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DO HOUSE PRICES AFFECT CONSUMPTION? A COMPARISON EXERCISE

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Do House Prices Affect Consumption? A Comparison Exercise[*,†]

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Abstract

This paper undertakes a comparison exercise to disentangle what drives the opposite findings regarding the effect of house prices on consumption documented in two papers using the same data set for the UK. On the one hand, Campbell and Cocco (2007) find that old owners are the most benefited by a house price increase and young renters the least, confirming the so-called *wealth hypothesis*. On the other hand, Attanasio, Blow, Hamilton, and Leicester (2009) find that house prices have the same impact on consumption across age groups, consistent with the so-called *common factor hypothesis*. We rule out that changes in the sample period, the definition of consumption, the data source, the type of price deflator, and empirical considerations such as endogeneity bias and sampling noise in the construction of synthetic cohorts are the driving factors of the opposite conclusions reached by the two papers. All our evidence points towards the empirical specification, i.e., whether it is a consumption function (an equation for the level of consumption) or an Euler equation (an equation for consumption growth) as the only plausible explanation to the conflicting results. Our findings revive the debate of whether there is an effect of house prices on consumption, an issue of increasing importance in the current context of declining house prices in industrialized countries.

JEL Classification: D13.
Keywords: Consumption, House prices, Wealth Hypothesis, Common Factor Hypothesis.

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"One should remember that professional and public perceptions of facts do not in the end rest solely on the validity of one particular empirical study. Any alleged fact that affects the way that we think about a phenomenon will be hardened diamond-like by the heat and pressure of repeated empirical examination before it becomes background to our beliefs about how the world works...it is crucial that as a profession we ensure that replication, or at least fear of replication, is our norm" (page 13 in Hamermesh (2007)).

1 Introduction

This paper looks at the validity of the wealth and the common factor hypotheses as alternative explanations to the relationship between changes in house prices and consumption in the UK. The wealth hypothesis suggests that rising house prices stimulate consumption by increasing households' perceived wealth. In contrast, the common factor hypothesis supports the fact that both, rises in house prices and consumption, are driven by common factors. Housing is the dominant component of wealth for the typical household in the United Kingdom. Banks and Tanner (2002) report that real estate accounted for 35% of aggregate household wealth in the UK in the mid 1990s, and more recent estimates suggest that in 2006-08 this figure rose to 39% (e.g., ONS 2009). Moreover, house prices also exhibit high levels of volatility, especially in the UK. Nominal house prices ranged from -10% to 30% between 1988 and 2000 (e.g., Campbell and Cocco 2007). In the last economic crisis, nominal house prices in the UK fell by 20.5% between October 2007 and February 2009, and following a short recovery, they have been declining again since July 2010. In January 2011 they are still 13% lower than in October 2007 (www.nationwide.co.uk). Understanding whether house prices affect consumption, and if so, the nature of this relationship, is therefore crucially important.

Using the UK Family Expenditure Survey (UK FES) we undertake a comparison exercise of two influential papers which, although posing a common research question, end up reaching opposite conclusions. On the one hand, Campbell and Cocco (2007) (CC thereafter) compare individuals across different age-homeownership status groups, and find that homeowners (especially old age homeowners) are advantaged by a rise in house prices. The authors interpret this result as supporting evidence for the wealth hypothesis because owners are more likely to benefit by a house price increase, particularly old age homeowners who are likely to have higher home values.[1] On the other hand, Attanasio, Blow, Hamilton, and Leicester (2009) (ABHL thereafter) find that house prices do not help much in explaining consumption and, in any case, have the same impact on consumption across age groups and homeownership status groups. According to these authors these findings suffice to discard the wealth channel hypothesis in favor of the common factor hypothesis. Moreover, ABHL find that the effect of house price growth on consumption does differ across age groups but it is the young that benefit most in this case, again contrary to the wealth hypothesis. ABHL conclude that the co-movement of house prices and consumption is likely to be caused by the productivity growth and that the longer life horizon of the young explains why they can consume relatively more out of a house price surge.

What is intriguing of this debate is that these somehow contradictory results regard the same country, the UK, are based on the same data set, the UK Family Expenditure Survey (FES), and are intended to be approximations to two different features of the same lifecycle model of consumption decisions.. However, although both papers test the same underlying theory, their methodologies are remarkably different. Some immediately acknowledgeable and potentially relevant differences relate to the time period investigated (CC's analysis spans from 1988 to 2001, considering the post-financial-liberalization years only, while ABHL's analysis includes all years from 1978 onwards), the type of expenditure considered (total non-housing in ABHL, non-durable in CC), the inclusion or otherwise of income and interest rate in the analysis, and the way in which the price deflator is constructed. More importantly, while CC compare groups of individuals of different ages and homeownership status simultaneously, ABHL draw their conclusions by focusing mainly on the age dimension.

Our comparison strategy starts from one paper's specification and results, and applies the necessary changes to ultimately arrive to the other paper's specification and results. We show that ABHL's findings regarding the effect of house prices on the consumption of older and younger households are robust to changes in the sample period, changes in the definition of consumption, and changes in the data source (both, price data and expenditure data). Moreover, although the magnitude of ABHL's coefficients is sensitive to the type of deflator used, the qualitative implications remain unchanged. Results from comparing the effect of house prices on the consumption of age-homeownership groups using ABHL's specification seem also consistent with the common factor hypothesis. In this case, although old owners are the group displaying

[1] Although not explicitly discussed, increased house prices can also impact total expenditure through improved collateral rather than directly (e.g., Browning, Gortz, and Leth-Petersen 2011).

the highest elasticity of consumption to house prices, the size of the elasticity is still much lower than the size estimated by CC and the differences between the age-homeownership groups remain economically small.

In turn, we find that the common factor hypothesis as proposed by ABHL is supported across a variety of specifications, whereas the wealth hypothesis as proposed by CC is only supported when an Euler Equation specification is estimated with synthetic-cohort level data as in CC. We further rule out that endogeneity bias arising from constructing synthetic cohorts on the basis of home ownership status as in CC is the cause of the different results found in the two papers. In fact, results from estimating an Euler equation specification on synthetic-cohort level data constructed on the basis of age, rather than age and homeownership as in CC, reveal that estimating an Euler equation yields results consistent with the wealth hypothesis, regardless of how synthetic cohorts are constructed. All our evidence points towards the empirical specification, i.e., whether it is a consumption function (an equation for the level of consumption) or an Euler equation (an equation for consumption growth) as the only plausible explanation to the conflicting results.

Our paper highlights the importance of replication in empirical economic research (see Dewald, Thursby, and Anderson 1986, Hamermesh 2007) and contributes to a vivid and ongoing debate in the literature about the effect of house prices on consumption. ABHL's results in favor of the common causality hypothesis confirm the results previously found by one of the authors when looking at an earlier period in the UK (see Attanasio and Weber 1994), but contrast with evidence using a different micro data for the UK suggesting an average marginal propensity to consume out of housing wealth of between 0.01 and 0.03 (see Disney, Gathergood, and Henley 2010). CC's findings in support of the wealth hypothesis add to a series of recent papers that use aggregate data on house prices and consumption (e.g., Case, Quigley, and Shiller 2001, Ludwig and Slok 2004, Slacalek 2009), and support the suggestion by Muellbauer and Murphy (1990) and discussed by Pagano (1990) and King (1990) that the boom in UK's consumption was due to a wealth effect from increased real house prices subsequent the financial liberalization that took place in the late 1980s in the UK. By being able to replicate both sets of results using the same micro evidence we are able to disentangle the strength and weaknesses of both hypotheses.

The paper is organized as follows. Section 2 describes our comparison exercise. Section 3 presents our main results and Section 4 concludes.

2 Empirical Strategy

Our comparison strategy starts from one paper's specification and results, and applies the necessary changes to arrive to the other paper's specification and ultimately the other paper's results. Our exercise focuses on the benchmark regression results for homeownership cohorts presented in Column (iv) of Table 4 (page 604 in Campbell and Cocco (2007)) and on the results presented in Column (III) of Table A.2 (pages 45-46 in Attanasio, Blow, Hamilton, and Leicester (2009)). Table 1 outlines the main differences between the two papers and provides a guidance to our comparison strategy. Table 1 can be read from left to right (from CC's results to ABHL's results) or from right to left (from ABHL's results to CC's results). For expositional purposes, we choose to present the comparison exercise as going from ABHL's results to CC's results.

ABHLs framework is based on a simple version of the life-cycle model, where household consumption (in levels) in each period is given by a fraction of lifetime wealth that depends only on age so that:

$$X_t = \kappa(age) W \exp(\varepsilon_t) \tag{1}$$

where where X_t is the household consumption expenditure at time t, W is the households lifetime wealth and ε_t is a residual term. W includes human wealth (discounted lifetime earnings), net financial wealth, pension and housing wealth. The function $\kappa(age)$ captures several factors, including the age composition of the household (and therefore the distance from the end of their lives), changes in household needs and changes in discount factors (which could be induced by changes in the probability of death). They capture some of these factors using observable variables (such as family size and composition), while they proxy others with a flexible function of age. Variation between different cohorts non-housing lifetime wealth is captured by cohort dummies. As ABHL concede, Equation 1 should be interpreted as only an approximation given that it is typically impossible to obtain a closed-form solution for consumption from a standard life-cycle model except under very strong and unattractive assumptions (such as quadratic utility).

Table 1: Empirical strategy step by step

		ABHL	CC
Step 1	Time Period	1978-2001	1988-2000
Step 2	Year-of-birth of the head cut-off	1905-1976	1940-1969
Step 3	Definition of age groups	old people: ≥ 60 years of age	old people: > 40 years of age
		young people: < 35 years of age	young people: ≤ 40 years of age
		middle age: between 35 and 59 years of age	n/a
Step 4	Nominal Regional house price data	Government	Nationwide
Step 5	Definition of consumption	Non housing	Non durable
	FES Data source	IFS version	UKDA version
Step 6	Price deflator data	National rpix	Household specific (CC's calculation)
	Real consumption and income	No adjustment for tails	Adjustment for tails
Step 7	Testing hypothesis	Age groups	Age-homeownership groups
Step 8	Empirical specification	Life-cycle model	Euler Equation
8.1	Covariates:		
	family size	no	yes
	socio-economic dummies	yes	no
	real interest rate	no	yes
	real total income	no	yes
8.2	Data Structure	Household level data	Synthetic age-homeownership cohorts
8.3	Estimation method	Pooled OLS	Panel (random effects)

Notes: Each row in this table highlights the differences between the two papers and the order of the steps we take to move from ABHLs to CCs specification and results. For example step 1 in row 1 indicates how the the time period is changed from being 1978-2001 as in ABHL to being 1988-2000 as in CC, so that after implementing the changes from steps 1 to 8, we arrive from ABHLs to CCs specification and results.

Once the level of regional house prices (h_t^r) are included in the regression, and after some manipulation of Equation 1, the final specification estimated by ABHL (Equation 6 in page 32 of ABHL) becomes:[2]

$$\ln X_t^{ch} = \alpha_c + f(age^c) + \gamma' z_t^{ch} + +\theta_Y h_t^r DY_t^{ch} + \theta_M h_t^r DM_t^{ch} + \theta_O h_t^r DO_t^{ch} + \varepsilon_t^c + \mu_t^{ch} \qquad (2)$$

where the superscripts ch denote household h belonging to cohort c, and μ_t^{ch} is the householdś deviation from the cohort average. By observing several cohorts over a long period of time, it is assumed that the consumption innovations ε_t^c average out to zero over time. Given appropriate normalization of the coefficients, the average (log) lifetime wealth of households belonging to cohort c is α_c. The vector z includes socio-economic characteristics at the household level, e.g. family size and composition as described below in step 8, that capture some of the age and other effects on consumption. The dummies DY, DM and DO indicate the age group to which the household belongs. As ABHL note, the coefficients on house prices cannot be interpreted as the causal effect of house prices on consumption, as they may also reflect common factors. Instead, by comparing the coefficients across age groups, they make the identifying assumption that, if house prices capture the direct wealth effect, the coefficient would be expected to be larger for older consumers, who have higher rates of homeownership. In contrast, if house prices capture differences in economic activity, and in particular expected future income, the effect would be greater for younger consumers, who stand to gain the most. In some specification, ABHL compare the effect for homeowners and renters, where age dummies are replaced by ones for tenure status.

Step 1 in our comparison exercise modifies ABHL's original specification and restricts the sample period of their analysis from 1978 until 2001 to the same period used by CC from 1988 until 2000. The longer period could be problematic on two fronts. First, the UK underwent a phase of financial liberalization after 1988 and second, the FES changed methodology in 2001. Thus, part of the explanation to both papers obtaining different results could lie the different

[2] In particular, taking logs, incorporating observable variables (vector z), and using a polynomial in age (function f), Equation 1 becomes $\ln X_t = f(age) + \gamma' z + \ln W + \varepsilon_t$. Although the FES is not a panel data set, the long time span makes it possible to take advantage of the cohort variation in the data to estimate a consumption profile for each cohort. By averaging over birth cohort c and estimating it using individual data as opposed to average cohort data, the specification ABHL use is given by: $\ln X_t^{ch} = \alpha_c + f(age^c) + \gamma' z_t^{ch} + \varepsilon_t^c + \mu_t^{ch}$, where the superscripts ch denote household h belonging to cohort c.

periods considered. By restricting the time span we lose the two oldest cohorts, i.e., those born before 1915.

Step 2 restricts the households in ABHL's sample to those whose head is born between 1940 and 1969, as in CC. Here, we additionally lose the five oldest cohorts (cohorts born between 1915 and 1945) and the two youngest cohorts (cohorts born between 1970 and 1979). More importantly, loosing the oldest cohorts means loosing one of the age categories considered by ABHL (the so-called "old").

Step 3 then redefines the age groups in ABHL's. The cut-off age between young and old (or middle aged, according to ABHL categories) becomes 40 as in CC, rather than 35 as in ABHL. Thus, young individuals are those less than 41 years old, and old individuals are those individuals older than 40 years old.

In step 4 we replace the quarterly Government regional house price data used by ABHL with the quarterly Nationwide regional house price data used by CC[3]. Both ABHL and CC use mix-adjusted house prices, i.e. prices adjusted for the type of dwellings purchased so that the series is more informative than a simple house price average; moreover, CC specifically uses an index of house prices with base 1993, quarter 1=100. In 1993 the source of the Government data changed from leading building societies to all mortgage lenders. This change determined a gap between house prices recorded by Nationwide and those recorded by the Government agency and from the early nineties the former are consistently lower in value. Thus, a different measure of house prices might be also part of the explanation as to why the two papers reach different conclusions.

In step 5 we change ABHL's definition of consumption from non-housing consumption to non-durable consumption, as in CC's. Non-housing consumption in ABHL is constructed by adding up all expenditure from FES except expenditure on rents, mortgage payments, local taxes, water charges, and housing repairs and maintenance. We redefine consumption to be non-durable consumption defined as in CC, which is constructed as the sum over the following expenditure items: food, alcohol, tobacco, fuel, household services, clothing, personal goods and

[3]Both ABHL and CC exclude Northern Ireland and consider 11 Standard Statistical Regions (SSR) labeled as follows: 1 = Northern England 2 = Yorkshire and the Humbria 3 = North West England 4 = East Midlands 5 = West Midlands 6 = East Anglia 7 = Greater London 8 = South East England (exc. Greater London) 9 = South West England 10 = Wales 11 = Scotland. Both Government and Nationwide data can be freely downloaded from http://www.communities.gov.uk/index.asp?id=1156110 and www.nationwide.co.uk/hpi/regions.htm. Notice that quarterly regional Government data (Table 591 and Table 508) are available only for the new Government Office Regions (GOR) which differ from the old SSR available in FES; moreover, for some of these regions, the relevant series is not available prior 1992 and has to be extrapolated.

services, public transport, leisure services. The two definitions of consumption are inherently different. Non-housing consumption includes some forms of durable consumption which non-durable consumption does not. While the use of non durable consumption is coherent with the assumption of intertemporal separability used to derive Euler equations, from a theoretical and practical perspective, it is not clear in the literature that durable consumption should be used in a life-cycle model. The investment aspect of durable goods might make the behavior of durable consumption different from non-durable consumption over the life-cycle. It is also unclear how to assign consumption of durable goods from expenditure data. Differences in the expenditure categories included in each paper can thus certainly account for the different results.

In this step we also move from the IFS version of FES, used by ABHL, to the UK Data Archive public version of FES, used by CC. This change of dataset is necessary because the dataset used by ABHL is extracted from the IFS harmonized version of the FES original raw data and provides a slightly different definition of household income and some expenditure items, which would affect the measure of non durable consumption and the household specific price deflator to be defined below. It also comprises a somewhat higher number of observations.

In Step 6 we change the price deflator. ABHL use the publicly available national retail price index excluding housing (RPIX) while CC use a household specific price deflator. Because the price deflator affects all the real variables used in the analysis, except for the real interest rate which is deflated using RPI as in CC, it is a potential explanation to the different results obtained in these two papers. We use the household specific price deflator to calculate real consumption, real income, and real house prices. Following CC, the household specific price deflator pd_i is a standard Stone price index, computed as a weighted average of the retail price indices corresponding to the expenditure groups, where the weights are the shares of the expenditure groups in the household overall non durable expenditure. In particular, let e_{sh} be household h expenditure for the expenditure group s, and p_s be the corresponding retail price index, then pd_h is computed as follows:

$$pd_h = \sum_{s=1}^{S} \alpha_{sh} \cdot p_s \tag{3}$$

where S is the number of expenditure groups and $\alpha_{sh} = e_{sh} / \sum_{s=1}^{S} e_{sh}$.

In Step 7 we move to a specification that includes age-homeownership interactions, as in CC, but maintains ABHL's specification in Equation 2. Comparing average effects across either the age dimension or the homeownership status dimension separately, as ABHL do, may indeed hide the true effect of house prices on consumption. For example, the true effect of house prices on consumption may be positive for old and young owners and negative for old and young renters. Under this scenario the average effect of house prices on consumption by age group is likely to be negligible for both age groups, young and old. Thus, we might be tempted to conclude that house prices have no effect on consumption, and if anything, this effect is the same across age groups. These average effects would however be hiding a differential effect across homeownership status within each age group.[4] Nonetheless, age and homeownership are very different variables in nature. An individual can choose whether to buy or not to buy a house, but he or she cannot choose his or her age. It is not the goal of this paper to deal with these endogeneity issues beyond for purposes of the comparison exercise. CC's paper recognizes this potential limitation and the authors devote much of the paper to deal with it in several ways. To the extent that CC's analysis and main findings stem from and provide strong support for their paper's benchmark specification used in our comparison exercise, it is still a very valuable exercise to look at the robustness of this rather parsimonious specification.

In step 8 we change the empirical specification to that of CC's. This step involves changing the list of covariates included in the analysis, the data structure (synthetic cohorts rather than household level data), and the functional form (an Euler equation estimated by a GLS random-effects model with AR(1) disturbances as in CC rather than a reduced form life-cycle model estimated in levels as a pooled OLS regression as in ABHL). CC's baseline regression consists of regressing changes in consumption on changes in house prices, controlling for household income, leverage, and other demographic variables, for cohorts of homeowners and renters. In particular, they estimate the following based on an Euler equation (Equation 3 in CC page 600):

$$\triangle c_{i,t+1} = \beta_0 + \beta_1 r_{t+1} + \beta_2 \triangle y_{i,t+1} + \beta_3 \triangle p_{t+1} + \beta_4 \triangle z_{i,t+1} + \varepsilon_{i,t+1} \tag{4}$$

where the subscript i denotes cohort, r_{t+1} is the real interest rate between periods t and $t+1$,

[4] A similar point is made in Hryshko, Luengo-Prado, and Sorensen (2010), who find that the consumption drop upon the arrival of a negative income shock is lower in the presence of house-price appreciation, albeit only for homeowners. These authors interpret these findings as a wealth or collateral effect from increased house prices for owners. They also find that increases in house prices have a positive effect on the consumption of owners and renters in the US, and justify the direct effect of house prices on the consumption of renters as being the result of house prices being correlated with income or expectations of future income.

$\triangle c_{i,t+1} = \ln c_{i,t+1} - \ln c_{i,t}$ is real non-durable consumption growth, $\triangle y_{i,t+1} = \ln y_{i,t+1} - \ln y_{i,t}$ is real income growth, $\triangle p_{i,t+1} = \ln p_{i,t+1} - \ln p_{i,t}$ is real house price growth, and $Z_{i,t+1}$ is a vector of cohort characteristics which includes demographic variables.

It is generally argued that the level of real income should not be an explanatory variable in the reduced form of the life-cycle equation used in ABHL, as the deterministic part of the income is already captured by the constant term and the innovations to permanent income as well as transitory shocks to current income are part of the residuals (see Attanasio, Blow, Hamilton, and Leicester 2009). Similarly, measures of income are usually only included in Euler equations as part of an "excess sensitivity" test to approximate the variance (and possible higher order moments) of consumption growth (see Carroll 2001), which enters the log linear Euler equation when the approximation used is a second order Taylor expansion (see Ludvigson and Paxson 2001). Here we follow CC specification and include the real household income as an additional control, calculated as gross current income of the head plus gross current income of wife as defined in CC. It is worth noting that the empirical error term in the Euler Equation will contain expectational errors (see Attanasio and Weber 1993) or p.634 or section 3.1 of Carroll (2001). This means any uncertain variables (income growth, house price growth, the interest rate) are endogenous and need to be instrumented for (generally with at least two lags). This is indeed what CC do with respect to income. Because our aim is to see whether the most parsimonious results in CC can be replicated, we do not pursue this any further.

We also include the real interest rate and compute it, as in CC, on the basis of the Bank of England base nominal interest and ex-post RPI inflation[5]. We also exclude demographic and socio-economic characteristics as controls (number of children in the household, number of adults, a dummy for the presence of two or more adults, education dummies, occupation dummies, a polynomial of age up to the power of five, region dummies, and monthly dummies). These covariates are an essential part of the reduced form life-cycle model but not of the Euler equation model. Instead, following CC's specification, we include the log of household size, a quadratic function of age and quarter dummies. We also use birth-homeownership cohort dummies as opposed to birth cohort dummies.

The construction of cohorts on the basis of age-homeownership used by CC may be problematic because of the endogeneity of the homeownership status. This endogenous selection

[5] RPI is the quarterly retail price index. Results are not substantially different if inflation is computed using the quarterly retail price index excluding housing.

implies that synthetic cohorts constructed this way are not a random draw of the population survey which leads to biased estimators (e.g., Browning, Deaton, and Irish 1985, Deaton 1985). Thus, the data structure may also explain the different results by the two papers. Similarly, the functional forms used in each paper are very different from a theoretical point of view. The Euler equation and the reduced form life-cycle model stem from the same permanent income hypothesis, according to which agents maximize their life time utility conditional on current resources and the information on the evolution of incomes and interest rates. However, the Euler equation estimated by CC is the standard log linearized first order condition of the intertemporal utility maximization derived on the assumption of an iso-elastic and additively separable utility function. Hence it is not a consumption function but an equilibrium condition. By contrast, the reduced form equation estimated by ABHL is a consumption function that accords with a simple life-cycle model, in that households are assumed to consume, in each period, a fraction of their lifetime wealth. This approach is essentially a way to approximate the consumption function when a closed form solution is not possible.[6]

3 Empirical Results

Table 2 shows results for each of the steps described in Section 2. Column *ABHL* replicates ABHL results, and columns 1-7 undertake each of the changes to ABHL's specification described in Table 1 to arrive to CC's results in Column *CC*. As in Table 1, Table 2 can be read from left to right (from ABHL's results in Column *ABHL* to CC's results in Column *CC*) or from right to left (from CC's results in Column *CC* to ABHL's results in Column *ABHL*).

Column *ABHL* reproduces ABHLs results. Although the level of house prices explains consumption over the life-cycle, the coefficients are remarkably similar for the three age groups considered. The elasticity of non-housing consumption to house prices is 0.16% for all groups, and the differences are not statistically significant at standard levels. ABHL's results are thus inconsistent with the wealth hypothesis and the authors conclude by saying that "on average over the past twenty-five years, these [collateral and wealth channel] effects have been smaller than the common causality channel" (see page 43, second paragraph in Attanasio, Blow, Hamilton,

[6]Since a closed form solution is possible only for very special and unrealistic preferences (it is not admitted, for example, in the largely used iso-elastic utility functions), one has to turn either to the Euler equation (CC's choice) or to an approximation of the consumption function (ABHL's choice). A further alternative would be to use numerical methods and simulations (see Attanasio and Weber 2010).

TABLE 2: Comparison of ABHL and CC's Results

	[*ABHL*]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[*CC*]
Log house price (old)	0.165***	0.168***	0.000	0.199***	0.181***	0.113***	0.349***		
	(0.01)	(0.02)	(0.00)	(0.02)	(0.02)	(0.02)	(0.01)		
Log house price (young)	0.161***	0.166***	0.198***	0.198***	0.181***	0.117***	0.353***		
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)		
Log house price (middle)	0.163***	0.166***	0.198***						
	(0.01)	(0.01)	(0.02)						
Log house price (old owners)								0.360***	
								(0.01)	
Log house price (young owners)								–0.001	
								(0.00)	
Log house price (old renters)								–0.034***	
								(0.00)	
Log house price (young renters)								–0.014***	
								(0.00)	
Δ Log house price (old owners)									1.673***
									(0.29)
Δ Log house price (young owners)									–0.890**
									(0.37)
Δ Log house price (old renters)									–0.949***
									(0.35)
Δ Log house price (young renters)									–1.673***
									(0.34)
Δ Log total household income									0.331***
									(0.03)
Real Interest rate									0.068**
									(0.03)
Birth cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Occupation dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Monthly dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Birth-homownership cohort dummies	No	No	No	No	No	No	No	No	Yes
Quarter dummies	No	No	No	No	No	No	No	No	Yes
R sq.	0.51	0.49	0.43	0.43	0.43	0.23	0.24	0.25	
N	149484	77723	47206	47206	47206	46797	46797	46797	624

Notes: The specifications in each column are described in Section 2. Column *ABHL* replicates ABHL results by estimating $\ln X_t^{ch} = \alpha_c + f(age^c) + \gamma' z_t^{ch} + +\theta_Y h_t^r DY_t^{ch} + \theta_M h_t^r DM_t^{ch} + \theta_O h_t^r DO_t^{ch} + \varepsilon_t^c + \mu_t^{ch}$, where the superscripts ch denote household h belonging to cohort c, and μ_t^{ch} is the households deviation from the cohort average and ε_t^c average out to zero. α_c are cohort fixed effects, and the vector vector z includes socio-economic characteristics at the household level. The dummies DY, DM and DO indicate the age group to which the household belongs. Column 1 changes the time period from 1978-2001 s in ABHL to 1988-2000 as in CC. Column 2 changes the restriction on the year of birth of the household head from 1905-1976 as in ABHL to 1940-1969 as in CC. Column 3 changes the definitions of age groups and redefines old and young as individuals older and younger than 40 as in CC. Column 4 changes the source for the nominal regional house price data from Government data to Nationwide data. Column 5 changes the definition of consumption from non-housing consumption as in ABHL to non-durable consumption as in CC. Column 6 changes the price deflator from rpix as in ABHL to a household specific price deflator as in CC. Column 7 moves from comparing age groups as in ABHL to comparing age and home ownership groups as in CC, albeit maintaining ABHL specification. Column *CC* replicates CC's results and changes the empirical specification to CCs baseline specification:$\triangle c_{i,t+1} = \beta_0 + \beta_1 r_{t+1} + \beta_2 \triangle y_{i,t+1} + \beta_3 p_{t+1} + \beta_4 \triangle z_{i,t+1} + \varepsilon_{i,t+1}$, where the subscript i denotes cohort, r_{t+1} is the log real interest rate between periods t and $t+1$, $\triangle c_{i,t+1} = \ln c_{i,t+1} - \ln c_{i,t}$ is real non-durable consumption growth, $\triangle y_{i,t+1} = \ln y_{i,t+1} - \ln y_{i,t}$ is real income growth, $\triangle p_{i,t+1} = \ln p_{i,t+1} - \ln p_{i,t}$ is real house price growth, and $Z_{i,t+1}$ is a vector of cohort characteristics which includes demographic variables. Standard errors in parentheses. *** (**) [*] significant at the 1 (5) [10]%.

and Leicester (2009)).

Column 1 shows the results from changing the time period from 1978 until 2001 as in ABHL to 1988 until 2000 as in CC. Sample sizes decrease from 149,484 observations to 77,723 observations. Results however do not significantly change from ABHL's results presented in the previous column, and thus continue to support the common factor hypothesis.

The specification in Column 2 drops cohorts born before 1940 and after 1969 from the sample as in CC. We lose the five oldest cohorts and the two youngest cohorts, which reduces the number of observations from 77,723 to 47,206. The magnitude of the coefficients for the young and middle aged (the remaining groups) remains virtually identical to that in Column *ABHL* up to two decimal points, and thus continue to lend support to the common factor hypothesis.

The specification in Column 3 redefines age groups according to CC's specification, where old households are considered to be those with household heads over 40 years old, and young households are those with household heads of 40 years old or less. The number of observations remains intact with respect to the previous specification. The house price coefficients remain virtually unchanged.

The specification in Column 4 uses the index of nominal house price data used by CC instead of the Government house price data. Figure 1 shows that the underlying house price data is different between the two papers, the Nationwide series used by CC being lower than the Government series used by ABHL. Time series plots of the regional prices in Figures 2 and 3 show that the difference between the two series starts from the early nineties, in conjunction with the change in the source of the Government data. The coefficients of interest presented in Column 4 experience a statistically significant drop with respect to the coefficients in the previous specification, and move from .199 and .198 to .181 for both old and young. Nonetheless, in contrast to what the wealth hypothesis would predict, the house price coefficients are identical in magnitude and not statistically significantly different between the two age groups at standard significance levels.[7]

The specification in Column 5 changes the definition of consumption from non-housing to non-durable consumption. The number of observations decreases slightly due to the change in the data source, from the IFS version of the FES used by ABHL to the UK Data Archive version

[7] We cannot reject the null hypothesis of equality between the coefficients of the young and the old: $F(1, 47156) = 0.03$. Prob$> F = 0.8697$.

FIGURE 1: Distributions of alternative house price data

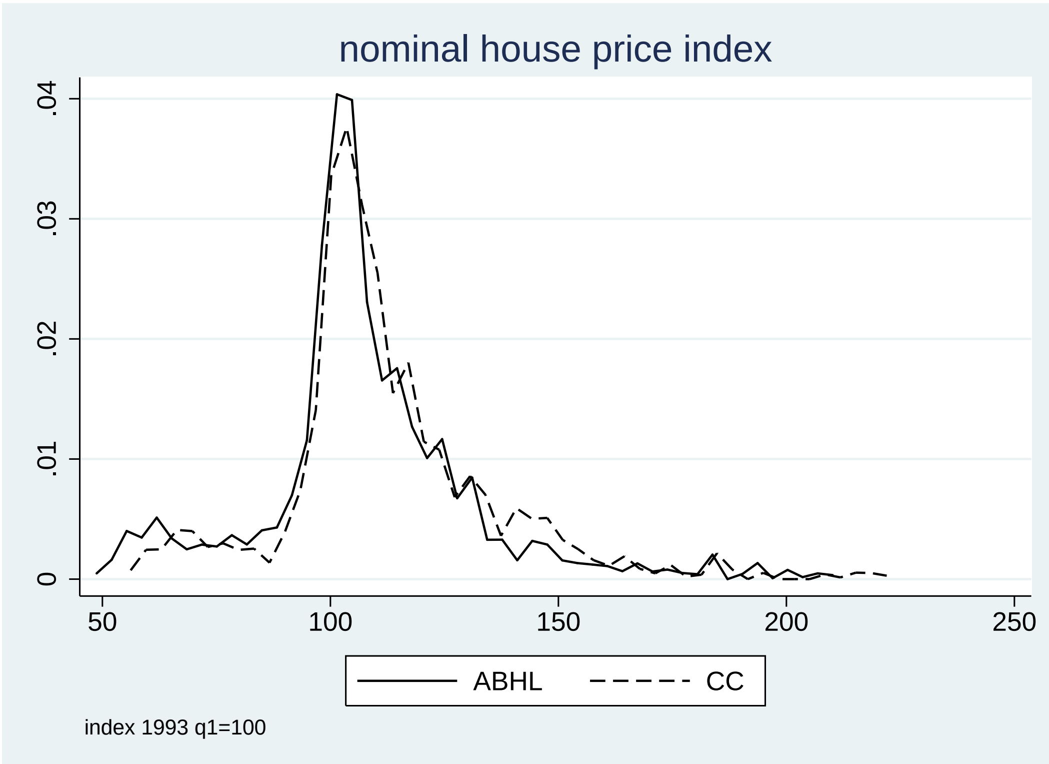


FIGURE 2: Time series of house price data

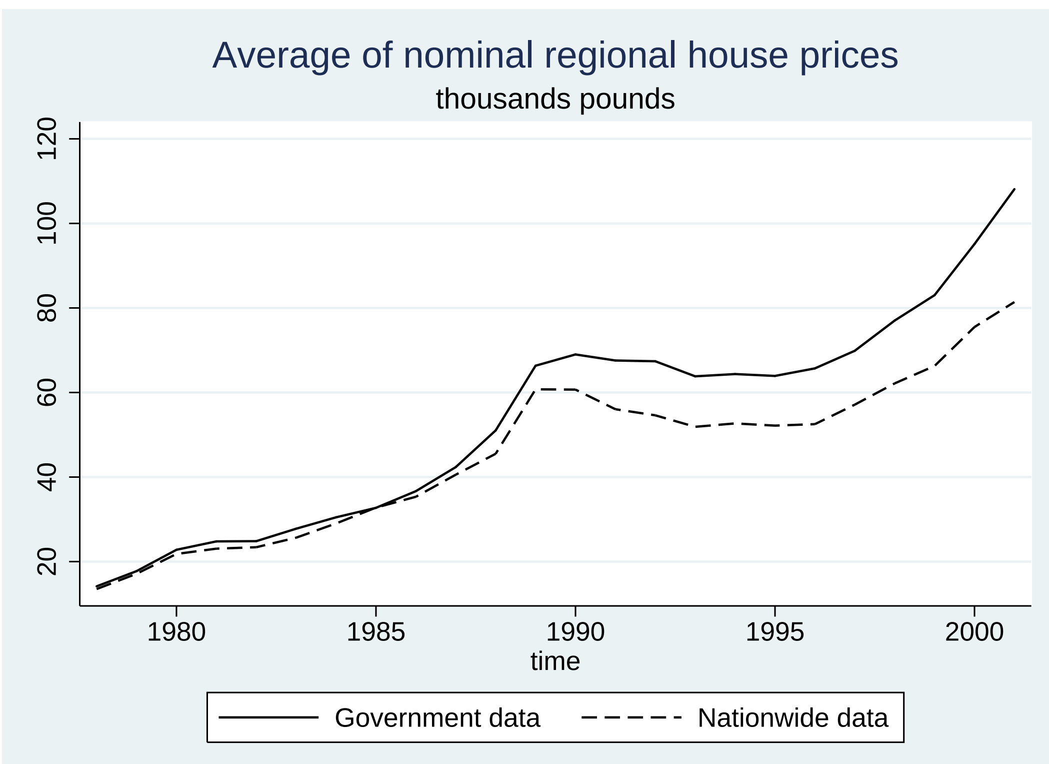
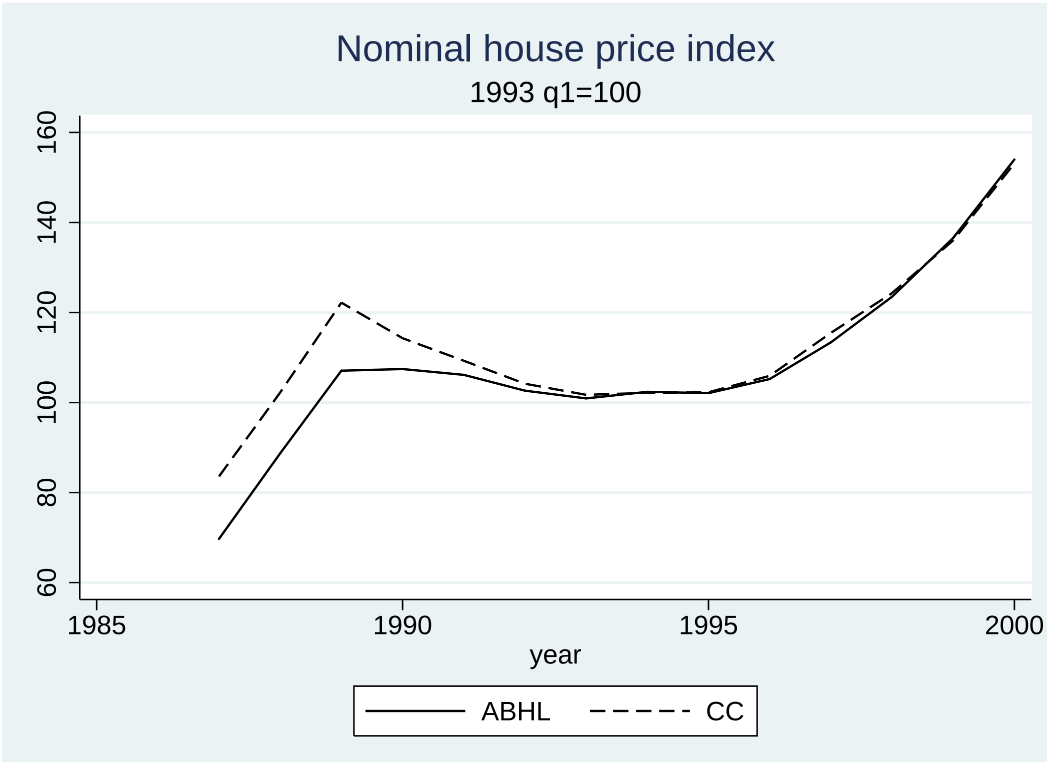


Figure 3: Time series of house price index data



of the FES used by CC. Figure 4 depicts the kernel density function of the two definitions of consumption. The distributions are indeed very similar, resulting in little changes in the coefficients with respect to the previous specification.[8] The coefficients on non-durable consumption drops further from .181 in Column 4 to .113 and .117 for old and young respectively. However, we still cannot reject the null that the coefficients of old and young are statistically different from each other at standard significance levels, providing no support for the wealth hypothesis.[9]

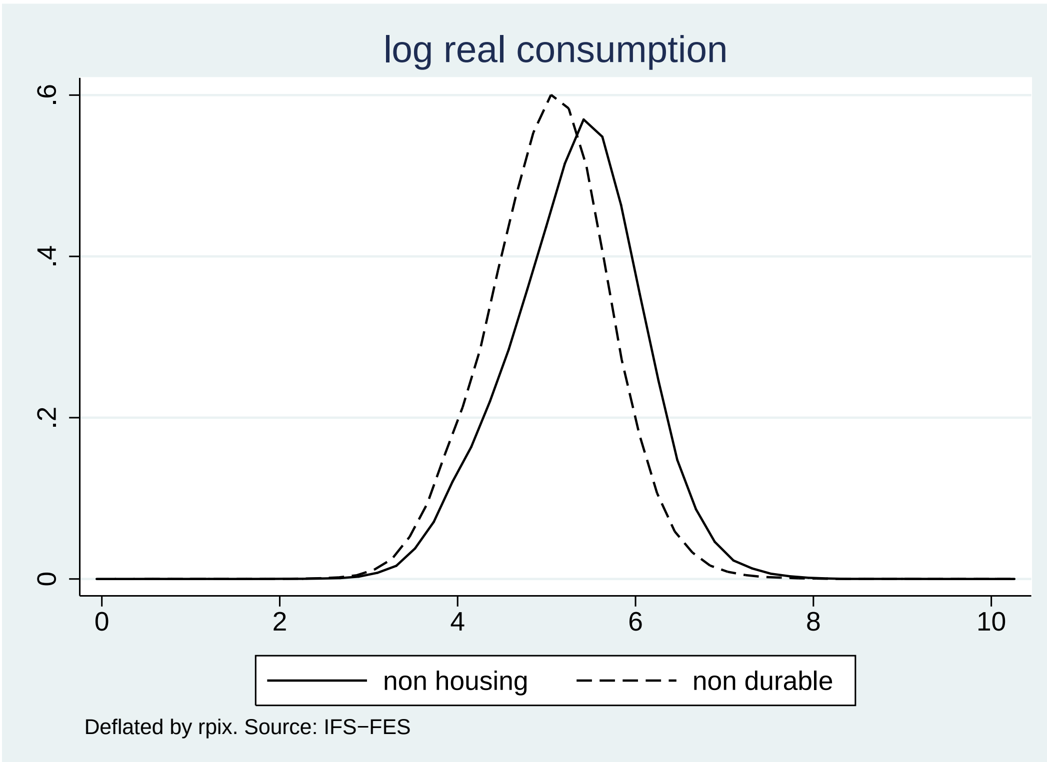
In Column 6 we use CC's household price deflator, rather than ABHL's RPIX, to convert nominal values of consumption and income to real values. The first panel in Figure 5 shows the densities of both price deflators: the household specific price deflator is smoother and has a greater variance than the rpix index.[10] The other panels in Figure 5 compare the densities of the

[8] We further explore differences in the data sets between the two papers in Appendix B. Our conclusions still hold after properly correcting the UK Data Archive version of the FES used by CC.

[9] We cannot reject the null hypothesis of equality between the house price coefficient of the young and the old: $F(1, 46747) = 1.81$. Prob $> F = 0.1784$. The coefficients of interest are slightly higher when using IFS-FES data and the closest definition of non durable consumption: 0.136 for old and 0.139 for young. The null of equality cannot be rejected at usual statistical levels.

[10] Notice that ABHL distinguish "food" expenditure into "food in "and "food out", whereas CC use the item "food" which is close to but not precisely equal to the sum of "food in" and "food out". The prices of "food in" and "food out" obtained from the IFS version of the FES data, which are needed to construct the household

Figure 4: Distributions of alternative definitions of non-durable consumption

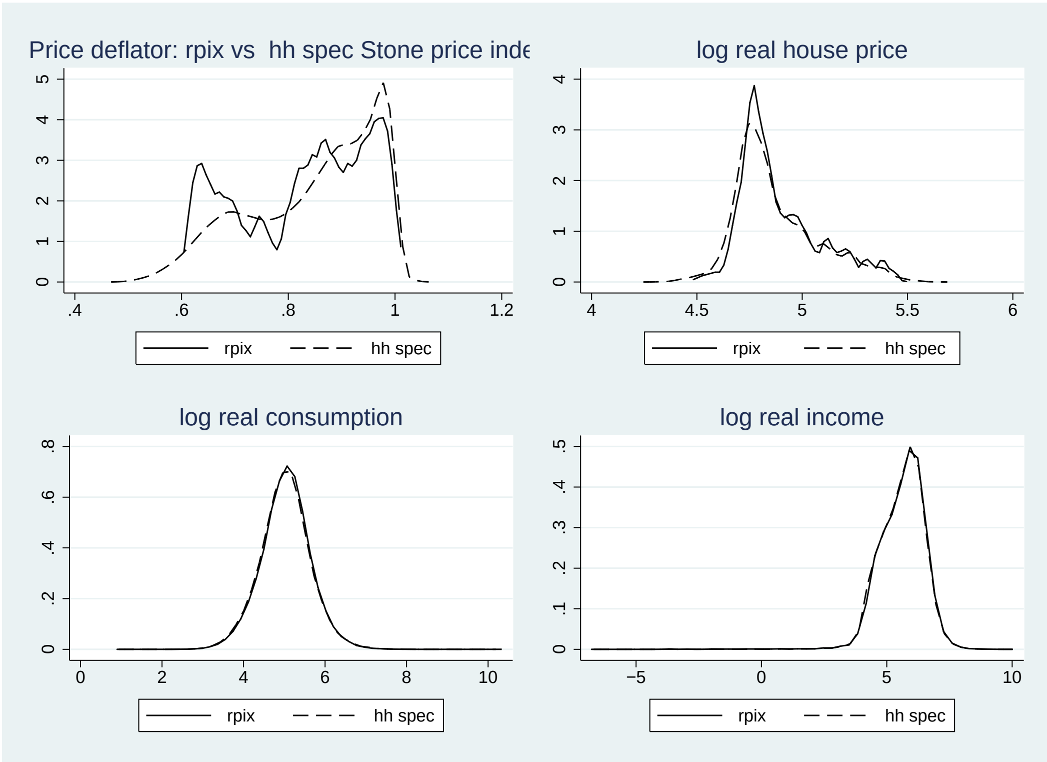


real variables of interest (i.e., consumption, income, and house prices) when using the household specific price deflator as in CC and the retail price deflator as in ABHL (either the monthly rpix for consumption and income or the quarterly rpixq for house prices). The underlying nominal variables are the same in both cases. Real log consumption and real log income are remarkably similar when using each of the price deflator, except for the tails. Real log of house prices is also similar, although there is more variation than with real log consumption and real log income.

The coefficients on non-durable consumption (not reported) increase significantly to 0.427 and 0.430 for old and young respectively, but are still far from the magnitude of CC's estimates presented in Column *CC* of Table 2. Moreover, these coefficients continue to lend support to the common factor hypothesis as they are not statistically different from each other. From here onwards we also adjust the tails of log real non-durable consumption and log real income as done by CC. Specifically, values which fall below 5% or beyond 95% of the distribution are given the values of the 95th and the 5th percentile respectively. In Column 7 we see that the tail

specific price deflator, are very different from each other and it turns out that the price of "food in" is the same as the price of "food" used by CC and obtained from Office of National Statistics.

FIGURE 5: Distributions of real variables with alternative price deflators



distribution correction implies a drop of the coefficients of interest to .353 (for young) and .349 (for old), but as before the two coefficients are not statistically different at standard significance levels.[11]

The specification in Column 7 introduces the age-homeownership groups as in CC, as opposed to the age groups used in ABHL's main specification. As in CC, in this specification the estimated coefficient on house prices measures the effects of house price changes on the consumption of old homeowners, and the estimated coefficients on the interaction variables measure the additional effects of house prices for the particular groups defined by the dummy variables. We find statistically significant heterogeneity in the consumption effects of house prices across the different groups, however these differences do not appear to be economically very big. The estimated coefficient on house prices is highest for old homeowners - though still much lower in magnitude than the corresponding coefficient estimated by CC (.360 vs 1.673). The effects of house prices on consumption are lower for renters than for old homeowners. The coefficients of house price interacted with the renter dummies are negative and significant for both old (-0.034)

[11]The null of equality cannot be rejected: F(1, 46747) = 2.06. Prob > F = 0.1509

and young (-0.014) renters. However, unlike the wealth hypothesis would predict, the elasticities for both groups remain positive and statistically different from zero.[12] In contrast to CC who find that young homeowners' consumption is less sensitive to house prices than old homeowners' consumption, we fail to find any difference between the elasticities of consumption to house prices for these two groups.

The specification in Column *CC* presents the results from changing the empirical specification and the data structure to get exactly CC's results (up to the third decimal point), so that quoting CC: "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 and young homeowners." (see page 603, third paragraph in Campbell and Cocco (2007)). As in the previous column, the consumption of old owners shows the highest (positive) sensitivity to house prices (1.673). This elasticity of consumption for old homeowners is however more than four times greater than the size found in the previous specification. The coefficients for the rest of the groups are not only different to the coefficients found in Column 7 but also compare differently against each other so that the wealth hypothesis is now supported. The groups in the middle (young home owners and old renters) have an elasticity of 0.783 and 0.724 respectively (the differences between these two groups are not statistically significant however). Young renters' consumption exhibits no sensitivity at all, which is not entirely consistent with the wealth hypothesis as CC recognize: "The small effect of house prices on the consumption of young renters is puzzling since a wealth effect should lead these households to cut consumption when house prices increase...." (see page 605, second paragraph in Campbell and Cocco (2007)).

3.1 Endogeneity of Homeownership Groups

The evidence presented so far in this Section shows that ABHL's results hold reasonably well (and thus support for the common factor hypothesis is found) throughout specifications where a life-cycle model of consumption is estimated using household level data. This is true for comparisons of age groups as well as comparisons of age-homeownership groups. In particular, results from comparing the effect of house prices on the consumption of age groups show that ABHL's results are robust to changes in the sample period, changes in the definition of consumption, and changes

[12] CC also find a positive elasticity of consumption for old renters and justify it by claiming that house prices may, to some extent, proxy for aggregate economic conditions. However, with regard to young renters, CC find a coefficient that is not significantly different from zero whereas in our case the coefficient is statistically different from zero and its size is close to that estimated for old homeowners.

in the data source (both, price data and expenditure data). Moreover, although the magnitude of ABHL's coefficients is sensitive to the use of the deflator, the qualitative implications remain unchanged. Results from comparing the effect of house prices on the consumption of age-homeownership groups seem also consistent with the common factor hypothesis. In this case, although old owners are the group displaying the highest elasticity of consumption to house prices, the size of the elasticity is still much lower than the size estimated by CC and the differences between the age-homeownership groups remain economically small. In turn, the wealth hypothesis is only supported when an Euler equation specification is estimated with synthetic-cohort level data. The results from estimating an Euler equation are however very volatile as shown in Appendix A. In particular, CC's results are not robust to variations of specification to the estimation of the Euler equation, as the estimation results from the additional intermediate steps between the results in Column 7 and Column *CC* in Table 2 in Appendix A show.

The fact that we fail to obtain results that are either qualitatively nor quantitatively in line with those of CC except when an Euler equation is estimated remains puzzling, as they are different empirical specifications, but are intended to be approximations to two different features of the same lifecycle model of consumption decisions. Thus, the different results when estimating an Euler equation model as opposed to a life-cycle model of consumption may stem from empirical considerations derived from the construction of synthetic cohorts. A potential problem in estimating an Euler equation on synthetic-cohort level data constructed on the basis of age and homeownership in this particular context is that this is a weak pseudo panel. The structure of the synthetic panel reported in Table 3 shows that the number of observations in the cells related to homeowners is small, which may create sampling noise (e.g., Browning, Deaton, and Irish 1985, Deaton 1985). Additionally, the Euler equation here is estimated using synthetic cohorts that are constructed on the basis of age and homeownership. Whereas age is exogenous, the decision to own a home or not is clearly endogenous and so the underlying population of homeowners is not a random draw of the overall population. In fact, not only will the composition cohorts be non-random, it will also change over time which poses serious problems for interpreting pseudo panel results.

Both set of authors are aware that the treatment of home ownership status as exogenous is problematic, and deal with the endogeneity problem differently. ABHL's analysis focuses on age

Table 3: Synthetic Cohort Panel Structure

		ABHL:IFS-FES			CC:Archive FES		
year of birth	homeowner	min cell	max cell	ave cell	min cell	max cell	ave cell
1940-44	0	21	44	31.2	18	54	29.4
1945-49	0	22	48	34.4	19	56	33.0
1950-54	0	23	52	38.6	23	51	36.7
1955-59	0	26	62	46.5	22	75	44.7
1960-64	0	35	80	58.6	29	104	57.4
1965-69	0	33	81	61.4	25	118	59.9
1940-44	1	69	131	99.5	69	166	101.1
1945-49	1	95	169	127.7	95	209	129.9
1950-54	1	87	143	116.5	84	185	118.1
1955-59	1	87	144	119.4	91	192	121.4
1960-64	1	83	140	115.5	84	226	118.7
1965-69	1	12	119	86.7	12	206	90.0

Notes: Number if observations in each synthetic-cohort group using IFS version of FES as in ABHL and UKDA version of FES as in CC.

groups.[13] However, to the extent that age is not a sufficient characterization to detect potential wealth effects and comparisons across homeownership status as well as age are desirable, then one needs to properly account for the endogeneity of homeownership status. Failure to do so may result in estimates that yield little support for the wealth hypothesis (as seen in Table 2). In contrast, CC's main focus is to address the endogeneity of homeownership in their baseline specification as reproduced in Column *CC* of Table 2. They discuss the endogeneity problem at length in their paper and take care of it by attempting to find out the extent of the bias using simulated household-level data in a model that jointly estimates consumption and the probability of becoming homeowner. They show that the endogeneity of cohort selection essentially affects the coefficients of old vs young homeowners but does not change the result that homeowners consume more out of house price increase than renters.[14]

In order to tease out the role of the endogeneity bias and sampling noise, we estimate a similar specification to that presented in Column *CC* of Table 2 but grouping consumers only according to their age (i.e., old vs young). In this case results should be free from any endogeneity bias as age groups are clearly exogenous. They should also be free from any sampling noise due to small cell sizes, since synthetic cohorts constructed on the bases of age are bigger. Results from estimating the Euler equation specification using year of birth synthetic cohort are indeed consistent with the wealth hypothesis. The coefficients of the two groups are statistically

[13] ABHL do not interact age and homeownership status but report the results of using homeownership status instead of age group dummies (see Table A2 in the Appendix, specification V in Attanasio, Blow, Hamilton, and Leicester (2009)). The coefficients for owners and renters are very similar in size and slightly higher for renters.

[14] The coefficient for young homeowners is highest in this case and CC justify it on the basis of credit constraints.

and economically different regardless of the construction of synthetic cohorts. Old households present a statistically significant elasticity of consumption to house prices of 1.34. In contrast, the elasticity of young households is much lower in magnitude (0.21) and not statistically significant.[15]

Our results suggest that empirical concerns based on the endogeneity bias and sampling noise introduced by homeownership synthetic cohorts is not what seems to be driving the different results between estimating an Euler equation as opposed to a life-cycle model of consumption, and ultimately, what drives the opposite conclusions reached by the two papers. The main difference relates to whether the empirical specification is a consumption function (an equation for the level of consumption) or an Euler equation (an equation for consumption growth). While results based on the life-cycle model are coherent with the common factor hypothesis, those based on the Euler equation approach cannot reject the wealth hypothesis. This result is associated to the age of the household's head and not necessarily (or exclusively) to his homeownership status.

4 Conclusion

This paper revisits the debate about the presence of wealth effects associated to house price changes. To that end, we compare the results from two influential papers which, although posing a common research question, end up reaching opposite conclusions. These somehow contradictory results regard the same country, the UK, and are based on the same data set, the UK Family Expenditure Survey (FES). However, although both papers test the same underlying theory, their methodologies are remarkably different.

This paper it confirms that the results can be reproduced. We find that support for the common factor hypothesis is found throughout specifications where a life-cycle model of consumption is estimated using household level data. Results are robust to changes in the sample period, changes in the definition of consumption, and changes in the data source (both, price data and expenditure data). Furthermore, although the magnitude of the house price coefficients is sensitive to the type of price deflator used, the qualitative implications remain unchanged. In

[15] Although results based on the Euler equation change somewhat once a slight oversight in CC's code is amended (as explained in Appendix B), the wealth hypothesis still finds support. In contrast, results based on the life-cycle model do not change substantially when correcting for the error, probably because the error magnifies in first differences. On the whole, the conclusion according to which the different results can be traced to the different specification used (Euler equation vs life-cycle model) still holds.

contrast, the wealth hypothesis finds some support only when an Euler equation specification is estimated with synthetic-cohort level data. We rule out that the results from estimating an Euler equation with synthetic-cohort level data are being driven by the problems generated by the construction of synthetic cohorts on the basis of an endogenous variable, such as home ownership status. We also rule out that these results are being driven by the sampling noise due to small sample sizes in some of the synthetic cohorts groups.

The crucial element driving the different results between the two papers is whether it is a consumption function (an equation for the level of consumption) or an Euler equation (an equation for consumption growth) that is being estimating. The opposite results therefore relate to the different empirical specifications of the underlying intertemporal utility maximization problem. Indeed both approaches are approximations. In particular, empirical consumption Euler equations have long been criticized for taking a linear short cut which produces significant approximation biases (e.g., Carroll 2001, Ludvigson and Paxson 2001), except in a few cases as in Attanasio and Low (2004).

Our comparison exercise draws attention to the need for further research on the virtues and limitations of Euler equations and on consumption functions in general. It is not possible to get a deeper understanding of the relative importance of the aggregation and the functional form for the results using this cross sectional data set. One possible way towards answering such a question would entail simulating theoretical models and undertaking a Monte Carlo analysis of the empirical techniques. The large number of economic models and specifications to choose from makes this path a really challenging line of research where obtaining any clean insight may be straight forward. A commending effort in this direction can be found in Attanasio, Leicester, and Wakefield (2011). This task is however beyond the aim of the current paper and we leave it for further research.

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Appendix A: Intermediate Steps

Table A-1 presents the intermediate steps necessary to move from the life-cycle specification presented in Column 7 in Table 2 to CC's baseline results in Column *CC* in Table 2. For ease of reading, Column 1 and Column 8 of Table A-1 reproduce Column 7 and Column *CC* of Table 2.

Results from Columns 1-4 in Table A-1 confirm our previous finding that the common factor hypothesis breaks down, statistically, when consumers are grouped not only according to their age but also according to their homeownership status. Including income (Column 2) and the real interest rate (Column 3) narrows the difference in the house price coefficients between the different groups. The elasticity of (old and young) homeowners' consumption to house prices drops from .36 to .27, the elasticity is the same for young renters, while old renters' consumption elasticity is only slightly lower. Economically speaking, the sizes of these last two elasticities are indeed very close in both specifications. Column 4 adds the log of family size as in CC and excludes some demographic and socio-economic variables, which results in old owners as the group with the highest elasticity of consumption to house prices. Yet, the size of the elasticity is still much lower than the size estimated by CC and the differences between the age-homeownership groups remain economically small.[16] The common factor hypothesis breaks down not only in an statistical sense, but also economically, when replacing birth cohort dummies with birth-homeownership cohort dummies (Column 5 in Table A-1). The use of birth-homeownership dummies raises the coefficients of renters by 10 percentage points or more while reducing the coefficient of old homeowners. On the whole, young renters now show the highest sensitivity of consumption to house prices and young owners show the least. Although the introduction of birth-homeownership cohort dummies takes the specification closer to CC's, at this stage not only any confirmation of the common factor hypothesis has faded, but the wealth hypothesis is also plainly rejected. As in Table 2, the wealth hypothesis is only supported under *CC*'s specification in Column 6.

Appendix B: Correcting the UKDA Version of FES

We detected two types of problems with the UK Data Archive version of FES used by CC. The first one is a missing data problem which concerns a) the expenditure category of "Clothing" and b) the wife's current income.
a) Data for "Clothing" are missing from October to December, from 1987 to 1993, and from January to March in 1994. CC recode these missing values to zero thus sharply increasing the variability of the series as well as that of the derived household specific price deflator. In this section, each missing year-month data is imputed a value obtained by multiplying the household's overall expenditure on all other non durable items in the relevant year-month by the share of "Clothing" in the household's total expenditure on all other non durable items in the same month of the nearest year available.
b) Data for the wife's gross current income are missing from September to December, from 1987 to 1994. CC recode these missing data to zero thus affecting their measure of household income defined as the sum of the head's and the wife's gross current incomes. Since the missing values

[16] Old owners' elasticity decreases slightly from .290 to .225 but becomes the highest among the four groups as the elasticities of young owners and young renters, which were in line with that of old owners up to this point, decline by around 2 percentage points. The elasticity of young owners also becomes similar, in size, to the elasticity of old renters.

TABLE A-1: Intermediate steps

	[1]	[2]	[3]	[4]	[5]	[6]
Log house price (old owners)	0.360***	0.268***	0.290***	0.225***	0.188***	
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Log house price (young owners)	–0.001	–0.001	–0.000	–0.017***	–0.026***	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Log house price (old renters)	–0.034***	–0.015***	–0.015***	–0.020***	0.122***	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	
Log house price (young renters)	–0.014***	0.003	0.003	–0.020***	0.149***	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	
Δ Log house price (old owners)						1.673***
						(0.29)
Δ Log house price (young owners)						–0.890**
						(0.37)
Δ Log house price (old renters)						–0.949***
						(0.35)
Δ Log house price (young renters)						–1.673***
						(0.34)
Log total household income		0.206***	0.207***	0.234***	0.232***	
		(0.00)	(0.00)	(0.00)	(0.00)	
Δ Log total household income						0.331***
						(0.03)
Real Interest Rate			–0.078***	–0.070***	–0.071***	0.068**
			(0.01)	(0.01)	(0.01)	(0.03)
Birth cohort dummies	Yes	Yes	Yes	Yes	No	No
Occupation dummies	Yes	Yes	Yes	No	No	No
Region dummies	Yes	Yes	Yes	No	No	No
Monthly dummies	Yes	Yes	Yes	No	No	No
Birth-homeownership cohort dummies	No	No	No	No	Yes	Yes
Quarter dummies	No	No	No	Yes	Yes	Yes
R sq.	0.25	0.30	0.30	0.28	0.29	
N	46797	46797	46797	46798	46798	624

Notes: The specifications in each column are described in Section 2. Column *ABHL* replicates ABHL results. Column 1 is equivalent to Column 7 in 2. Column 2 is same as Column 1 adding total household income as an additional control. Column 3 is the same as Column 2 adding the real interest rate as an additional control. Column 4 is the same as Column 3 with a different set of socio-economic controls as in CC (age, age squared, log of family size, quarter dummies and birth-cohort dummies). Column 5 is the same as Column 4 after replacing birth cohort dummies with birth-homeownership dummies. Column 6 estimates an Euler equation on synthetic-cohort level data constructed on the basis of age and home ownership status. Standard errors in parentheses. *** (**) [*] significant at the 1 (5) [10]%.

extend to all types of wife's incomes, we replace the measure of household income used by CC with the household gross current income available in the Archive with no missing values. Where both the sum of head's and wife's incomes and the overall household's income are available, the latter shows to be slightly higher, as expected.

The second problem is a coding error. Starting with the survey in the years 1993-1994, FES stopped collecting the data on the basis of solar years (i.e., from January to December of year t) and started collecting data on the basis of the financial year (i.e., from April of year t to March of year $t+1$). For the surveys 1993-1994 and beyond, quarters need therefore be recoded (from 1 to 2, 2 to 3, 3 to 4, and 4 to 1). However, the recoding has been accidently kept throughout the surveys in CC code, so that the quarters in the surveys from 1987 to 1993 are out of phase. Here we mend this error by limiting the quarters recoding to the surveys from 1993-1994 onwards.

Table B-1 shows some of the basic results presented in Table 2, using the corrected UK Data Archive version of the FES. Columns 1, 2 and 3 correspond to Columns 6, 7 and *CC*, respectively, of Table 2; Column 4 corresponds to Column *CC* of Table 2 using data on a pseudo panel constructed only according to birth cohorts, as explained in Section 3.1.

Results from regressions in levels presented in Columns 1 and 2 do not differ substantially from those obtained using non-corrected data. Young and old households do not differ in their response to house price changes (Column 1) and when allowing for birth-homeownership groups (Column 2) differences, both between homeowners and renters and between old and young renters, are quantitatively small (in the order of 0.01 to 0.03 over the main effect of 0.35).

Finally, estimates of the CC Euler equation specification (Column 3) show that both old and young households respond to a house price change in a way that is independent of their being homeowners or renters and old households show an elasticity significantly higher than renters (1.8 vs 0.3). Notice that this is virtually the same result we obtain when estimating the Euler equation using year of birth synthetic cohorts (Column 4).

Table B-1: Corrections of the UK Data Archive version of the FES

	[1]	[2]	[3]	[4]
Log house price (old)	0.337***			
	(0.01)			
Log house price (young)	0.341***			
	(0.01)			
Log house price (old owners)		0.348***		
		(0.01)		
Log house price (young owners)		–0.001		
		(0.00)		
Log house price (old renters)		–0.033***		
		(0.00)		
Log house price (young renters)		–0.013***		
		(0.00)		
Δ Log house price (old owners)			1.778***	
			(0.39)	
Δ Log house price (young owners)			–1.445***	
			(0.48)	
Δ Log house price (old renters)			–0.579	
			(0.46)	
Δ Log house price (young renters)			–1.437***	
			(0.46)	
Δ Log house price (old)				1.883***
				(0.36)
Δ Log house price (young)				0.487
				(0.31)
Δ Log total household income			0.266***	0.343***
			(0.05)	(0.08)
Real Interest Rate			0.029	0.023
			(0.04)	(0.04)
Birth cohort dummies	Yes	Yes	No	No
Occupation dummies	Yes	Yes	No	No
Region dummies	Yes	Yes	No	No
Monthly dummies	Yes	Yes	No	No
Birth-homeownership cohort dummies	No	No	Yes	No
Quarter dummies	No	No	Yes	Yes
R sq.	0.24	0.25		
N	46792	46792	624	312

Notes: Columns 1 and 2 are equivalent to Columns 6 and 7 in Table 2. Column 3 is equivalent to Column *CC* in Table 2 and Column 4 is identical to Column 3 but estimated on synthetic cohorts constructed on the basis of age of birth (as opposed to age and home ownership status in Column 3). Standard errors in parentheses. *** (**) [*] significant at the 1 (5) [10]%.