consumption.

Finally, we find that consumption responds to predictable changes in house prices, an effect which is consistent with an increase in house prices relaxing borrowing constraints, but that may also be explained by a precautionary savings motive. However, since it is predictable changes in aggregate and not regional house prices that mattter, and since the consumption of renters also responds to predictable changes in aggregate house prices, we conclude that this is an economy wide rather than a household level or regional effect.

There is a small recent literature that uses microeconomic data to study housing. Much of this literature asks how housing affects savings and asset allocation (Engelhardt 1996, Flavin and Yamashita 2002, Goetzmann 1993, Sheiner 1995, Skinner 1994, and the models of Cocco 2003 and Yao and Zhang 2003). Attanasio and Weber (1994), in the paper that is closest to ours, use FES micro data to investigate whether the financial liberalization that took place in the 1980s in the UK was responsible for the consumption boom at the end of that decade. To do so they study the consumption patterns of different groups of individuals, that are likely to be differently affected by financial liberalization, including homeowners and renters, and households living in different regions. However, they do not estimate consumption elasticities to house prices for these different groups of individuals. This is the main contribution of our paper.

The paper is organized as follows. Section 2 describes the data, and presents some summary statistics. This section also describes the different ways in which we construct pseudo-panels from repeated cross sections. Section 3 presents estimation results for our baseline regression, which consists of regressing changes in household consumption on changes in house prices, controlling for changes in household income, leverage, and demographic variables. In section 4 we use instrumental variables regressions to distinguish predictable and unpredictable movements in house prices and consumption, thereby partially disentangling wealth effects from other effects of house prices that work through borrowing constraints and precautionary saving. Section 5 considers issues that arise from the endogeneity of the homeownership decision, and section 6 concludes.

2 The Data

2.1 The Family Expenditure Survey

We obtain household-level data from the UK Family Expenditure Survey (FES) over the period 1988 to 2000. The FES is a continuous survey of households. Each household is interviewed only once. Each quarter there are about 1,750 households interviewed, so that over the thirteen years that constitute our sample there are approximately 91,000 observations. During a two week period the adult members of each household keep a diary of their consumption expenditures. In addition the survey contains a variety of other information, including the region where the household lives, income, demographics such as age and household composition, homeownerhsip status, and mortgage information.

We define total non-durable consumption as the sum of the two week reported expenditure on fuel, travel (excluding the purchase of any vehicles), food, alcohol, tobacco, clothing, household services, leisure goods and services, and other expenditure. For each of these goods we also have monthly price indices which we use to construct a household specific Stone price index, using the household-budget shares as weights. We use this house price index to obtain real non-durable consumption and income. These measures are similar to those constructed in empirical consumption studies, which will make it easier to compare our results to those previously obtained.

Most of the existing empirical tests of consumption theories focus on non-durable consumption.[3] Durable goods are long-lived and provide households with a flow of consumption services for several time periods. The FES and other comparable datasets contain information on durable goods expenditure, but not on durable goods consumption. This raises the additional difficulty of how to translate a given durables expenditure into a flow of consumption services. Because of these difficulties, and as in most of the consumption literature, we focus our analysis on non-durable consumption.

[3]Important exceptions are Mankiw (1982) and Heaton (1993). See also Piazzesi, Schneider and Tuzel (2003) for a recent paper testing non-separabilities between durable and non-durable consumption. Fernandez-Villaverde and Krueger (2002) characterize the evolution of durable expenditures over the life-cycle.

2.2 Life-cycle patterns

In the FES each household is observed only once, so that we use the methodology introduced in Browning, Deaton, and Irish (1985) and Deaton (1985) to construct panel data from a time-series of cross-sections, or a pseudo-panel. In this section we define cohorts based on the year of birth of the household head. Each cohort consists of households whose head was born within one five-year period: The oldest cohort is for individuals born between 1935 and 1939, and the youngest for individuals born between 1965 and 1969.

To obtain some insights about the evolution of the variables over the life-cycle we first regress log consumption and log income on ninety one year-cohort dummies, which correspond to seven cohorts and thirteen years of data, and three quarter dummies that capture seasonal effects. Each of the estimated coefficients on the year-cohort dummies capture mean cohort-year log consumption or income. Figure 2 plots the evolution of annualized non durable consumption and income over the life cycle. Each line corresponds to a different cohort. The age profiles are hump-shaped over the life-cycle, and similar to those obtained by Attanasio and Browning (1995), Carroll (1997), and Gourinchas and Parker (2002), among others. It is important to note that Figure 2 does not control for changes in family composition or other demographic variables.

In Figure 3 we again plot annual consumption and income, but with the sample restricted to homeowners. As expected, the labor income of homeowners is on average higher. Comparing the consumption profiles in Figures 2 and 3, we can see that, for each cohort, the consumption growth of homeowners is higher than that of the population as a whole. Obviously, one needs to be careful in interpreting this finding. Homeownership is endogenous, and correlated with income growth and demographic variables that may affect the growth rate of consumption.

To illustrate homeownership patterns over the life-cycle Figure 4 plots, for the different cohorts, the proportion of renters, homeowners with a mortgage, and homeowners outright. The proportion of renters is highest early in life, but declines steadily over life to reach roughly twenty percent from age forty-five onwards. Early in life and in mid-life the vast majority of households who own the house they live in have a mortgage outstanding. Because of this one may expect that mortgage payments, and the degree of household leverage, affects consumption patterns.

In the UK the vast majority of mortgages are adjustable-rate. Fixed-mortgages have only become more common in the last few years, and even these are not the typical US long-term fixed rate mortgage. They are characterized by a rate that is fixed for a couple of years, and then revert to an adjustable rate. Figure 5 plots the evolution over the life-cycle of real mortgage payments, for the sample of mortgage holders. Mortgage payments are highest early in life, and decline over the life-cycle. The average mortgage payments plotted in Figure 5 are for the sample of mortgage holders. For the sample of homeowners the decline would have been larger late in life, as a result of the increase in the proportion of owners outright shown in Figure 4.

Real payments on adjustable-rate mortgages are highly sensitive to movements in inflation and nominal interest rates. An increase in expected inflation drives up nominal interest rates and required nominal payments, but in the short run the price level does not increase proportionally so real mortgage payments increase (Campbell and Cocco, 2003). This effect can be seen in Figure 5, where for each cohort there is a similar pattern in real mortgage payments over time, with high real mortgage payments in the early years of the survey, and low in the later years. This reflects the high nominal interest rates in the years 1989 to 1992 (illustrated in Figure 1).

To explore this issue further we have also computed, for each cohort, the correlation between real mortgage payments and the nominal interest rate: these correlations are large and positive, with values that range from 0.71 to 0.89, with an average value of 0.81. The correlations of real mortgage payments with the nominal interest rate are considerably higher than the correlations of real mortgage payments with the real interest rate, which are on average equal to 0.67. This reflects the fact that the interest rate effects on real mortgage payments for adjustable-rate nominal mortgages come from high nominal interest rates which accelerate the required real payments on this type of mortgages (Campbell and Cocco, 2003).

2.3 Regional and homeownership cohorts

In the previous section we grouped households only by their year of birth. We now exploit other information in the dataset by defining cohorts in two alternative ways. In the first, we define nine cohorts based on the year of birth of the household head and the region where the household lives. We consider three ranges for the year of

birth and three UK regions: North, Center and South.[4] These regions were defined based on the correlation between house prices among them. We would like to be able to consider finer ranges for year of birth and region in our cohort definitions, but that would lead to a decrease in cell size and to an increase in measurement error.

Table 1 shows the nine cohorts that we consider, together with the age of the head of the household in 1988 and 2000. We exclude elderly households since their consumption patterns are likely to be heavily influenced by health considerations which affect their subjective discount rate. Table 1 also reports, for each cohort, the minimum, maximum, and mean quarterly cell size. The fact that we have regional consumption and house price data will allow us to investigate whether regional house prices explain regional consumption patterns, beyond what is explained by UK wide house prices.[5]

We construct a second set of cohorts based on the year of birth of the household head and homeownership status. More precisely, we consider six ranges for the year of birth, and whether the household is a renter or homeowner. Being able to distinguish between homeowners and renters is important for understanding the link between house prices and consumption for several reasons. First, renters are short housing and therefore the wealth effect associated with a house price increase should be negative. Second an increase in house prices does not directly lead to a relaxation of the borrowing constraints renters face. Thus, unless the house price increase is due to improved future aggregate economic conditions, which also benefit renters, an increase in house prices should have a negative effect on the consumption of renters.

Table 2 reports for each cohort of homeowners and renters the minimum, maximum and mean cell size. Mean cell size is relatively small for old renters. Due to cell size considerations, when we construct cohorts based on homeownership status we cannot split cohorts further based on the region where the household lives. This means that we loose explanatory power from regional differences, unless different cohorts of homeowners and renters tend to live in different regions. Another important issue that one needs to keep in mind when interpreting the regression results for these cohorts is that homeowners and renters differ along several important dimensions. Homeowners are on average older than renters (median age of 40 as compared

[4]The North includes households living in Scotland, North West, North East, Yorkshire and Humberside. Center: East Midlands, West Midlands, Wales, Eastern Anglia. South: South East, South West, London.

[5]Lustig and Van Nieuwerburg (2004) use US regional data to test the extent to which borrowing against housing allows for consumption risk sharing across regions.

with 36 for renters), have larger families (mean family size of 3 as compared with 2.8 for renters), 104% greater income, and 33% greater consumption than renters.

Table 3 reports some summary statistics for our cohort mean data, including consumption, income, and family size. Panel A reports the data for the regional cohorts, whereas Panel B reports the data for the cohorts of homeowners and renters. The sample selection issue that arises from our split of the sample between homeowners and renters can clearly be seen in Table 3B, in the quarterly differences in income and consumption. As they age, those households that remain renters are those with lower income and consumption. In section 5 we test the robustness of the results to two alternative ways of defining cohorts that deal in part with the biases that may arise as a result of the endogeneity of the transition from renting to owning.

2.4 House price data

We obtain house price data from Nationwide, a leading UK building society. Nationwide house prices are mix adjusted, i.e. they track a representative house price over time, rather than the simple average price. This avoids the house price index being influenced by a change in the mix of houses (proportion of different property types, locations, etc). Nationwide obtains the house price information from their lending data for properties at the post survey approval stage. Importantly, the fact that the information is obtained at the post survey approval stage may introduce some lag in the house price data, since the transaction price will probably have been agreed between buyer and seller a few weeks before this date.[6]

We match the quarterly regional house price indices from Nationwide to each household in the FES. In this way we are able to obtain, for each household, a region specific measure of house prices, which should allow us to obtain a better estimate of the effect of house prices on consumption, than simply using a UK wide house price index.

Table 4 reports the coefficients of correlation between quarterly (and annual) house price changes in the three regions we define. As expected the correlations are higher between regions that are closer geographically (North and Center, and Center

[6]More information on the methodology used by Nationwide to construct the house price series is available at http://www.nationwide.co.uk/hpi/methodology.htm. The house price data are available at http://www.nationwide.co.uk/hpi/historical.htm.

and South), and are somewhat higher for annual than quarterly house price changes. Figure 6 plots the evolution over time of house prices in these three regions.

In addition to this information, we obtain quarterly series for nominal interest rates, namely the Bank of England rate, and the retail price index. We show the history of nominal interest rates and inflation together with house price returns in Figure 1.

3 House Price Changes and Consumption

3.1 Baseline regression

We first present our baseline regression, which consists of regressing changes in consumption on changes in house prices, controlling for household income, leverage, and other demographic variables. We estimate this regression using a pseudo-panel constructed in several different ways, that explore the micro nature of the data, and allows us to partially disentangle between the different channels through which house prices may affect consumption. More precisely, we estimate:

$$\Delta c_{i,t+1} = \beta_0 + \beta_1 r_{t+1} + \beta_2 \Delta y_{i,t+1} + \beta_3 \Delta p_{i,t+1} + \beta_4 \Delta m_{i,t+1} + \beta_5 Z_{i,t+1} + \epsilon_{i,t+1} \quad (1)$$

where the subscript i denotes household, r_{t+1} is the log real interest rate between periods t and $t+1$, $\Delta c_{i,t+1} = ln(C_{i,t+1}) - ln(C_{it})$ is real non-durable consumption growth, $\Delta y_{i,t+1} = ln(Y_{i,t+1}) - ln(Y_{it})$ is real income growth, $\Delta p_{i,t+1} = ln(P_{i,t+1}) - ln(P_{it})$ is real house price growth, $\Delta m_{i,t+1} = ln(M_{i,t+1}) - ln(M_{it})$ is changes in real mortgage payments, and $Z_{i,t+1}$ is a vector of household characteristics which includes demographic variables.

3.2 Estimation Results for Regional Cohorts

Table 5 shows the estimation results for the baseline regression (1), for several different specifications. The standard errors reported in parenthesis below the estimated

coefficients are corrected for both first-order serial correlation and heteroscedasticity. In all specifications we include quarter and cohort dummies (the estimated coefficients are not reported), and we control for demographics by including a second order polynomial of age and changes in the logarithm of family size.

In specifications (i) and (ii) we include as independent variables changes in log household income and house prices in the region where the household lives, respectively, whereas in specification (iii) we include these two variables simultaneously. The estimated coefficients are positive and statistically significant, so that consumption growth is positively correlated with income growth and house price changes. The estimated coefficients on house prices and income decrease in magnitude when we include these two variables simultaneously in the regression, which suggests some degree of colinearity between regional house prices and income. Nevertheless, both are significant in statistical and economic terms in specification (*iii*).

The estimated coefficient on house prices in this specification is 1.22. Thus, a one percent increase in the value of the house is associated with a 1.22 percent increase in real non-durable consumption. To understand what such a value means in pounds, let us consider the value of a representative house in the UK in the last quarter of 2000, which was 81,628 British pounds. In the same year the average two-week consumption from the FES data was 200 British pounds. Thus, an increase in the value of the house by one percent, or by 816 pounds would lead to an increase in annual consumption consumption of 63 pounds.

In specification (iv) we also include as independent variables the change in the proportion of homeowners, both with a mortgage and outright. The estimated negative coefficients show that increases in the proportion of homeowners are associated with slower non-durable consumption growth. However, neither of the estimated coefficients is significantly different from zero.

The regional cohorts definition allows us to investigate whether regional house prices explain regional consumption, beyond what is explained by UK wide house prices. In order to do so, we construct an additional explanatory variable which is regional house price changes less UK wide house price changes. In specification (vi) we see that this variable is statistically significant in explaining consumption. This confirms the existence of a regional link between house prices and consumption.

Since in the UK most of the outstanding mortgages are adjustable rate, the effect of house prices on consumption may depend on what happens to household mortgage

payments when house prices change. To test this hypothesis the last specification in Table 5 includes changes in real mortgage payments as an additional explanatory variable. The estimated coefficient is not significantly different from zero. In addition, and to test whether a given percentagehouse price increase has a bigger proportional effect on consumption if households are highly leveraged, we have interacted house price growth with the level of the mortgage-income ratio. When we include this variable in the regression the estimated coefficient is positive but not significantly different from zero (results not reported).

3.3 Estimation Results for Cohorts of Homeowners and Renters

Table 6 shows the results for the baseline regression for the cohorts of homeowners and renters. As before we find that house price changes are positively correlated with consumption growth, and that this correlation decreases when we control for labor income growth. The effects of house price changes on consumption may depend on age and homeownership status. To investigate this issue in specification (iv) we include as independent variables changes in house prices interacted with dummy variables for young homeowners, young renters, and old renters. Young (old) are those younger (older) than forty years of age.[7] In this specification the estimated coefficient on Δp_t measures the effects of house price changes in the consumption of old homeowners, and the estimated coefficients on house price changes interacted with the dummy variables measures the additional effect of house prices for the group of individuals to which the dummy variable refers to.

Interestingly, we find that there is significant heterogeneity in the effects of house prices on consumption across the different groups of individuals. The estimated coefficient on house prices is highest for old homeowners, and almost three times the one we estimated in specification (iii) where we did not interact house price changes with age and homeownership status. In addition, the effects of house prices on consumption are lower for young homeowners and for renters than for old homeowners, since we estimate negative coefficients for house price changes interacted with dummy variables for these groups of individuals. In fact, the magnitude of the estimated coefficients tells us that the effects of house price changes on consumption are lowest for young renters, followed by old renters, young homeowners, and with the largest effect being

[7] We have also experimented a cutoff age between young and old of forty-five years and the results were similar.

for old homeowners. All these estimated coefficients are statistically different than each other at the one percent level of significance, except for the estimated coefficients for young homeowners and old renters which are not significantly different from one another. The effect of house prices on consumption is not statistically different from zero for young renters, but it is positive for all other groups of individuals. The fact that the estimated coefficient on house prices for old renters is positive suggests the house prices may, to some extent, proxy for aggregate economic conditions.

In the last two specifications in Table 6 we include changes in real mortgage payments as an additional explanatory variable. In specification (v) we include it on its own, and in specification (vi) we include it on its own and also interacted with a dummy variable for young homeowners. Obviously, for renters these variables are equal to zero. Interestingly, we find that increases in real mortgage payments are negatively correlated with consumption growth (specification v), and that this negative effect is due to the changes in real mortgage payments of young and not old homeowners (specification vi). Since in the UK the vast majority of mortgages are adjustable-rate, and mortgage payment changes have no wealth effects for this type of mortgages (Campbell and Cocco 2003), the likely explanation for the negative estimated coefficient is the presence of borrowing constraints, whose effects we try to separate from wealth effects in the next section.

4 Borrowing constraints Versus Wealth Effects

In the previous section we have estimated the effects of house prices on consumption without distinguishing between borrowing constraints and wealth effects. In order to do so, we now explore the *predictable* or *unpredictable* nature of the increase/decrease in house prices. What matters for there to be a wealth effect are unpredictable house prices changes. That is, the wealth effect takes place, and non-durable consumption should respond to unpredictable house price movements. On the other hand, a *predictable* increase in house prices has no wealth effect, but it may still relax borrowing constraints. Obviously, this reasoning requires that there are predictable changes in house prices, and indeed several papers have documented positive serial correlation in residential real estate returns (Case and Shiller, 1989, Poterba, 1991). It also requires that housing becomes available as collateral only when the increase in house prices is realized and not when it can be predicted.

It is important to note that although we denominate these two channels as borrowing constraints and wealth effects of house prices, our approach only allow us to partially differentiate between the two. This is because the two channels are not mutually exclusive: an unexpected increase in house prices may have a positive wealth effect and at the same time relax borrowing constraints.[8]

4.1 Borrowing constraints

If a predictable increase in house prices relaxes borrowing constraints, the consumption of borrowing constrained households should respond to predictable changes in house prices. We focus on predictable changes because there should be no wealth effect associated with them.

Our test of whether non-durable consumption responds to predictable changes in house prices is closely related to the consumption literature on excess sensitivity of consumption to income. The hypothesis to be tested is the permanent income hypothesis, which postulates that consumption should respond only to unpredictable changes in income. Instead, Flavin (1981) has found that consumption responds positively to predictable changes in income, and has interpreted this finding as evidence that consumers face borrowing constraints. Following Flavin's influential paper, there have been many papers investigating whether there is indeed excess sensitivity and its link to borrowing constraints, using both macro (Hall 1978, Campbell and Mankiw 1989, 1991, Carroll and Summers 1991, Christiano, Eichenbaum, and Marshall 1991) and micro data (Hall and Mishkin 1982, Zeldes 1989, Runkle 1991, Attanasio and Browning 1995, Attanasio and Weber 1995).[9]

The equation that we estimate is the one usually estimated in tests of excess sensitivity. The novelty of our analysis is that we also include as regressor house price growth in the region where the household lives. More precisely we estimate equation (1) using lagged variables as instruments, which essentially corresponds to estimating the following model:

[8] One additional difficulty for the interpretation of the results is that precautionary savings may also lead consumption to respond to predictable changes in house prices. We discuss this below.

[9] See the survey of Browning and Lusardi (1996) for further references.

$$\Delta c_{i,t+1} = \beta_0 + \beta_1 E_t r_{t+1} + \beta_2 E_t \Delta y_{i,t+1} + \beta_3 E_t \Delta p_{i,t+1} + \beta_4 E_t Z_{i,t+1} + \epsilon_{i,t+1} \qquad (2)$$

In words, we ask whether consumption responds to predictable changes in income and house prices. If the permanent income hypothesis were true, β_2 and β_3 should be zero. If on the other hand households are borrowing constrained and a predictable increase in house prices increases their borrowing capacity, the estimated coefficient β_3 will be positive.

The fact that we take first differences of cohort means introduces an $MA(1)$ structure in the residuals of the equation to be estimated, which raises some important issues for our choice of instruments, and also for the computation of standard errors (see Deaton (1992) for a textbook treatment). To allow for the MA structure of the residuals we use instruments dated $t-1$ and earlier, i.e. variables twice lagged. We estimate equation (2) for the all cohorts simultaneously, but include as independent variables cohort fixed effects.

In the vector of variables Z_{it+1} we include the first differences of age, age squared, and family size. These variables can be expected to appear in the felicity function so that we include their change contemporaneously with the change in consumption. Age and age squared are taken as exogenous, as are the cohort and seasonal (quarter) fixed effects. However changes in family size are considered to be endogenous, so that we use as instrument the second lag of change in family size.

The real interest rate, $\Delta y_{i,t+1}$ and $\Delta p_{i,t+1}$ are also considered to be endogenous and are instrumented. We use as instruments the second lag of changes in log consumption, income, house prices, and the second lag of the interest rate and the inflation rate.

4.2 Wealth effects

If there are wealth effects associated with house price fluctuations, then the wealth effects occur when there are unpredictable house price movements. That is: consumption should respond to unpredictable changes in house prices. Therefore, in order to test this hypothesis, we must first identify unpredictable house price changes.

To do so we first estimate $E_t\Delta p_{i,t+1}$, and then obtain shocks to house prices as $\Delta p_{i,t+1} - E_t\Delta p_{i,t+1}$. In our estimate of expected house price changes, we include as explanatory variables the same instrumental variables that we have used in the previous subsection. We repeat this procedure for income, and for consumption, so as obtain measures of the unexpected changes in income and consumption, $(\Delta y_{i,t+1} - E_t\Delta y_{i,t+1})$ and $(\Delta c_{i,t+1} - E_t\Delta c_{i,t+1})$, respectively. We then test whether unexpected changes in consumption react to unexpected changes in house prices by estimating the following regression:

$$\Delta c_{i,t+1} - E_t\Delta c_{i,t+1} = \alpha_0 + \alpha_1(\Delta r_{i,t+1} - E_t\Delta r_{i,t+1}) + \alpha_2(\Delta y_{i,t+1} - E_t\Delta y_{i,t+1}) + \alpha_3(\Delta p_{i,t+1} - E_t\Delta p_{i,t+1}) + \eta_{i,} \tag{3}$$

where $\eta_{i,t+1}$ is the residual. It is important to clarify a few issues regarding equation (3), since this is not an equation usually estimated in the consumption literature.

If we exclude the unexpected change in house prices from the set of explanatory variables, the above equation is not very informative when trying to distinguish between different consumption theories; whether the permanent hypothesis holds, or whether consumers are liquidity constrained, consumption should respond positively to unexpected changes in income. The same is not true, however, for the response of consumption to an unexpected change in house prices. The sign of the estimated coefficient α_3 allows us to test whether there is a wealth effect associated with house price shocks. It should be positive for households who are long housing, negative for households who are short housing, and zero for households who are neither short nor long housing.

The estimation of the wealth effects of house price shocks requires us to identify those households who are likely to be short and long housing. Whether an household is short or long housing is likely to be strongly correlated with age, with young households being short housing, and older households being long housing. Another crucial variable for this purpose is homeownership status: renters are likely to be short housing. Using age and homeownership as proxies for long/short housing has the additional advantage that these variables are likely to be relatively free from measurement error.

Due to the micro nature of our data, measurement error clearly is the most worry some issue when estimating equation (3). Given that we are using house prices from

Nationwide, and not from household survey data, measurement error is more likely to be an issue for consumption and income, than for house prices. Measurement error poses a problem, because even when measurement error in income is orthogonal to everything else, it means that it is impossible to separate innovations in income from measurement error. This means that it is impossible to estimate the effects of unexpected shocks to income on consumption, or the parameter α_2. The estimated value is likely to be biased towards zero in the presence of orthogonal measurement error.

Another scenario is when measurement error in income is positively correlated with measurement error in consumption, which can also be interpreted as transitory consumption and income being simultaneously high/low. Measurement error of this nature biases the estimated parameter α_2 upwards. Below we interpret the results from our regression analysis in light of the possible measurement error. In addition in section 5 we perform some robustness checks that try to minimize the impact of measurement error.

4.3 Estimation results for regional cohorts

Borrowing Constraints

The first three columns of Table 7 show the estimation results for the instrumental variables regressions. All specifications include cohort and quarter fixed effects, changes in age and age squared, and changes in family size (coefficients not reported). The estimated coefficients on the real interest rate and income growth variables match those typically obtained in other consumption studies, both in sign and statistical significance. The estimated coefficient for income growth is positive and statistically significant. This is the well known finding of excess sensitivity of consumption to income, which has been interpreted by Flavin (1981) and Zeldes (1989), among others, as evidence of borrowing constraints.

The novelty of our analysis is that, in addition to income, we also include predictable changes in house prices as an additional explanatory variable. Since housing is an asset that can be used as collateral an increase in house prices increases borrowing capacity, and allows borrowing constrained homeowners to increase consumption.

Interestingly, we estimate positive coefficients on house price changes, both for regional and UK house prices (specifications (i) and (ii), respectively).

However, in specification (iii) we find that regional house price changes less UK house price changes have no explanatory power beyond that of UK house prices changes. This suggests that if the channel at work is indeed borrowing constraints, then it may be a macro effect rather than a direct channel. If homeowners in a given region are borrowing constrained, and increases in the price of their house allow them to increase consumption, we should observe regional house prices being important. Instead only aggregate house prices matter, which suggests that aggregate borrowing capacity is the relevant variable. Our analysis of the cohorts of homeowners and renters below will shed some more light on this issue.

Wealth Effects

Columns (iv) through (vii) of Table 7 show the results for the unpredictable house price changes. As expected, the estimated coefficient on unexpected income changes is positive. Of more interest is the fact that we also estimate positive coefficients for unexpected house price changes. Moreover, and in contrast to specification (iii), unpredictable *regional* house price changes are statistically significant. This shows that the wealth channel through which house prices affect consumption has a regional component.

4.4 Estimation results for homeowner-renter cohorts

Borrowing Constraints

In columns (i) through (iv) of Table 8 we examine the effects of predictable changes in house prices on consumption. In specification (i) we find that the estimated coefficient on house prices is significantly positive so that consumption responds positively to predictable changes in house prices. In specification (ii) we include as additional dependent variables predictable house price changes interacted with dummy variables for young homeowners, young renters, and old renters. The estimated incremental effects of house prices for these three groups of individuals are negative, but there are differences in statistical significance.

The effect of house prices on the consumption of young homeowners is not statistically different from the effects of house prices on the consumption of old homeowners. Furthermore, the impact of house prices on the consumption of young and old renters is significantly lower than the effects of house prices on the consumption of old homeowners, and in specification (ii) they are not statistically different from zero. In other words, we cannot reject the null hypothesis that the estimated coefficients on Δp_t plus on $\Delta p_t \times$ Young Renter and on Δp_t plus on $\Delta p_t \times$ Old Renter are equal to zero. Thus the results in specification (ii) are consistent with a borrowing constraints channel that is micro in nature.

However, this is no longer the case once we include changes in real mortgage payments as an additional independent variable. In specifications (iii) and (iv) we still cannot reject the null hypothesis that the estimated coefficient on Δp_t plus on $\Delta p_t \times$ Young Renter are equal to zero, but we reject the hypothesis that the estimated coefficients on Δp_t plus on $\Delta p_t \times$ Old Renter are equal to zero. Thus, the consumption of old renters responds positively to predictable changes in house prices, an effect which cannot be explained by a relaxation of borrowing constraints at an household level.

This suggests that if the channel through which predictable changes in house prices affect consumption is borrowing constraints, then at least for old renters it is an aggregate effect. Obviously, we cannot rule out that for homeowners the channel is a direct one, but these results combined with those for the regional cohorts point to the existence of a macro/aggregate channel. In other words, an increase in house prices lead to an easing of borrowing constraints economy wide, also in terms of uncollateralized borrowing, which benefits renters.

It is important to emphasize that one should be careful when comparing the magnitude of the estimated coefficients on the effects of house prices for old homeowners and old renters, and drawing strong conclusions from these. First, for some of the cohorts of old renters the average cell size is relatively small. Second, and as previously discussed, renters are on average poorer than homeowners, and they may face more severe borrowing constraints. Third, there is an alternative explanation, other than borrowing constraints, for the results in Table 8, which is a precautionary savings motive. As Carroll (1997) pointed out, in the presence of a precautionary savings motive the rate of growth of consumption should depend also on a variance term. If next period's income, house prices and consumption growth are risky, consumption now should be lower, and consumption growth should be higher. Renters tend

to have lower assets, and for this reason they are less protected from consumption variability.[10]

Wealth Effects

Columns (v) through (vii) of Table 8 show the estimation results for the wealth effects for the cohorts of homeowners and renters. Recall that theory predicts the wealth effects should be largest and positive for old homeowners, and should be smallest and negative for young renters. The results in table 8 provide some empirical support for these predictions.

In specification (vi) we see that the wealth effects of house price shocks are largest and positive for old homeowners: the estimated coefficients on house price shocks interacted with dummies for young homeowners, old renters, and young renters are all negative. Among the latter three, the estimated coefficient for young renters is largest (in absolute value) and statistically different from zero. Thus the wealth effects of house price shocks are smallest for young renters. When we add the estimated coefficients on innovations in Δp_t and on innovations in $\Delta p_t \times$ Young Renter we obtain a coefficient that is not significantly different than zero.

It is also interesting to see that in specification (vii) we find no wealth effect of changes in mortgage payments on consumption. This is consistent with theory given that these are mostly adjustable-rate mortgages. As Campbell and Cocco (2003) show an increase in expected inflation and nominal interest rates accelerates real mortgage payments on adjustable-rate mortgages, and although this has no wealth effect, it may force borrowing constrained homeowners to temporarily cut back their consumption. This may be the reason why in specification (iii) we estimate a negative coefficient for predictable changes in mortgage payments.

It is possible that some of the estimated coefficients in Table 8 are influenced by measurement error. If measurement error in income (or transitory income) is positively correlated with measurement error in consumption (or transitory consumption), this would bias upward the estimated coefficient on unexpected shocks to income. Given that we are using house price data from Nationwide and income and consumption data from FES, measurement error in consumption that is correlated with house

[10] See the buffer-stock models of Deaton (1991) and Carroll (1997). Carroll (1992) and Carroll and Samwick (1997) provide empirical evidence.

price data is a less likely scenario than measurement error in consumption that is correlated with income. In spite of the fact that we cannot rule out the possibility that measurement error is influencing the statistically significance or the magnitude of the estimated coefficients, it is nevertheless a significant finding that we estimate the smallest and largest wealth effects of shocks to house prices for those households who are more likely to be short and long housing, respectively.

5 Robustness

5.1 Endogeneity of Renting/Homeownership Decision

In the previous sections we have exogenously split the sample between homeowners and renters. This is likely to be problematic, since the decision of whether to become homeowner is endogenous, and correlated with individual characteristics such as income and consumption. Over the life-cycle, the individuals who remain as renters are the ones whose incomes are stagnating or declining. Individuals with rising incomes become homeowners. That means that over time for a fixed birth year, the cohort of renters shrinks and becomes more concentrated in the low-income population. This can clearly be seen in Table 3, panel B, which shows that average consumption and income growth is negative for renters and positive for homeowners. Thus, the pseudo-panel methodology and households moving endogenously from one category to another clearly affects cohort means of consumption and income. These average cohort effects are captured by the fixed effects in the regressions.

More problematic for our analysis is if there is also an effect on covariances and thus on the estimated regression coefficients. For example, suppose that when house prices begin to rise those renters with high income and consumption rush out and buy first houses, or suppose that an increase in the transition rate from renting to homeowning by these individuals drives up house prices. In this case, for a fixed birth year, the mean consumption of renters in quarter $t-1$ may be larger than in quarter t, and the change in mean consumption negative, simply because in response to the increase in house prices those renters with higher consumption and income became homeowners. Even though in the regressions we are controlling for changes in the same renters' and homeowners' income, there may be some correlation between changes in house prices and consumption that is simply due to renters becoming homeowners.

In order to partially address this issue, we use a variable in the FES data which measures the number of months/years that the head of the household has lived at the present address. More precisely, we restrict the sample to those households who have lived for more than 6 months at the present address. This means dropping five (fourteen) percent of households who report being homeowners (renters) at the time of the survey. We then construct cohorts of homeowners and renters for this restricted set of households. We are thus excluding households which changed homeownership status recently.[11] This is our first alternative way to construct cohorts.

We also construct cohorts of renters in a second way, so as to include in the analysis households that switch from renters at $t-1$ to homeowners at t. Most households who switch from renters to homeonwers do so early in life. Therefore, we have constructed cohorts of renters which include: (a) renters who have lived at the present address for more than six months; and (b) homeowners younger than 32 years of age who have lived at the present address for less than six months, i.e. the group of "new homeowners." We classify the latter as renters for the purpose of computing cohort averages, so as to address the potential bias on the estimated coefficient on house prices changes that arises from households switching from renters to homeowners. The cohorts of homeowners were defined in the same way as before, i.e. they include those who own a house and who have lived at the present address for more than six months.[12]

In order to investigate the extent to which the transition from renting to homeowning is correlated with house prices, and also the cutoff age for our definition of the new homeowners group, we have constructed a variable that is equal to the ratio of the number of individuals in the new homeowners group to the number of individuals in the renters group, for those younger than a given age. It is on average equal to twenty percent when we set the cutoff age to 32. It is also for this cutoff age that the correlation between this ratio and house price changes is largest, equal to eighteen percent, but marginally insignificant (robust p-value equal to 10.3 percent and R-squared equal to 3.18 percent). This significance decreases further when we include quarter fixed effects in the regression.[13] Thus there seems to be some weak evidence

[11] Obviously, households who were renters in $t-1$, bought the *same* house they were living in and became homeowners in t will be included, but in principle there are not many such households.

[12] In this analysis we are still missing those individuals that switch from homeowners at $t-1$ to renters at t. Identifying them is more difficult given the nature of the data available. However, since we have restricted the sample to households with head not older than 60 years of age, these households are likely to be far fewer than those switching from renter to homeowner.

[13] In this case the R-squared increases to 8.17 percent.

that the switch from renter to homeowner is positively correlated with house prices changes.

Table 9 shows the estimation results for the baseline regression. Column (i) replicates the results shown in the last column of Table 6. Column (ii) shows the results when we restrict the sample to households who have lived at the present address for more than six months, and column (iii) shows the results when we include the new homeowners as well. As can be seen from table 11, the results in columns (ii) and (iii) are similar to those in column (i). The estimated coefficient on income changes is slightly larger, and that on house price changes slightly smaller, but of a similar order of magnitude. In particular, it is still the case that the effects of house prices on consumption are largest for old homeowners and smallest for young renters. Table 10 shows that we also obtain similar results for the IV regressions and for the wealth effects of house price changes.

In this section we have relied on information on the number of months/years at the present address to at least partially deal with the bias that may arise because of households switching homeownership status in response to house prices. We have also used the same variable to deal with regional mobility in the definition of regional cohorts. When we restrict the sample to households who reported living at the present address for at least six months the results were similar.

5.2 Other Robustness Checks

We have carried out several other robustness checks which we now describe. Since the results were similar to those already reported we do not report them. First, we have considered an expanded set of instrumental variables. In addition to the second lag of changes in consumption, income, house prices, mortgage payments, interest rate and inflation rate, we have also included the third lag of these variables. Second, we have tried to minimize the impact of measurement error by truncating the values of income and consumption changes below and above the 5th and 95th percentiles of their respective distributions, at their 5th and 95th percentile values, respectively. Finally, and bearing in mind that measurement error is more likely to be an issue for those cohorts whose quarter cell sizes are not very large, we have estimated regressions that weight observations by the inverse of cell size.

6 Conclusion

This paper studied the response of household consumption to house prices using micro level data. We have estimated the largest and a positive elasticity of consumption to house prices for old households who are homeowners. These are the households that are more likely to be long housing. On the other hand, we have estimated the smallest and equal to zero elasticity of consumption to house prices for young households who are renters. These households are likely to be short housing. The estimated elasticity for the old homeowners group is as large as 1.7, controlling for interest rates, household income, and other demographic variables. This age heterogeneity is important since it suggests that as the population ages and becomes more concentrated in the old homeowners group, aggregate consumption will become more responsive to house prices. The recent years characterized by increases in property prices, and a strong private consumption preventing the UK economy from falling into recession, points to the relevance of our estimates.

We have found, controlling for economy-wide house prices and for regional income, that regional house prices are important for explaining consumption. This shows that it is important to allow for regional heterogeneity when estimating the effects of house prices on consumption. Finally, we have found that consumption responds to predictable changes in house prices, an effect which is consistent with an increase in house prices relaxing borrowing constraints, but that may also be explained by a precautionary savings motive. The analysis of regional effects and of the response of consumption of cohorts of homeowners and renters to house prices suggests that the effects of predictable changes in house prices are aggregate, rather than regional or direct effects.

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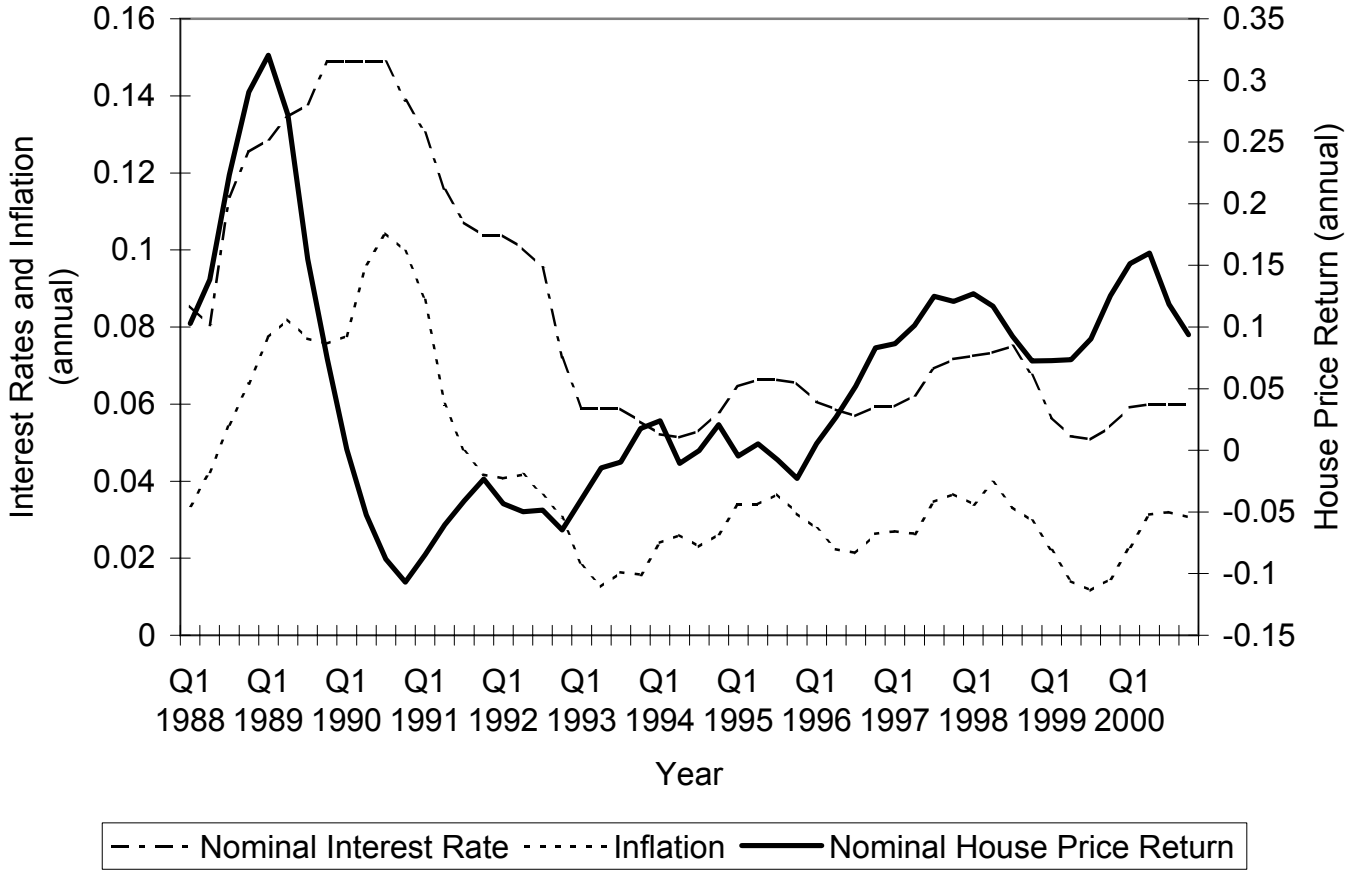
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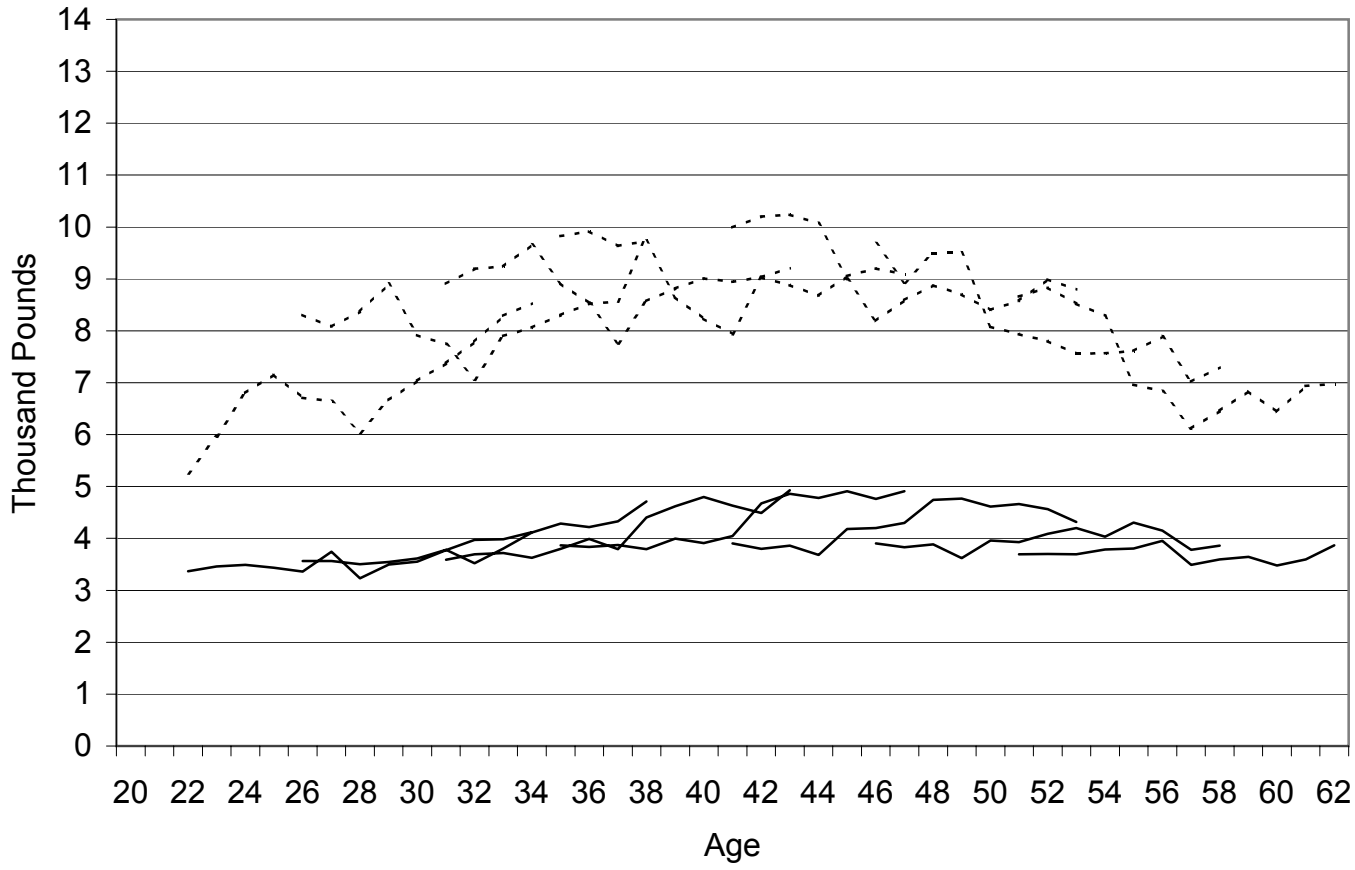
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Figure 1: Interest Rate, Inflation, and House Prices in the United Kingdom



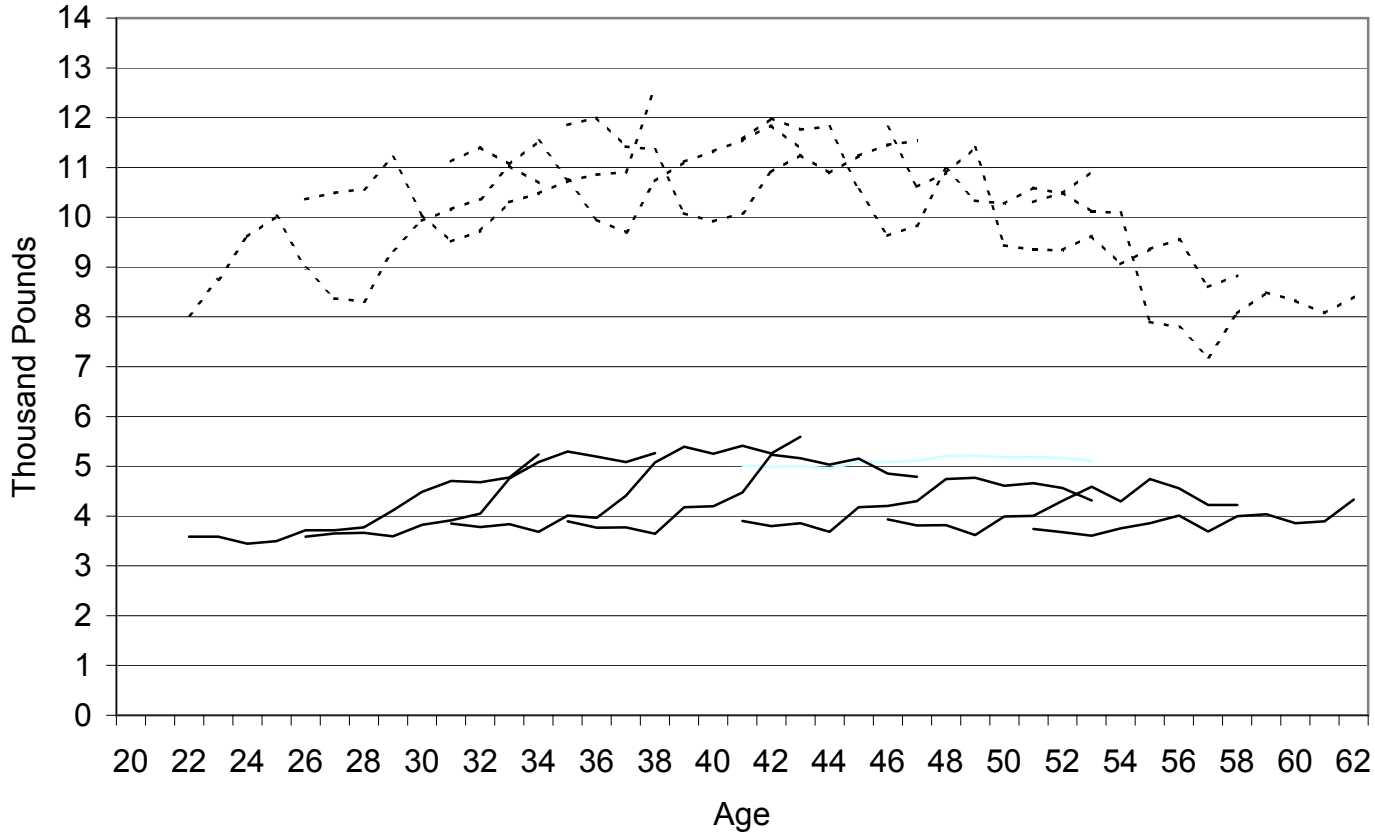
Note to Figure 1: This figure shows nominal interest rates, inflation rate and house price return for the United Kingdom. The inflation rate measure is the change in the Retail Price Index. The house price data is from Nationwide. The series are quarterly, but are in annual terms.

Figure 2: Non Durable Consumption and Income Over the Life Cycle



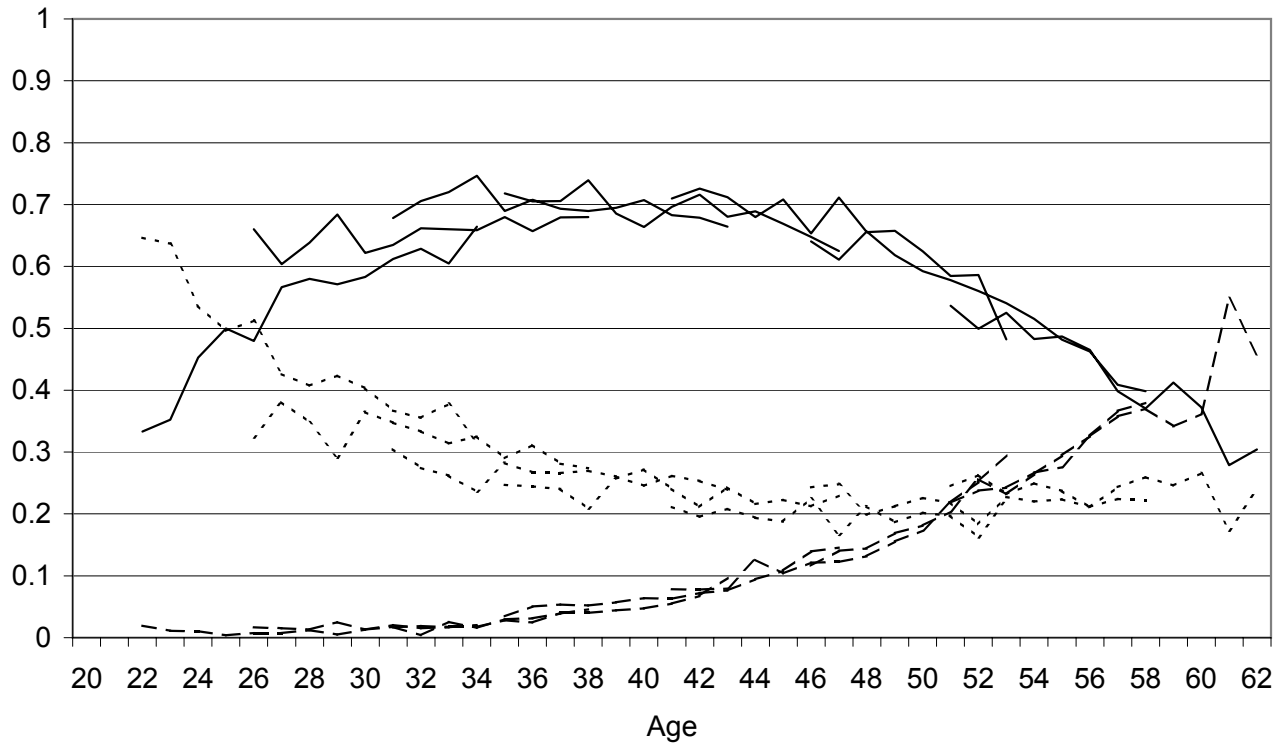
Note to Figure 2: This figure plots annual real non-durable consumption (solid line) and real income (dashed line) over the life-cycle for different cohorts. The data is from the UK Family Expenditure Survey. The age-cohort income and consumption were obtained by regressing consumption and income on year-cohort dummies. Annual values were obtained by multiplying the two week consumption and income by twenty six.

Figure 3: Non Durable Consumption and Income Over the Life Cycle for Homeowners



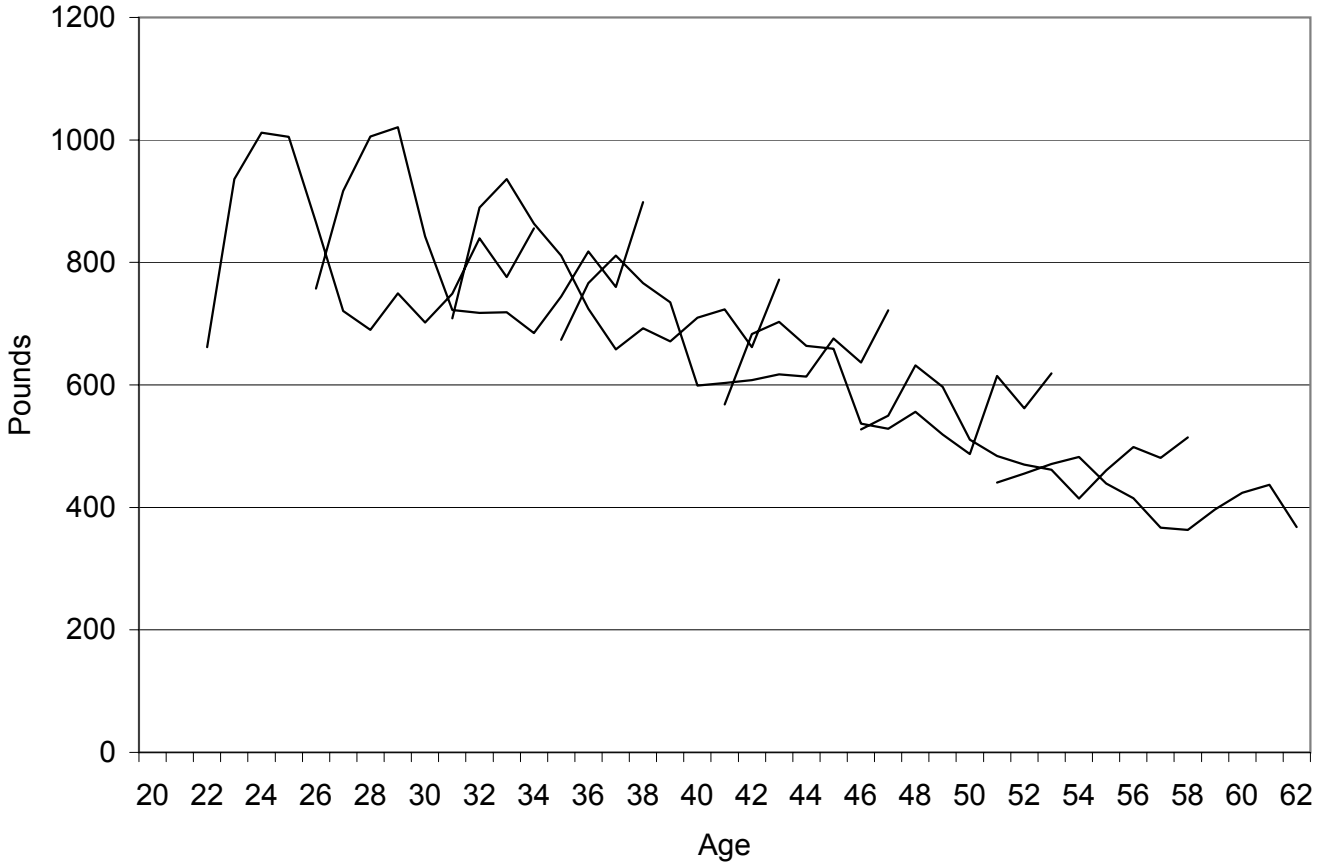
Note to Figure 3: This figure plots annual real non-durable consumption (solid line) and real income (dashed line) over the life-cycle for different cohorts, and with the sample restricted to homeowners. The data is from the UK Family Expenditure Survey. The age-cohort income and consumption were obtained by regressing consumption and income on year-cohort dummies. Annual values were obtained by multiplying the two week consumption and income by twenty six.

Figure 4: Proportion of Renters (dashed), Owners with Mortgage (solid), and Owners Outright



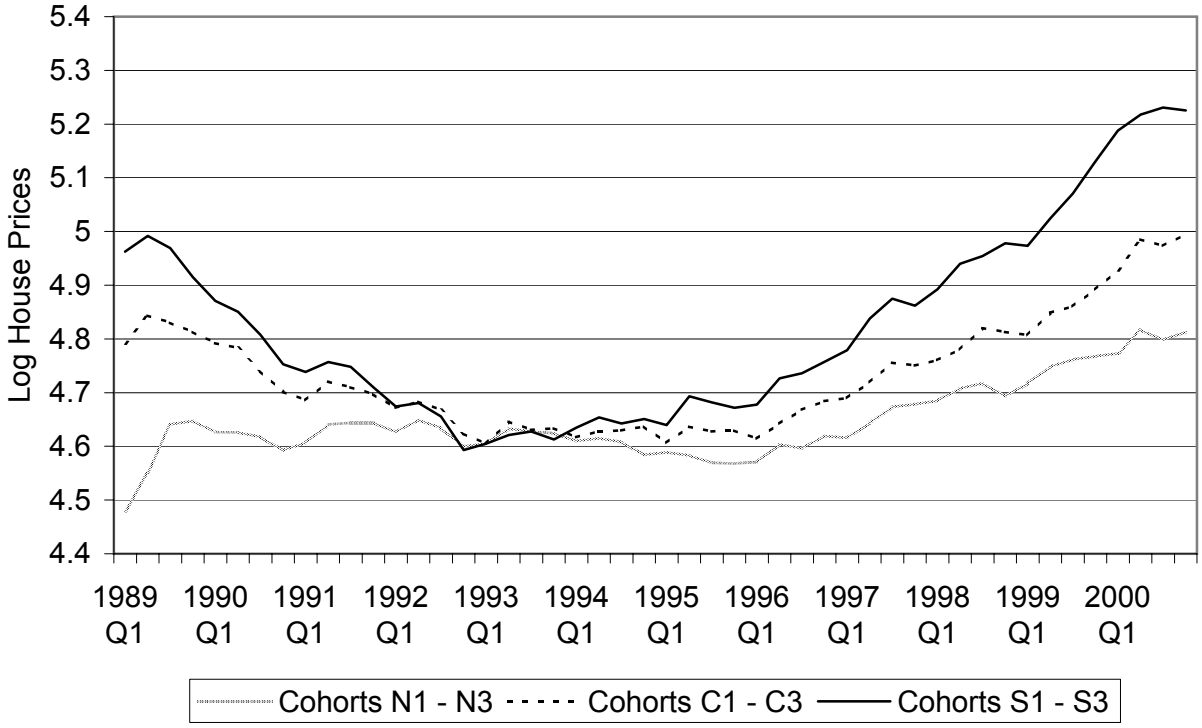
Note to Figure 4: This figure plots the proportion of renters, homeowners with mortgage, and owners outright over the life-cycle for different cohorts. The data is from the UK Family Expenditure Survey for the years 1988 to 2000.

Figure 5: Mortgage Payments Over the Life Cycle



Note to Figure 5: This figure plots annual real mortgage payments over the life-cycle for mortgage holders, and for different cohorts. The data is from the UK Family Expenditure Survey for the years 1988 to 2000.

Figure 6: Regional House Prices in The United Kingdom



Note to Figure 6: This figure shows the evolution of house prices in the three UK regions that we consider: North, Center, and South.
North: Scotland, North West, North East, Yorkshire and Humberside.
Center: East Midlands, West Midlands, Wales, Eastern Anglia.
South: South East, South West, London.

Table 1: Regional Cohort Definition and Cell Size

Cohort	Region	Year of birth	Age in 1988	Age in 2000	Min cell size	Max cell size	Mean cell size
N1	North	1940-1949	39-48	51-60	64	160	99
N2	North	1950-1959	29-38	41-50	82	161	112
N3	North	1960-1969	19-28	31-40	58	209	105
C1	Center	1940-1949	39-48	51-60	53	120	74
C2	Center	1950-1959	29-38	41-50	51	141	79
C3	Center	1960-1969	19-28	31-40	28	159	71
S1	South	1940-1949	39-48	51-60	77	205	113
S2	South	1950-1959	29-38	41-50	94	201	124
S3	South	1960-1969	19-28	31-40	65	286	117

Note to Table 1: This table shows the regional cohort definitions and the cell size. We consider three regions: North, Center and South. North: Scotland, North West, North East, Yorkshire and Humberside. Center: East Midlands, West Midlands, Wales, Eastern Anglia. South: South East, South West, London.

Table 2: Homeowners/Renters Cohort Definition and Cell Size

Cohort	Homeownership	Year of birth	Age in 1988	Age in 2000	Min cell size	Max cell size	Mean cell size
H1	Homeowner	1940-1944	44-48	56-60	69	166	99
R1	Renter	1940-1944	44-48	56-60	18	54	28
H2	Homeowner	1945-1949	39-43	51-55	95	209	127
R2	Renter	1945-1949	39-43	51-55	19	56	31
H3	Homeowner	1950-1954	34-38	46-50	84	185	116
R3	Renter	1950-1954	34-38	46-50	23	51	35
H4	Homeowner	1955-1959	29-33	41-45	91	192	119
R4	Renter	1955-1959	29-33	41-45	22	75	43
H5	Homeowner	1960-1964	24-28	36-40	84	226	115
R5	Renter	1960-1964	24-28	36-40	29	104	55
H6	Homeowner	1965-1969	19-23	31-35	12	206	75
R6	Renter	1965-1969	19-23	31-35	25	118	57

Note to Table 2: This table shows the homeowner/renter cohort definitions and the cell size.

Table 3, Panel A: Cohort Mean Data Summary: Regional Cohorts.

Variable	Mean	Min	Max
North			
Δ ln c $\times$ 100	0.327	-52.377	58.865
Δ ln y $\times$ 100	0.413	-38.768	49.111
Δ ln (mortgage payments)	0.325	-38.604	37.708
Family size	2.564	1.558	3.401
Center			
Δ ln c $\times$ 100	0.386	-44.617	51.261
Δ ln y $\times$ 100	0.332	-51.387	55.881
Δ ln (mortgage payments)	0.453	-32.799	38.689
Family size	2.632	1.521	3.441
South			
Δ ln c $\times$ 100	0.489	-50.052	54.368
Δ ln y $\times$ 100	0.515	-37.129	49.516
Δ ln (mortgage payments)	0.225	-31.136	32.878
Family size	2.511	1.558	3.178

Note to Table 3, Panel A: First differences are all quarterly. Δ ln(Mortgage Payments) is calculated for mortgage holders. Family size is number of adults plus children in the household. This Table shows summary statistics for regional cohorts N, C and S whose definition is shown in Table 1.

Table 3, Panel B: Cohort Mean Data Summary: Homeowners/Renters Cohort Definition.

Variable	Mean	Min	Max
	Renters		
Δ ln c $\times$ 100	-0.485	-54.157	44.901
Δ ln y $\times$ 100	-0.082	-60.956	75.190
Family size	2.314	1.270	3.667
	Homeowners		
Δ ln c $\times$ 100	0.611	-55.743	66.204
Δ ln y $\times$ 100	0.401	-39.140	49.224
Family size	2.547	1.642	3.428

Note to Table 3, Panel B: First differences are all quarterly. Family size is number of adults plus children in the household. This table shows summary statistics for the cohorts of renters and homeowners.

Table 4: Summary Statistics and Correlation Matrix for Cohort Quarterly (Annual) Log House Price Returns

Region	North	Center	South
Mean	1.27 (4.43)	1.23 (3.42)	0.94 (2.84)
St Dev	3.04 (9.11)	3.80 (9.83)	3.59 (10.02)
Min	-3.47 (-5.45)	-4.43 (-11.15)	-6.26 (-16.22)
Max	9.69 (33.95)	14.70 (42.54)	9.83 (21.50)
	Correlation Matrix		
	North	Center	South
North	1.00		
Center	0.62 (0.80)	1.00	
South	0.30 (0.35)	0.72 (0.77)	1.00

Note to Table 4: This table shows summary statistics and correlation between quarterly (annual) house price returns for the three UK regions that we consider: North, Center and South. North: Scotland, North West, North East, Yorkshire and Humberside. Center: East Midlands, West Midlands, Wales, Eastern Anglia. South: South East, South West, London.

Table 5: Regression results for Regional Cohorts

Independent Variable	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Real interest rate	0.097	0.094	0.091	0.092	0.102	0.096	0.096
	(0.029)	(0.030)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
Δ ln y_t	0.466		0.406	0.424	0.414	0.414	0.411
	(0.036)		(0.035)	(0.037)	(0.038)	(0.038)	(0.039)
Δ ln p_t		1.585	1.222	1.218			
		(0.179)	(0.164)	(0.165)			
Δ ln $p_t^{U.K.}$					1.334	1.371	1.381
					(0.184)	(0.184)	(0.185)
Δ ln p_t - Δ ln $p_t^{U.K.}$						0.724	0.716
						(0.313)	(0.314)
Δ $mort_t$							0.015
							(0.039)
Δ own outright				-0.187	-0.135	-0.160	-0.157
				(0.137)	(0.138)	(0.138)	(0.138)
Δ mortgage				-0.092	-0.068	-0.077	-0.075
				(0.078)	(0.078)	(0.079)	(0.079)
Δ Age	-0.112	-0.077	-0.070	-0.075	-0.054	-0.062	-0.062
	(0.045)	(0.049)	(0.043)	(0.044)	(0.044)	(0.044)	(0.044)
Δ Age squared	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Δ Ln Family size	0.135	0.167	0.150	0.150	0.131	0.142	0.142
	(0.049)	(0.053)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
R^2	0.702	0.607	0.707	0.708	0.708	0.708	0.708

Note to table 5: The dependent variable is Δ ln c_t, where c is real non-durable consumption. The independent variables include the real interest rate, quarterly changes in household income, and quarterly changes in house prices, both regional (Δ ln p) and U.K. wide (Δ ln p U.K.). Δ ln p_t - Δ ln $p_t^{U.K.}$ is the difference between regional house price changes and UK wide house price changes. Δ $mort_t$ is the difference in real mortgage payments. Δ own outright (Δ mortgage) is the difference in the proportion of homeowners outright (with a mortgage). The equation was estimated using synthetic cohort techniques and data for the regional cohorts N, C,

and S. All regressions include quarter dummies and cohort dummies (not reported). The standard errors shown in parenthesis are corrected for heteroscedasticity and first order serial correlation.

Table 6: Regression results for cohorts of homeowners and renters

Independent Variable	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Real interest rate	0.072	0.056	0.065	0.067	0.073	0.070
	(0.029)	(0.030)	(0.029)	(0.028)	(0.028)	(0.028)
Δ ln y_t	0.367		0.320	0.333	0.344	0.344
	(0.031)		(0.032)	(0.032)	(0.032)	(0.032)
Δ ln p_t		1.022	0.651	1.673	1.705	1.700
		(0.132)	(0.129)	(0.291)	(0.290)	(0.290)
Δ ln p_t $\times$ Young Homeowner				-0.877	-0.772	-0.676
				(0.367)	(0.369)	(0.373)
Δ ln p_t $\times$ Young Renter				-1.670	-1.694	-1.676
				(0.344)	(0.343)	(0.343)
Δ ln p_t $\times$ Old Renter				-0.931	-0.966	-0.958
				(0.356)	(0.355)	(0.354)
Δ $mort_t$					-0.129	0.007
					(0.061)	(0.098)
Δ $mort_t$ $\times$ Young Homeowner						-0.217
						(0.123)
Δ Age	-0.114	-0.115	-0.108	-0.108	-0.120	-0.110
	(0.052)	(0.055)	(0.051)	(0.051)	(0.051)	(0.051)
Δ Age squared	0.001	0.001	0.001	0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Δ Ln Family size	0.155	0.214	0.160	0.160	0.154	0.152
	(0.037)	(0.039)	(0.037)	(0.037)	(0.036)	(0.036)
R^2	0.603	0.542	0.613	0.622	0.624	0.625

Note to table 6: The dependent variable is Δ ln c_t, where c is real non-durable consumption. The independent variables include the real interest rate, quarterly changes in household income, quarterly changes in house prices (Δ ln p) , quarterly changes in house prices interacted with dummy variables for young homeowners, and young and old renters, and quarterly changes in mortgage payments (Δ m_t), also interacted with a dummy for young homeowner. Young (old) are those younger (older) than forty years of age. The equation was estimated using synthetic cohort techniques and data for the the cohorts of homeowners (H) and renters (R). All regressions include

quarter dummies and cohort dummies (not reported). The standard errors shown in parenthesis are corrected for heteroscedasticity and first order serial correlation.

Table 7: Instrumental Variables Regressions and Wealth Effects for Regional Cohorts

	Instrumental Variables			Wealth Effects		
Independent Variable	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Real interest rate	0.092	0.120	0.129			
	(0.063)	(0.062)	(0.064)			
Δ ln y_t	0.497	0.526	0.549			
	(0.215)	(0.210)	(0.214)			
Δ ln p_t	1.950					
	(0.499)					
Δ ln $p_t^{U.K.}$		2.506	2.451			
		(0.517)	(0.525)			
Δ ln p_t - Δ ln $p_t^{U.K.}$			-0.599			
			(1.008)			
Innov. in real interest rate				0.074	0.080	0.076
				(0.026)	(0.026)	(0.026)
Innov. in income				0.420	0.417	0.416
				(0.036)	(0.037)	(0.037)
Innov. in Δ ln p_t				0.794		
				(0.160)		
Innov. in Δ ln $p_t^{U.K.}$					0.842	0.867
					(0.182)	(0.182)
Innov. in Δ ln p_t - Δ ln $p_t^{U.K.}$						0.585
						(0.293)

Note to table 7: In specifications (i) through (iii) the dependent variable is Δ ln c_t, where c is real non-durable consumption. The independent variables include the real interest rate, quarterly changes in household income, and quarterly changes in house prices, both regional (Δ ln p) and U.K. wide (Δ ln p U.K.). Δ ln p_t - Δ ln $p_t^{U.K.}$ is the difference between regional house price changes and UK wide house price changes. The regressions include changes in age, age squared, changes in family size, quarter dummies and cohort dummies (not reported). The equation was estimated using synthetic cohort techniques and instrumental variables. The instruments used were the second lag of changes in non-durable consumption, income, regional and U.K. wide

house prices, the second lags of nominal interest rates and inflation, and the second lag of changes in family size. In specifications (iv) through (vi) the independent variables are the innovations in income, house prices and real interest rate obtained as the residual of the first stage regressions in the IV estimation. The standard errors are corrected for heteroscedasticity and first-order serial correlation.

Table 8: Instrumental Variables Regressions and Wealth Effects for Cohorts of Homeowners and Renters

	Instrumental Variables				Wealth Effects		
Independent Variable	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Real interest rate	0.171	0.183	0.120	0.126			
	(0.065)	(0.065)	(0.069)	(0.069)			
Δ ln y_t	0.331	0.392	0.369	0.377			
	(0.122)	(0.122)	(0.121)	(0.122)			
Δ ln p_t	1.573	3.280	4.164	4.139			
	(0.731)	(0.916)	(0.974)	(0.974)			
Δ ln p_t $\times$ Young Owner		-1.353	-1.354	-1.415			
		(0.872)	(0.868)	(0.871)			
Δ ln p_t $\times$ Young Renter		-2.719	-2.791	-2.728			
		(0.825)	(0.821)	(0.825)			
Δ ln p_t $\times$ Old Renter		-2.256	-2.377	-2.363			
		(0.832)	(0.829)	(0.829)			
Δ $mort_t$			-0.669	-0.455			
			(0.260)	(0.363)			
Δ $mort_t$ $\times$ Young Owner				-0.342			
				(0.406)			
Innov. in real interest rate					0.049	0.053	0.056
					(0.028)	(0.028)	(0.028
Innov. in income					0.349	0.350	0.355
					(0.033)	(0.033)	(0.034
Innov. in Δ ln p_t					0.519	1.108	1.112
					(0.129)	(0.325)	(0.328
Innov. in Δ ln p_t $\times$ Young Homeowner						-0.463	-0.348
						(0.416)	(0.429
Innov. in Δ ln p_t $\times$ Young Renter						-1.097	-1.10
						(0.388)	(0.390
Innov. in Δ ln p_t $\times$ Old Renter						-0.403	-0.41
						(0.396)	(0.399
Innov. in Δ $mort_t$							-0.010
							(0.095
Innov. In Δ $mort_t$ $\times$ Young Homeowner							-0.098
							(0.126

Note to table 8: In specifications (i) through (iv) the dependent variable is Δ ln c_t, where c is real non-durable consumption. The independent variables include the real interest rate, quarterly changes in household income, quarterly changes in house prices (Δ ln p), quarterly changes in house prices interacted with dummies for young homeowner, and young and old renter, quarterly changes in mortgage payments (Δ $mort_t$), also interacted with dummy for young homeowner. The regressions include changes in age, age squared, changes in family size, quarter dummies and cohort dummies (not reported). The equation was estimated using synthetic cohort techniques and instrumental variables. The instruments used were the second lag of changes in non-durable consumption, income, regional and U.K. wide house prices, the second lags of nominal interest rates and inflation, and the second lag of changes in family size. In specifications (v) through (vii) the independent variables are the innovations in income, house prices and real interest rate obtained as the residual of the first stage regressions in the IV estimation. The standard errors are corrected for heteroscedasticity and first-order serial correlation.

Table 9: Endogeneity of Homewoners and Renters: Regression results.

Independent Variable	(i)	(ii)	(iii)
Real interest rate	0.070	0.076	0.075
	(0.028)	(0.028)	(0.027)
Δ ln y_t	0.344	0.360	0.371
	(0.032)	(0.032)	(0.032)
Δ ln p_t	1.700	1.705	1.652
	(0.290)	(0.292)	(0.283)
Δ ln p_t $\times$ Young Homeowner	-0.676	-0.636	-0.631
	(0.373)	(0.368)	(0.358)
Δ ln p_t $\times$ Young Renter	-1.676	-1.827	-1.655
	(0.343)	(0.339)	(0.336)
Δ ln p_t $\times$ Old Renter	-0.958	-1.097	-1.078
	(0.354)	(0.354)	(0.345)
Δ $mort_t$	0.007	0.015	0.014
	(0.098)	(0.098)	(0.095)
Δ $mort_t$ $\times$ Young Homeowner	-0.217	-0.175	-0.179
	(0.123)	(0.122)	(0.119)
Δ Age	-0.110	-0.105	-0.089
	(0.051)	(0.051)	(0.051)
Δ Age squared	0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)
Δ Ln Family size	0.152	0.165	0.178
	(0.036)	(0.036)	(0.036)
R^2	0.625	0.613	0.635

Note to table 9: The dependent variable is Δ ln c_t, where c is real non-durable consumption. The independent variables include the real interest rate, quarterly changes in household income, quarterly changes in house prices (Δ ln p) , quarterly changes in house prices interacted with dummy variables for young homeowners, and young and old renters, and quarterly changes in mortgage payments (Δ m_t), also interacted with a dummy for young homeowner. Young (old) are those younger (older) than forty years of age. The equation was estimated using synthetic cohort techniques and data for the the cohorts of homeowners (H) and renters (R). The

columns differ in the way the cohorts of homeowners and renters are defined. In (i) homewoners (and renters) in quarter t are those who reported being homeowners (renters) in quarter t. In (ii) homeowners (and renters) are those who reported being homeowners (and renters) in quarter t and who reported living at the current address for at least six months. In (iii) homeowners (and renters) are those who reported being homeowners (and renters) in quarter t and who reported living at the current address for at least six months. In addition in (iii) we classify as renters those who reported being homeowners who live at the present address for less than six months and who are younger than thirty-two years of age. All regressions include quarter dummies and cohort dummies (not reported). The standard errors shown in parenthesis are corrected for heteroscedasticity and first order serial correlation.

Table 10, Panel A: Endogeneity of Homewoners and Renters: IV regressions.

Independent Variable	(i)	(ii)	(iii)
Real interest rate	0.120	0.137	0.117
	(0.069)	(0.076)	(0.073)
Δ ln y_t	0.369	0.354	0.391
	(0.121)	(0.118)	(0.125)
Δ ln p_t	4.164	3.822	3.533
	(0.974)	(0.919)	(0.927)
Δ ln p_t $\times$ Young Homeowner	-1.354	-1.136	-1.198
	(0.868)	(0.868)	(0.872)
Δ ln p_t $\times$ Young Renter	-2.791	-2.982	-2.635
	(0.821)	(0.821)	(0.839)
Δ ln p_t $\times$ Old Renter	-2.377	-2.344	-2.372
	(0.829)	(0.832)	(0.838)
Δ $mort_t$	-0.669	-0.483	-0.488
	(0.260)	(0.330)	(0.330)

Table 10, Panel B: Endogeneity of Homewoners and Renters: Wealth Effects.

Independent Variable	(iv)	(v)	(vi)
Innov. in real int. rate	0.056	0.062	0.062
	(0.028)	(0.028)	(0.028)
Innov. in income	0.355	0.379	0.390
	(0.034)	(0.035)	(0.034)
Innov. in Δ ln p_t	1.112	1.076	1.068
	(0.328)	(0.331)	(0.321)
In. in Δln$p_t$$\times$Young Homeowner	-0.348	-0.264	-0.277
	(0.429)	(0.430)	(0.417)
In. in Δln$p_t$$\times$Young Renter	-1.107	-1.211	-1.057
	(0.390)	(0.387)	(0.379)
In. in Δln$p_t$$\times$Old Renter	-0.411	-0.563	-0.559
	(0.399)	(0.402)	(0.390)
In. in $\Delta mort_t$	-0.010	0.023	0.024
	(0.095)	(0.094)	(0.091)
In. In $\Delta mort_t$$\times$Young Homeowner	-0.098	-0.117	-0.133
	(0.126)	(0.126)	(0.122)

Note to table 10: In specifications (i) through (iii) the dependent variable is Δ ln c_t, where c is real non-durable consumption. The independent variables include the real interest rate, quarterly changes in household income, quarterly changes in house prices (Δ ln p), quarterly changes in house prices interacted with dummies for young homeowner, and young and old renter, quarterly changes in mortgage payments (Δ $mort_t$). The regressions include changes in age, age squared, changes in family size, quarter dummies and cohort dummies (not reported). The equations were estimated using synthetic cohort techniques and instrumental variables. The instruments used were the second lag of changes in non-durable consumption, income, house prices, mortgage payments, the second lag of nominal interest rates and inflation, and the second lag of changes in family size. In columns (iv) through (vi) the dependent variable is innovations in Δ ln c_t, where c is real non-durable consumption. The independent variables are the innovations in income, house prices, real interest rate, and real mortgage payments obtained as the residual of the first stage regressions in the IV estimation. The columns differ in the way the cohorts of homeowners and renters are defined. In (i) and (iv) homewoners (and renters) in quarter t are those who reported being homeowners (renters) in quarter t. In (ii) and (v) homeowners (and renters) are those who reported being homeowners (and renters) in quarter t and who reported living at the current address for at least six months. In (iii) and (vi) homeowners (and renters) are those who reported being homeowners (and renters) in quarter t and who reported living at the current address for at least six months. In addition in (iii) and (vi) we classify as renters those who reported being homeowners who live at the present address for less than six months and who are younger than thirty-two years of age. Standard errors are shown in parenthesis. The standard errors are corrected for first order serial correlation and heteroscedasticity.