Life-Cycle Consumption Patterns at Older Ages in the US and the UK: Can Medical Expenditures Explain the Difference?

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Abstract

This paper documents significantly steeper declines in nondurable expenditures in the UK compared to the US, in spite of income paths being similar. Several possible causes are explored, including different employment paths, housing ownership and expenses, levels and paths of health status, number of household members, and out-of -pocket medical expenditures. Among all the potential explanations considered, those relating to healthcare — differences in levels and age paths in medical expenses and medical expenditure risk — can fully account for the steeper declines in nondurable consumption in the UK compared to the US.

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As populations in advanced countries continue to age, a key concern for policymakers is whether individuals have saved enough to fund their consumption needs over increasingly long retirement periods. Understanding trajectories of consumption and wealth as individuals age is crucial to resolving this question. Research on life cycle consumption patterns has typically concentrated on working ages with an emphasis on expected paths in labor income, economic wage shocks, and retirement; see for example the *Review of Economic Dynamics* special issue on micro facts (Violante (2010)). However, this leaves out an important and growing span of life during the post-retirement years where other factors such as health, mortality, health expenses and shifts in housing expenditures and recreation may play an increasingly central role. Moreover, these are areas where there are large cross-country institutional differences - for example in housing markets and in whether medical care is privately or government financed—that may have important implications for patterns of nondurable consumption at older ages.

In the United Kingdom, average nondurable expenditure between the ages of 45 and 79 falls by 2.2 percent each year. This compares to 1.4 percent for the United States. To illustrate, the first panel of Figure 1 plots nondurable expenditures in the UK and US by age averaged across birth cohorts. It's clear that spending remains roughly constant after age 50 in the US while it falls much more rapidly in the UK.

What can explain a difference of this magnitude? An obvious starting point is to examine age paths of income to access the extent to which consumption expenditures are tracking age paths in household income. But the second panel in Figure 1, which plots cohort averaged paths of household income at older ages in the two countries, demonstrates that, if anything, incomes decline at a slightly faster rate in the US than the UK.[2] This therefore seems unlikely to be the major reason for a flatter spending profile in the US. In this paper we

[2] In both countries income is measured as the sum of salary, investment, interest, rental and transfer income and other income net of tax payments. In neither country does income include capital gains on property or other investments.

investigate other possible reasons that may explain the dramatically different patterns of nondurable consumption of older ages in the two countries by investigating differences in both inter and intra-temporal consumption for households around and beyond retirement age.

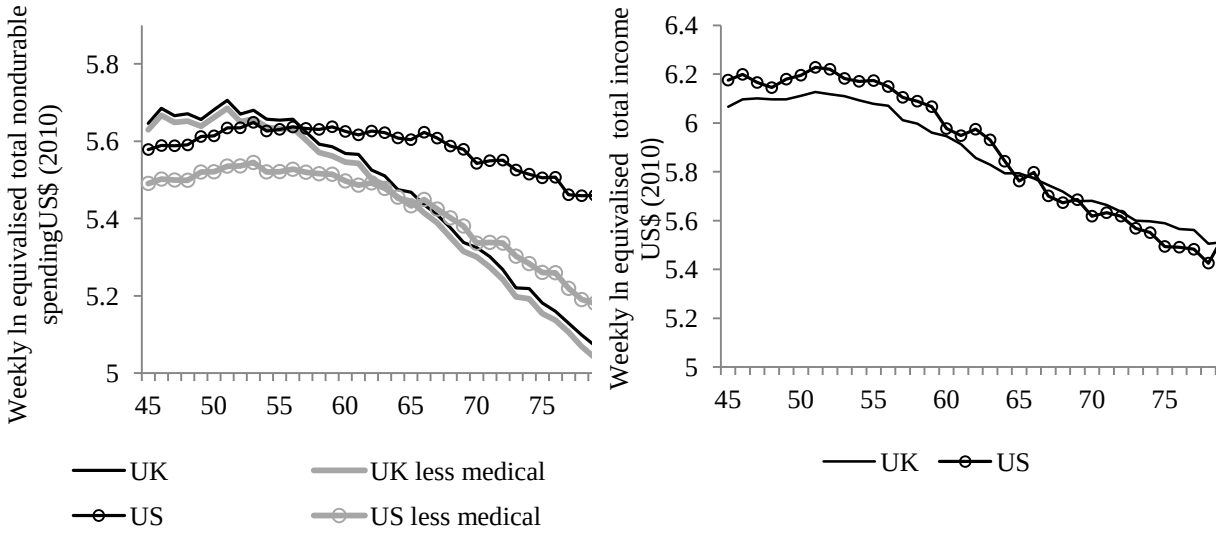

Figure 1. Nondurable Spending and Incomes in the US and UK by Age, 1984-2010

Note: Authors' calculations using BLS Consumer Expenditure Survey 1984-2010 and ONS Living Costs and Food Survey 1984-2010. Values are in US$ (2010). Figures equivalized using the modified OECD scale. The definition of spending includes medical expenditures.

The set of factors that we explore in this paper include: differential cohort effects in the two countries that may distort average life-cycle age profiles, differences in timing of retirement in the presence of separabilities with employment, differential paths of housing expenditures possibly driven by institutional differences in housing markets between countries, level and path differences in health status and mortality, and finally the levels, prices and volatility of medical spending, as in the US deteriorating health with age leads to higher spending there while this is not true in the UK because of the National Health Service (NHS). We include spending on non-medical nondurables in the two countries Figure 1. It is

immediately clear that this helps account for a significant fraction, though not all, of the difference between the two countries.[3]

Our empirical strategy is to first quantify cross-country differences in three potential factors—employment, housing status and health—and look for any immediate differences that might explain the differential consumption paths observed in Figure 1. We find that most of these variables evolve in a broadly similar way in both countries, although there are some notable differences. But even in the absence of profile differences, these three factors could play a role in explaining the different shape of spending profiles if there are differences in non-separabilities between these variables and consumption expenditures across the two countries. Hence, we move on to look for evidence of such non-separabilities by examining their effect on within-period budget allocations in a simple demand system estimated in each of the two countries. We find evidence that the relationship between health expenditures and mortality and employment is much stronger in the US, suggesting that a model of nondurable non-medical spending paths might display more similarities across countries.

We next consider inter-temporal profiles and non-separabilities by estimating a model of consumption growth. We indeed find that the definition of nondurable consumption spending is particularly important when attempting to account for the cross-country difference in spending growth. Once medical expenditures are removed, the difference in the decline in spending between the two countries shrinks by around three quarters. Different papers have made different decisions about whether medical expenditures should be included in the definition of nondurable consumption. For instance, Heathcote, Perri, and Violante (2010)

[3] Changes in medical spending at older ages could in principle be driven by changes in medical consumption in the two countries or differences in the prices paid for medical care. Purchasing Power Parities (PPP) for medical care from the OECD suggest that the level of prices (paid by both government and consumers) is consistently higher in the US than the UK (see http://stats.oecd.org/Index.aspx?DataSetCode=PPP2014). In 2005, for example, UK prices were estimated to be 78% of costs in the US. In Appendix B, we also consider the rate of change of medical prices in the US versus the UK for the period 1988-2010. Price movements in the two countries track each other quite closely for much of this period but US medical price inflation is higher in the latter years of the sample. If medical care is a normal good, this would tend to reduce US consumption of medical care relative to the UK.

and Attanasio and Pistaferri (2014) include medical spending in their measures of expenditure while for instance Attanasio and Weber (1995), Banks, Blundell and Lewbel (1997), Blundell, Pistaferri and Preston (2008), and Attanasio, Hurst and Pistaferri (2012) do not (often on the grounds that spending on healthcare is more akin to investment than consumption spending). Our results highlight the importance of giving careful considerations to such choices.

We then examine whether controlling differences in employment, housing status and health can account for remaining differences in the rate of nondurable consumption growth in the two countries. We model non-medical consumption *conditional* on health status and real medical expenditures. This approach allows preferences for non-medical consumption to change in a non-separable way with health and the consumption of medical goods. It also captures any substitution effects driven by the change in the relative price of medical consumption. We also consider the role medical expense uncertainty may play in explaining consumption profiles in the US, partly by exploiting differences in the institutional environments in the two countries. Precautionary savings against medical expense risk play an important role in US consumption decisions, increasing consumption growth at older ages in that country by around 0.80 percentage points per year on average for the ages we consider. Precautionary motives against medical expense risk in the UK are, by contrast, negligible.

The rest of the paper is organized as follows. In the next section we describe in more detail the essential features of the data we assemble to look at these issues and document cohort specific paths of nondurable spending and household income for both countries. We then move on to look at various potential explanations for the cross-country differences in turn. To illustrate, Section II provides a description for cohort specific age paths in employment in the two countries and discusses their implications for consumption profiles,

Section III provides a parallel treatment for housing by describing age paths of housing ownership and Section IV focuses on levels and paths of health status and differential levels and age patterns of medical expenditures. We then estimate within-period and inter-temporal models of nondurable spending patterns in each country that incorporate these factors in order to explore their role. Section V contains within-period demand models for the various sub-components of total nondurable expenditure conditioning on factors just discussed. Section VI presents results obtained from an inter-temporal model of growth rates in total nondurable expenditures for each country to identify factors that may account for different shaped consumption paths at older ages. The final section highlights our main conclusions.

I. The Life-Cycle Pattern of Consumption and Income

We use two repeated cross-sectional surveys widely viewed as containing the highest quality measurement of household expenditure and its components in each country – the Consumer Expenditure Survey (CEX) in the US and the Living Costs and Food Survey (LCFS) in the UK. While these surveys do not cover the same individuals for long periods of time, we organize the data to create a pseudo-panel and track cohort consumption behavior by age (in the manner of Browning, Deaton, and Irish (1985)). To do this we group individual observations by 5-year birth cohorts and take averages within each year. Cohorts are determined by the age of the household head. Following this approach allows us to merge in information from other surveys at the cohort-year level where necessary.

The LCFS is an annual cross-sectional survey that has been running in one form or another since 1961. The LCFS, formerly known as the Family Expenditure Survey, is conducted by the Office for National Statistics (ONS), the UK's national statistical agency and has been the basis of a number of studies of intra- and inter-temporal spending patterns. Currently it interviews around 6,000 households throughout the UK and continuously throughout the year. The survey begins with an interview with questions about demographic

characteristics, income, large purchases over the last year and regular expenditures (such as magazine subscriptions, internet subscription costs and so on). Each household member over 16 then records all spending in a diary over the next two weeks.

For the US we make use of the Consumer Expenditure survey (CEX). This survey has carried out by the Bureau of Labor Statistics (BLS) on a continuous basis since 1980. For some quarters prior to 1984, the survey only covered households living in urban areas. The CEX includes two separate surveys, a diary survey which works much like the LCFS, and an interview survey, where households are asked to recall their spending on a range of spending categories over the previous three months. The interview survey is also a short panel, as the same households are interviewed on up to 5 occasions. The first of these interviews collects some basic data on family characteristics. Each subsequent interview updates this information and asks questions concerning household spending over the previous 3 months. Information on incomes and labor force participation are however only collected in the 2nd and 5th interviews (except for new household members and members who have newly started work), meaning that income and spending data for the 3rd and 4th interviews need not cover the same time periods. In this paper we only make use of the interview survey.[4] Around 5-8000 households are interviewed in each quarter.

In both UK and US surveys, spending data are provided for hundreds of highly disaggregated individual product codes. We allocate these goods into 8 broader categories defined to be consistent across the two countries: food in, food out, other nondurables, medical, housing related, recreation and transport and durables. Some examples of what are included in these categories are given in Table 1. We do not include rental payments or mortgage interest in any of these definitions as we do not observe the "shadow price" of

[4] While the methodology employed in the CEX diary survey is arguably more similar to that used in the LCFS than the interview survey, the diary survey has lower sample sizes, tends to exhibit greater variability in responses, and tends to under report spending relative to the interview survey (Bee, Meyer and Sullivan (2015)). For these reasons, we make use of the interview survey instead.

owned housing in the LCFS, nor can we estimate it easily (the CEX does include a self-reported imputed rental costs for owned properties). We define total nondurable expenditures to include all rows in Table 1 with the exception of the final row measuring durable spending.

Household income data are derived from the same surveys and cohort age profiles obtained in the same manner. Household income is defined comprehensively to include all sources of income for the head of household, the spouse/partner, and all other household members net of taxes. US expenditures and incomes are deflated to 2010 terms using the Consumer Price Index (CPI). UK variables are deflated to 2010 terms using the Retail Prices Index and then converted into dollars using PPP exchange rates for that year taken from the OECD. Both surveys contain measures of standard definitions of labor force participation. From 1994 onwards, the CEX also contains detailed questions on the nature of households' health insurance policies and Medicare coverage. In both data sets we restrict out attention to households where the head is aged 45-79. This is because ages in the LCFS are top-coded at age 80 from 2002 onwards.[5]

Table 1. Spending Categories

Food in	Food at home
Food out	Food in restaurants, school dinners, catering.
Other nondurables	Alcohol, tobacco, clothes, books, tobacco, child care, pet goods and services.
Medical	Health insurance premia, fees for services from health professionals, drugs, medical equipment, care in nursing homes, care of invalids.
Housing related	Electricity, gas and water bills, domestic services, repairs, building insurance.
Recreation	Sporting goods, musical instruments, CDs, entertainment, holidays
Transport	Motoring costs, petrol, fares for public transport, air fares.
Durables	Vehicles, white goods, black goods.

[5] We also plotted spending, income and demographics up to age 85 in the two countries using data up to 2001 only. The patterns in the two countries are very similar. Results are available on request.

To control for measurement error and impacts of extreme values on life-cycle paths, we trim households in the top or bottom 1 percent of distribution of income and expenditure. In the CEX we take data from 1984 (so as to consistently include a nationwide sample) until 2010. For the LCFS we take data from 1978 until 2010. We stop in 2010 in both countries as we do not have mortality data for either country after this date.

Figure 1 shows spending at different ages average across different birth cohorts and different years. This means that differences between the two countries shown there may partly be driven by differences in cohort and time effects. To understand whether the patterns in Figure 1 are driven by cohort effects, Figures 2 and 3 show how spending and incomes decline *within* cohorts in the two countries. Before plotting these, we remove average differences across cohorts by regressing spending and income on cohort dummies and taking the residuals. It is clear that cohort effects by themselves cannot account for the main puzzle with which we motivated this paper. Although the spending decline observed in the UK is somewhat smaller when one looks within individual cohorts rather than averaging across them, the age pattern nondurable consumption at older ages in the USA remains relatively flat. Within cohort declines in incomes are also similar across the countries.[6]

II. Differences in Employment and Retirement

One dimension of labor force behavior at older ages that has been studied in the context of consumption age profiles involves the impact of retirement on levels and time paths of consumption. Consumption levels and paths may not be independent of the retirement

[6] In the CEX there were two changes to the way incomes were measured that matter for Figure 3. One occurred in 2001 and the other in 2004. The first introduced a bracketing question for those who did not report their incomes first time round. The second introduced imputation for non-responders. The income definition we employ makes use of non-bracketed responses only from 2001 and non-imputed values for income from 2006 onwards. In 2004 and 2005 it is not possible to remove non-imputed income values.

decision if preferences over employment and consumption are not separable, or individuals do not fully anticipate income reductions coincident with labor market retirement, (Banks et al. (1998)). The importance of this in explaining consumption trajectories at older ages is substantial. In the US, it has been estimated that work related expenditures account for the entire decline in nondurable spending from middle age to age 75 (Aguiar and Hurst (2013)). In addition to any direct costs associated with work, movements out of employment may also be associated with having more time to spend shopping for discounts or for home production of some goods (Aguiar and Hurst (2007)). This could partially explain cross-country differences if there are differences in the links between labor supply and consumption expenditures in the two countries, or if declines in employment were more rapid in one country than another (or both).

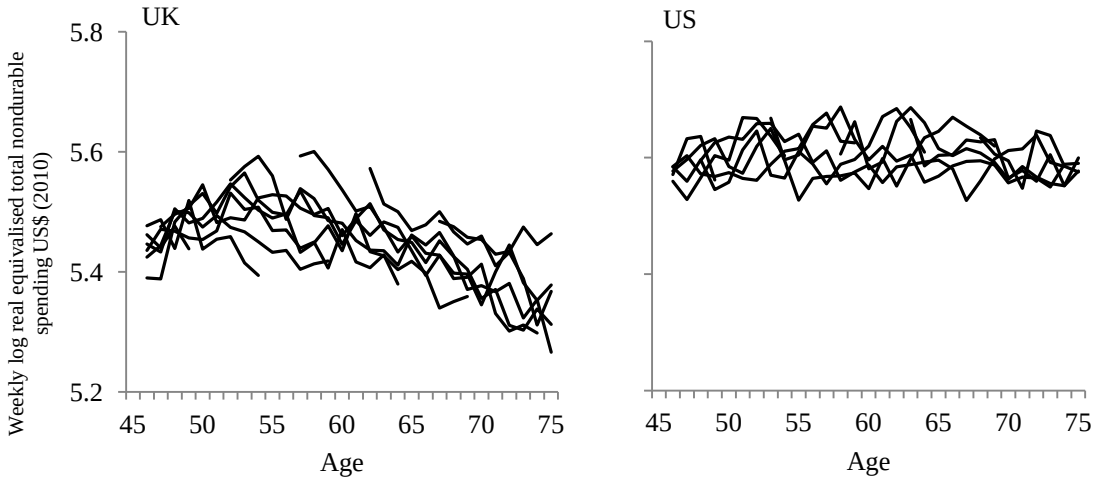

Figure 2. Nondurable Spending by Cohort and Age

Note: Data from LCFS in the UK and CEX for the US. Each line represents average log nondurable expenditures at each age for 5-year birth cohorts over the periods they are observed between ages 45 and 79 over the period 1984-2010. Average differences across cohorts are removed by regressing spending on cohort dummies and taking the residuals. Values are in US$ (2010). Figures equivalized using the modified OECD scale.

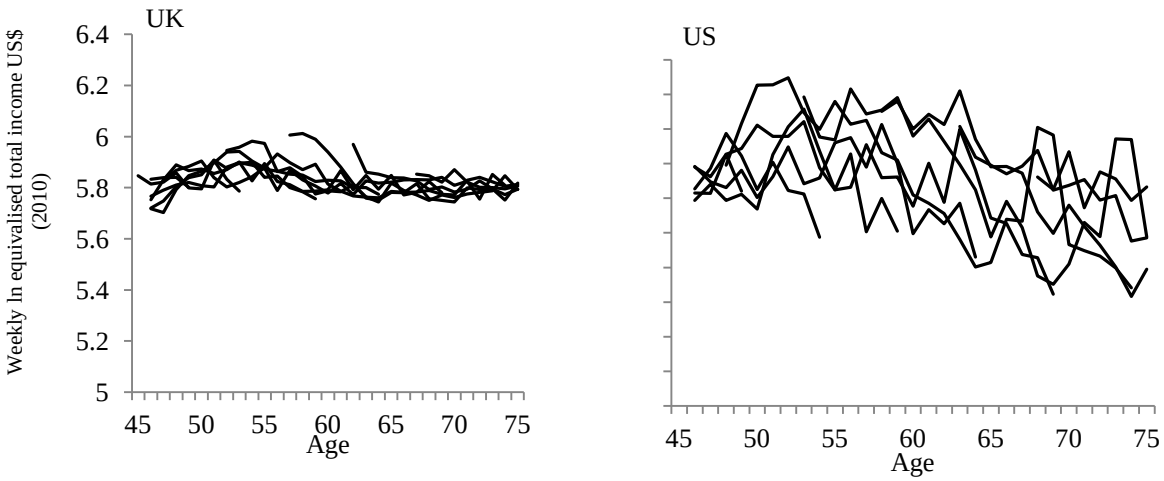

Figure 3: Log Household Income by Cohort and Age

Note: Data from LCFS in the UK and CEX for the US. Each line represents average log incomes at each age for 5- year birth cohorts over the periods they are observed between ages 45 and 79 over the period 1984-2010. Average differences across cohorts are removed by regressing incomes on cohort dummies and taking the residuals. Values are in US$ (2010). Figures equivalized using the modified OECD scale.

We illustrate age patterns of labor force participation by age in Figure 4 for men in both countries. Male age patterns of employment are clear with steady declines in participation from almost ninety percent to relatively small rates of participation by the mid-sixties.

These declines in male employment by age are somewhat more rapid in the UK compared to the United States. However, in the absence of non-separabilities in employment and consumption, differences in paths of employment at older ages in the two countries do not seem large enough to be the major explanation for the substantial differences in consumption profiles. We will examine the role of non-separabilities between labor supply and consumption in explaining the cross-country difference in consumption profiles in more detail in Sections V and VI below.[7]

[7]Age paths for women (not shown) also display the same pattern of rapid declining employment rates with age as women exit the labor force in both countries.

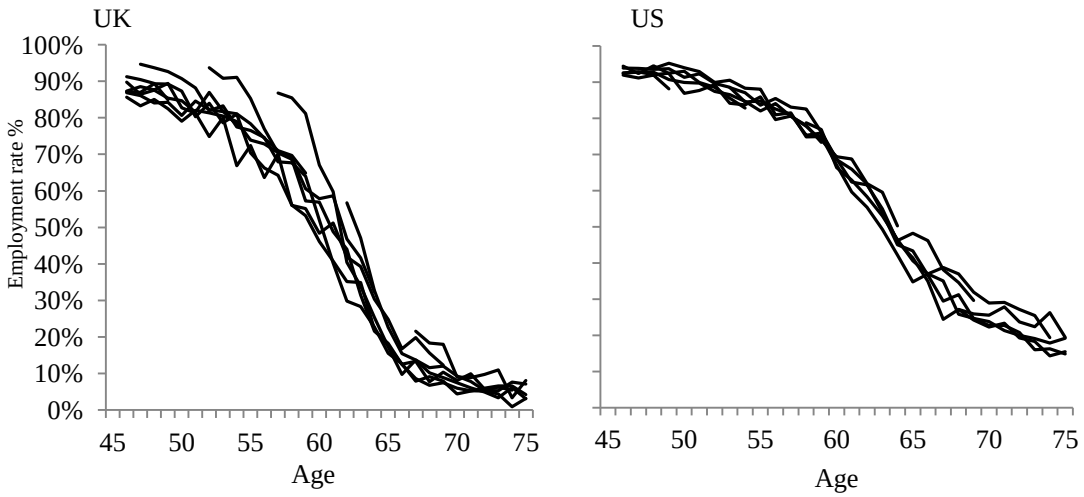

Figure 4. Employment Rates: Men by Cohort and Age

Note: Data from LCFS in the UK and CEX for the US. Each line represents average employment rates for men at each age for 5-year birth cohorts over the periods they are observed between ages 45 and 79 over the period 1984-2010.

III. Housing Ownership and Downsizing

Housing related decisions and expenditures represent another spending category in which there are important institutional differences between the countries that may affect levels and age paths of expenditures at older ages. We have provided evidence in other work that there exists far less geographical mobility in Britain compared to the United States and more downsizing in the US compared to the UK as a meaningful fraction of older Americans move to smaller homes (i.e., fewer rooms) with little evidence of such downsizing in Britain (Banks et al. (2010;2012)). While this lower rate of British mobility was characteristic of both owners and renters, the differential was particularly high among renters.

For British households over age 50, the probability of being a homeowner is about thirteen percentage points lower than for an American household, a deficit mostly offset by a higher probability of renting in highly subsidized 'social' housing. The major secular changes in housing tenure at older ages have decidedly taken place in the UK and not the US. The fraction of older British people owning their own home increased by almost thirty percentage points (from less than half to over 80 percent) from the 1908-12 cohort to the 1943-47 cohort.

In contrast over the same set of birth cohorts and age groups, the fraction of older American households who were home owners has remained relatively stable at around 80 percent.

The primary reason for this secular change in home ownership rates for older British households is due to changes in the proportion of individuals in social housing. In the UK there is a system of subsidized housing, often referred to as local authority, social or council housing. Those who are allocated a property pay a below-market rent, and the landlord will be either the local authority or a housing association. Individuals entitled to such a rental property are placed on a waiting list until suitable accommodation becomes available. While entitlement to live in social housing is subject to a strict means test, once allocated a property, tenants can usually stay for life irrespective of any changes in circumstance. Social renters have a severely reduced incentive and ability to move or to downsize their property, for several reasons. Even if a tenant's current circumstances mean that they are still entitled to social housing, moving can be very difficult because of shortages of social housing. Existing tenants are treated the same as new applicants, so if they are not in a priority group, they may not be allocated a different property. For those whose circumstances have changed in such a way that they would no longer be entitled to social housing if they were to reapply, there is a large incentive not to move as they may not be allocated a different property at all and may have to move into the private sector and pay full market rent.

There has been a sharp across cohort decline in social rental housing in the UK that parallels the increase in home ownership across cohorts (which for space considerations we do not plot). There was an almost 30 percentage point decline in the fraction of British households in social rental housing, which is pretty much the same percentage point increase observed in home ownership. Over the same set of birth cohorts, ages, and years there was little change in the fraction of households in private rental housing. These changes reflect the introduction of a 'Right-to-buy' in 1980 which required local authorities to sell council-

owned housing at a discount to eligible tenants (the policy was later extended to other forms of social housing).

The differences in levels and trends in ownership patterns between the two countries may partially contribute to an understanding of the differences in age-consumption profiles. We examine the impact conditioning on these differences might play in Section VI below.

IV. Health and the Divergence of Medical Expenditures

Our health measures are based on self-reported health status, age specific mortality rates, and out-of-pocket medical expenditures by cohort, age, and gender. Neither the CEX nor LCFS include information on health or mortality, so we draw these from other sources,

A. *Health Status*

For the UK health status data come from two cross-sectional surveys, the Health Survey for England (HSE) and the General Household survey (GHS). These surveys contain information on household's self-reported health which we average by age, sex and cohort. Two surveys are used as we do not have GHS data after 2006, and HSE data before 1991. In addition, there are two breaks in the GHS (in 1997 and 1999), due to redesigns of the survey, which interrupt the series. We make use of GHS data up to 1997 and HSE data from 1997 onwards. In the GHS respondents are asked about their general health status over the last 12 months which they answer on a three point scale: answers can be "Good", "Fairly good", or "Poor". In the HSE, households are asked to report their general health on a 5 point scale "Very good", "good", "fair", "bad", or "very bad". For consistency we group these into three categories (by putting the final three responses into a single "worst health" group). We then average health status by age, year, and sex and use this information to impute health of household heads in the LCFS. The switch from the GHS to the HSE surveys introduces a downward shift in the level of self-reported health statuses beginning in 1997. In what follows we remove this discontinuity by regressing health status in both surveys on a GHS

dummy and taking the residuals. To our self-reported health data, we add data on mortality rates by age, sex and cohort/year from the ONS Mortality tables.

For the US we use the National Health Interview Surveys (NHIS). NHIS is an ongoing nationwide survey of about 40,000 households. Since 1982, NHIS used a 5 point scale to measure respondents' general health status "Would you say your health in general was excellent, very good, good, fair, or poor?" We create three categories for consistency with our UK measure. These three groups are "excellent" or "very good", "good", and "fair" or "poor". We use these to impute health statuses to household heads and spouses in the CEX in the same way we do for the LCFS. We also calculate the proportion of responses that are self-reported in each cell to use as a control. Mortality data for the United States are obtained from the Berkeley life tables which also give death rates by age, gender and year (**http://www.demog.berkeley.edu** /~bmd/states.html).

Figure 5 plots proportions of those in worst health in both countries showing several distinct patterns in health status in both countries. First levels of worse health are always higher in the UK than in the US. However, these different levels of subjective health status in the UK compared to the US have been shown to be due to different subjective health thresholds between the two countries. In the age groups we are considering the British are typically healthier than the Americans with prevalence of almost all diseases higher in the US compared to the UK (Banks et al. (2006)). At the same objective health levels, the British report themselves in worse health on subjective scales. The second pattern to note in Figure 5 is that the fraction of a cohort in poor health rises with age in both countries. The third pattern concerns cohort effects in these paths of health at older ages. While, there is little evidence of cohort differences in the UK; cohort differences are however apparent in the US. Finally, we note that subjective health declines faster with age in the UK than the US. We attempt to

account for the potential role of health status in explaining the different expenditure patterns we observe in Figure 1 in our regression analysis below.

The impact of declining health on consumption decisions in a life-cycle model will depend on how it affects the marginal utility of consumption. If poor health reduces the marginal utility of consumption, then we will observe that consumption declines more steeply with age as health deteriorates. Various papers have investigated the dependence of the marginal utility of consumption on health without achieving consensus on either its sign or magnitude (see Finkelstein, Luttmer and Notowidigdo (2009) for a survey of the available literature). Lillard and Weiss (1997) find that there is substantial positive effect on marginal utility using panel data on consumption (as inferred from income flows and asset changes) and health shocks. By contrast, employing a novel approach that combines data on permanent

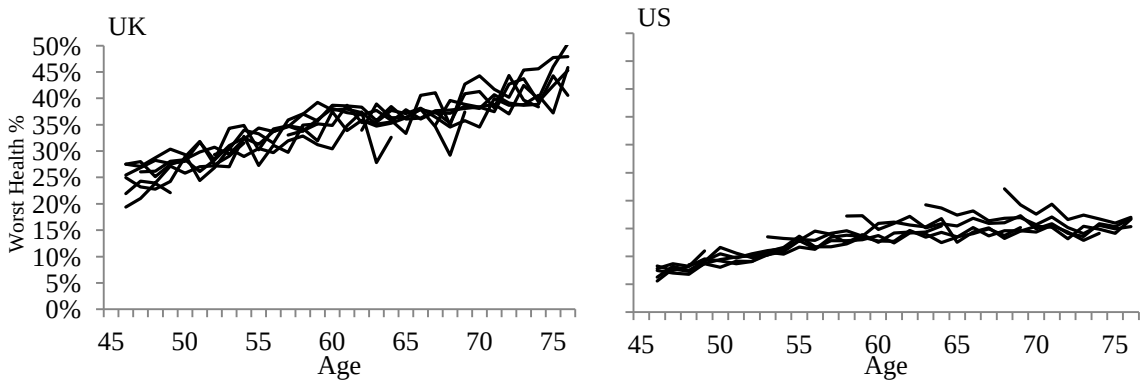

Figure 5. Proportion of Responders in Worst Health by Cohort and Age

Note: Data for the UK is from the HSE and GHS surveys spliced together (adjusted to remove discontinuity between the surveys). Data for the US is from the NHIS. Each line represents proportion of household heads reporting being in the worst health condition at each age for 5- year birth cohorts over the periods they are observed between ages 45 and 79 over the period 1984-2010.

income, utility proxies and health data, Finkelstein, Luttmer, and Notowidigdo (2008) find a substantial negative effect. Other studies have essentially found no effect. De Nardi, French and Jones (2010) estimate a model allowing preferences over consumption to be health dependent. They find that the parameter governing the effect of health on the marginal utility is negative but statistically insignificant.

Table 2: Life Expectancies at Different Ages, 1984 and 2010

Age	UK	US
	1984	
	Males	
60	16.60	17.79
65	13.24	14.48
70	10.31	11.52
75	7.86	8.99
80	5.91	6.82
	Females	
60	21.06	22.48
65	17.20	18.63
70	13.63	15.03
75	10.44	11.77
80	7.70	8.85
	2010	
	Males	
60	22.03	21.64
65	18.03	17.89
70	14.33	14.39
75	11.00	11.19
80	8.10	8.37
	Females	
60	24.92	24.63
65	20.66	20.50
70	16.61	16.63
75	12.88	13.05
80	9.55	9.83

Note: For the UK these are taken from the ONS lifetables. US figures are obtained from the Human Mortality Database (http://www.demog.berkeley.edu /~bmd/states.html)

B. *Life Expectancies and Age Paths of Mortality*

We present information on life expectancies at different ages in two countries in Table 2. The top panel shows life expectancies in 1984. The bottom panel shows equivalent figures for 2010. For both men and women, life expectancies at each given age tended to be greater in the US than the UK in the early part of our sample (these differences had largely disappeared by the end of our sample period in 2010).

In the standard life cycle model, higher age specific mortality risk acts like a decline in the interest rate encouraging current consumption and producing a steeper decline in

consumption with age. Mortality risk rises steeply with age in both countries with mortality risk about ten times larger at age 70 compared to age 45. There is evidence of cohort improvements in mortality that are larger in the UK compared to the US. However, the shape of the age mortality risk function appears to be similar in the two countries suggesting once again that differential mortality risk by age, see Hurd (1989), does not appear to be the likely source of the significantly differently age shapes in consumption in the two countries documented in Figure 1. In any case, we account for mortality's potential role in explaining spending differences within a regression framework in what follows.

C. *Medical Expenses*

On the health side of potential explanations, we have so far explored age patterns at older ages in general health status and mortality. While both health dimensions may play a role in shaping consumption profiles at older ages their ability either alone or together to account for the much flatter nondurable consumption with age in the United States compared to the UK seems limited. The final health dimension we examine—health expenditures—appears to us to offer far more potential since there are large differences between the two countries. While consumption of medical services may increase in both countries as individuals age, differences in how the costs of these are financed will show up as differences in both the level of measured out-of-pocket expenditures and their dispersion.

How health costs are financed at older ages in the two countries are quite different. To a large extent, UK medical costs at all ages are paid by the state with very little absorbed by the individual. [8] State provision not only includes medications, doctor visits, and hospitalizations. Charges are however typically levied for prescription drugs and dental care. There are also often charges for long-term care costs as we discuss below.

[8] In 2016 for example, healthcare expenditures totaled $4192 per capita in the UK, of which roughly 80% was paid for by the government. This compared to $9892 in the US of which roughly 50% was public expenditure (see https://data.oecd.org/healthres/health-spending.htm)

The situation is very different in the US where government assistance for health care is incomplete and a large proportion of the costs of medical insurance are met by employers or directly by households rather than by government. Government assistance for health care in the US is mostly provided through the Medicare and Medicaid programs.[9] Figure 6 shows enrolment under the two schemes over the ages we consider. Medicare provides some insurance for the vast majority (over 90%) of households with heads over 65 but only a limited proportion of younger households. Around 10% of households receive some assistance from Medicaid, a share which also increases somewhat (from around 7% to around 10%) as individuals' age from 45 to 75.

While previous studies have found that Medicare eligibility reduces both the mean and variance of out-of-pocket (OOP) medical expenditures (Barcellos and Jacobson (2015)), it does not eliminate the need for them entirely. Coverage is neither free nor comprehensive with various direct costs for households. While hospital insurance (Medicare Part A) is typically provided free of charge, insurance for doctor's services and prescription drugs (covered under Parts B and D) involve income-contingent premia. Individuals covered under Medicare Part C (or Medicare advantage) contract with a private company to receive their part A and B coverage and may pay a higher premium for additional coverage. In addition, Medicare does not cover the costs of all treatments and even when treatments are covered patients must pay deductibles, co-payments and co-insurance from their own resources.

[9] Medicare is a government insurance program for the elderly. Most individuals become eligible for the scheme when they turn 65. Eligibility is automatic for those who have worked and accumulated Social Security credits for at least 10 years prior to reaching this age, but those who do not meet this requirement may also qualify on the basis of their spouse's contribution history. There are however some groups who can qualify at younger ages. For example, those who have received Social Security disability benefits for at least 24 months automatically receive partial coverage. Around 12% of the population is already enrolled by the time they reach age 65 (Card et al. (2009)). Medicaid is general scheme that provides reduced cost or free health services for low-income and low wealth households, including those attempting to meet the costs of their long-term care. Exactly who or what is eligible varies from state to state with the federal government specifying minimum standards of coverage.

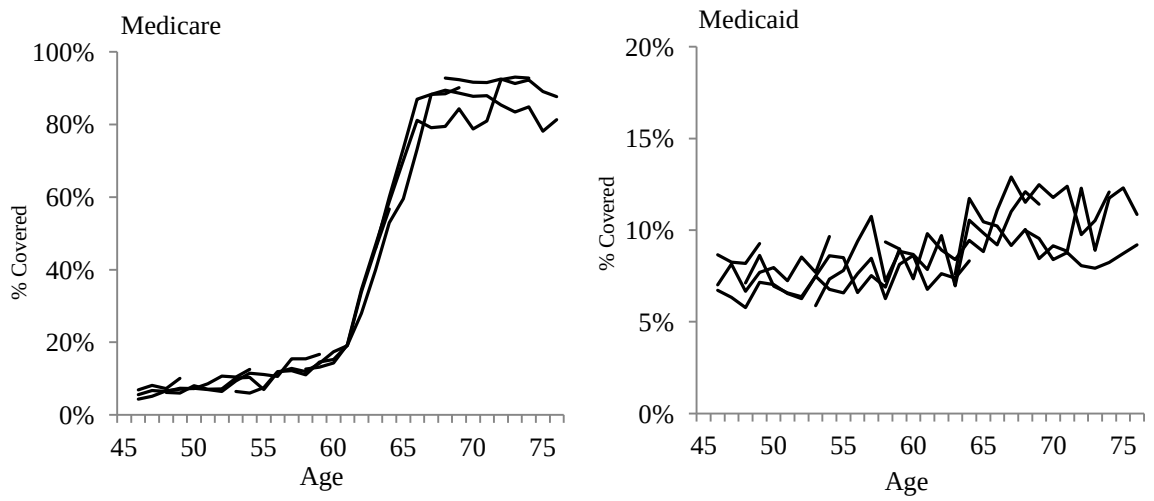

Figure 6. Proportions Covered by Government Programs, US

Note: Data from CEX. Each line represents proportions of households with at least one member covered by Medicare or Medicaid at each age for 5- year birth cohorts over the periods they are observed between ages 45 and 79 over the period 1994-2010.

A further institutional difference between the two countries is that, in the US, a large fraction of individuals have their private insurance costs covered by third parties (usually employers). This proportion tends to decline with age however as individuals retire and leave the labor market. Prior to age 65, a majority of American households have their insurance at least partially paid for by some third party but this falls to around 40% at age 70 as the left panel in Figure 7 shows. Similarly, the proportion of households who have insurance but pay nothing (shown in the right panel of Figure 7) falls from 20% at age 45 to less than 3% at 75. For workers the share of health costs paid by employers is substantial, at around 75-80% of the total.[10]

The institutions in the two countries naturally have consequences for paths of medical expenditures as individual's age. We plot the budget shares for medical spending in for the two countries in the two panels of Figure 8. Not only are medical costs in the UK lower as a share of the budget (always under 5 percent) but there are only modest increases in this share

[10] See Exhibit 4.1 in http://meps.ahrq.gov/mepsweb/data_stats/MEPSICChartbook.pdf

with age. In contrast, the US graph indicates much higher and sharply rising medical costs shares at older ages in the US that are not due solely to cohort effects. To illustrate, medical costs shares in the US are approximately eight percent at age 45 and rise steadily until they are around 20 percent of the total budget by age 70.

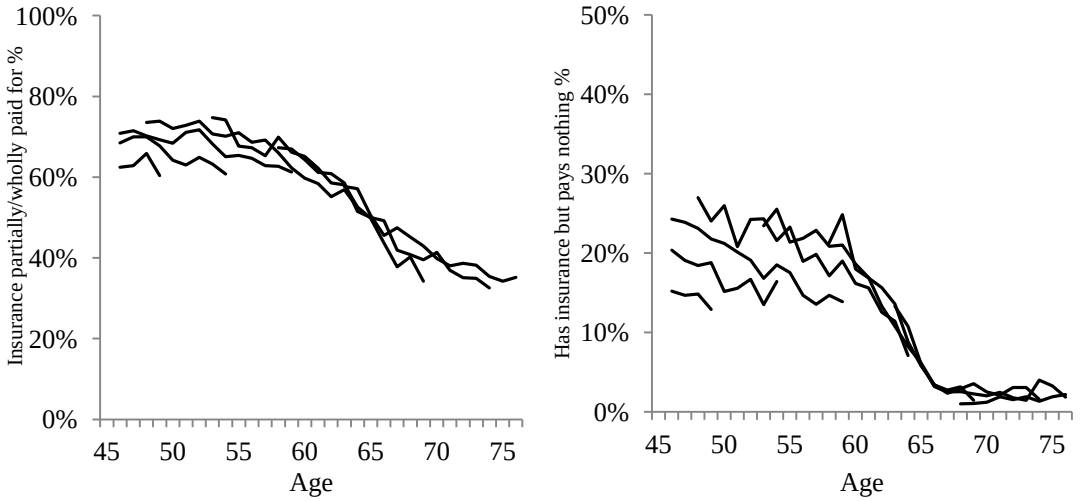

Figure 7. Insurance paid for by others, US

Note: Data from CEX. Each line represents average coverage rates at each age for 5- year birth cohorts over the periods they are observed between ages 45 and 79 over the period 1994-2010. The left panel shows the proportion of households who report insurance policies wholly or partially financed by third parties. The right panel shows the proportion of households who pay no insurance costs but report being covered by insurance paid for by third parties.

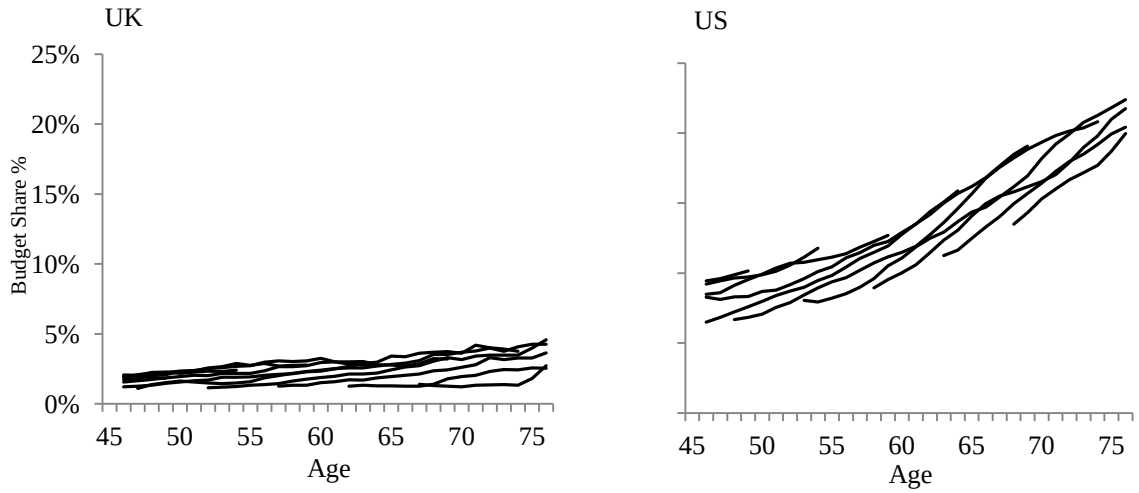

Figure 8. Share of Cohort Spending on Medical Care

Note: Data from LCFS in the UK and CEX for the US. Each line represents average budget shares out of nondurable expenditures at each age for 5- year birth cohorts over the periods they are observed between ages 45 and 79 over the period 1984-2010.

The decomposition of these medical expenditures for a single cohort is shown in Figure 9.[11] In the UK, the majority of medical spending goes towards non-insurance costs. In the US insurance premia are far more important. Medicare spending begins to rise when the head reaches age 65 but the trajectory of overall spending is smooth.

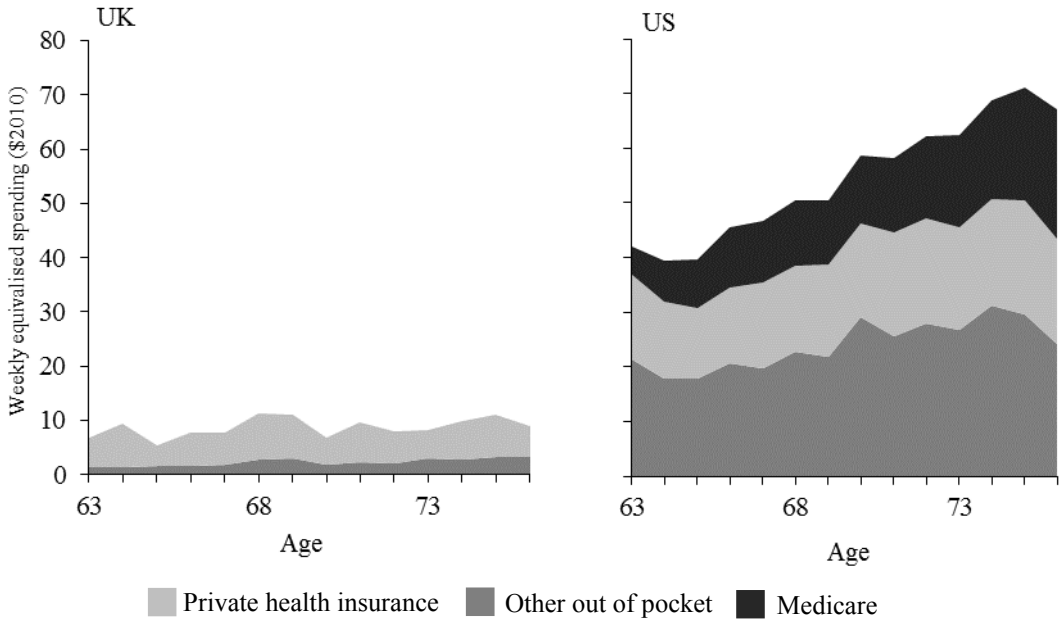

Figure 9. Composition of Medical Spending (1928-32 Birth Cohort)

Note: Data from LCFS in the UK and CEX for the US. Values shown over the period 1994-2010. Values are in US$ (2010).

Information on the distribution of medical expenses, and the riskiness of such expenses, is harder to come by, particularly in the UK. Table 3 compares the distribution of annual OOP medical expenses by major categories in the UK and US, for all households aged 60 or over.[12] The HRS only includes medical equipment spending in later years and so these are not included in the US data. Consistent with the graphs for the 1928-1932 cohort in Figure 9 above, the table shows that average costs in the US are almost seven times larger in

[11] Results from other cohorts are very similar.

[12] The best source of information to breakdown such expenses is the longitudinal ageing surveys and we use the US Health and Retirement Survey for this analysis. Since the level of out of pocket medical expenses is so low the English equivalent of the HRS does not collect information on such spending, so we use the cross-sectional LCFS data as in rest of our analysis above.

Table 3:Yearly Medical Expenditures by Country- 2000-2006 Age 60+

A. UK

Variable	Mean	P25	Median	P75	P90	P95
Total	762	0	46	375	1,729	3,788
Excluding insurance	574	0	13	255	989	2,243
Private insurance	188	0	0	0	88	881
Prescription drugs	118	0	0	129	342	553
Health services	234	0	0	0	0	1,118
Hospital	41	0	0	0	0	0
Medical equipment	180	0	0	0	0	145

B. US

Variable	Mean	P25	Median	P75	P90	P95
Total	5,201	443	2,458	6,125	11,929	17,313
Excluding insurance	3,361	225	1,122	3,025	6,568	11,152
Private insurance	1,772	32	509	1,592	3,711	5,889
Prescription drugs	1,841	0	150	2,429	5,701	8,236
Health services	964	6	189	718	1,838	2,952
Hospital	301	0	0	0	365	1,062

Note: Data from the Health and Retirement Survey in the US and LCFS in the UK. Values are annual averages for households where at least one member is aged 60 or over. Values are in US$ (2010). Figures exclude spending on nursing homes.

the US than they are in the UK, with a mean of over $5,201 per year compared to just $762 in the UK,. And even though insurance makes up proportionately more of the US expenses, the country differences are of the same order of magnitude if we exclude insurance payments. But the US data also exhibit considerably greater variance. To illustrate health expenses at

the 95th percentile are around $17,313 per year (compared to $3,788 in the UK), indicating a much larger risk of very large medical costs in the US.[13]

One final 'institutional' difference between the two countries may be in the nature or extent of family ties and caring by family members and this may have effects on medical expenses. A full investigation of the links between family care and other medical expenses is an important topic for future research but it is beyond the scope of this paper. We briefly investigated the link between health, family care and OOP medical expenses in the HRS data. For individuals reporting three or more limitations in Instrumental Activities of Daily Living (IADLs), 97% reported receiving some assistance from family, but this had no relationship with OOP expenses. In the UK we cannot make a similar calculation since there is no dataset with OOP expenses and health, disability or the receipt of family care, however since OOP expenses are so low for so many individuals, as discussed above, such a relationship between family caring and OOP medical expenses is unlikely to be important.

D. *Long-Term Care Costs*

One important source of medical cost uncertainty is in the cost of long-term care. This tends to be most important at older ages (for instance, rising over three-fold in the US for those aged over 85 compared to those aged 75-84 (Fahle, McGarry and Skinner (2016)). However, in so far as these expenses also generate precautionary motives, they may also affect spending behavior of households within our sample (Ameriks et al. (2017)).

In the UK, long-term care costs are not typically covered by the NHS, though care costs are often paid for, wholly or partially subject to a means test of resources by local

[13] Since the HRS data are a panel we can also look at longer term spending totals, and indeed the persistence of expenses over time. As well as being highly concentrated, medical expenses are also shown to be strongly persistent over the six year period, with the correlation between total medical expenditures in 2002 and total medical expenditures two and four years later being 0.66 and 0.6 respectively. (Full results available from authors on request).

authorities. Estimates on the relative importance of private versus public spending on long term care indicates that the majority of costs in the UK are paid for by the public sector. Private spending on formal care is roughly half the value of spending by local authorities (National Audit Office, 2014) and only around a quarter of over 65s receiving formal care report paying for it themselves (Crawford and Stoye, 2017).

In the US Medicare does not directly cover the costs of long term nursing care, though it can cover related costs such as care in skilled nursing facilities and home health care. Long-term care costs are often covered under the Medicaid program, subject to a means test of resources. In 2004, the proportion of total long-term care costs paid for under these two programs was nearly 60% (CBO, 2004).

Despite differences in the institutions for funding long-term care costs, both the overall level and proportion of long-term care financed through private spending is similar in the two countries (OECD, 2005). And census data show that the proportion of the population aged 65 and over who are resident in institutions is also very similar in the two countries at around 3.6% in the UK and 4.1% in the US (Peeters et al., 2013, Fig.1).

Nursing home costs are not well covered in our household expenditure surveys so in order to make what comparisons we can we draw on the English Longitudinal Study of Ageing, which only includes nursing home care costs in its most recent wave (covering spending in the period 2014-2016). We then compare this to the latest wave of the HRS to which we have access (covering the period 2012-2014). Even in these two surveys, which focus specifically on the older population, the measurement of costs, and even the coverage of the survey, is not comparable for those who are resident in institutions, with the main difference being that the ELSA data does not currently include any measures of spending for those currently residing in institutions. In this respect, HRS data has 3.7% of households over

aged 60 with at least one member resident in an institution and a mean spending over the last two years of $847 in 2010 prices. This is lower than all but one component of out of pocket medical expenses identified in panel B of Table 3 for the US. But the distribution is highly skewed for those who do incur costs (median out-of-pocket spending over the previous two years amongst those in institutions was $930, the 75th percentile was $31,157 and the 95th percentile was $104,950).

The ageing surveys do, however, have comparable measures for out-of-pocket nursing home spending over the last two years for those currently residing in the household sector. Once again, mean spending is low although a minority of households pay high costs. These patterns are similar in the two countries. 98.3% of the US household population over aged 60 either did not use nursing home or institutional care in the previous two years or else paid nothing for their usage. The corresponding number in England is 99.4%. Mean annual spending was $53 in the US and $30 in England and, conditional on having to pay something the top of the distribution in each country was rather similar. Further details of the distribution of these transitory nursing home costs is in Table A1 of Appendix A.

Taking all this evidence together, it is clear that nursing home costs are small on average but a significant expense but for a small minority of households as would be expected. But the risks of high nursing home expenses and the size of the out-of-pocket costs if they are incurred are both somewhat similar in the two countries.

V. Expenditure Allocations across Goods and the Life-cycle

In the previous sections we noted possible links between trends in demographic variables and consumption at older ages. We have highlighted differences in particular in the decline in employment, and the pattern of home ownership between the two countries. We

have also noted strikingly different patterns of medical expenditures, summarized in Figure 8, largely reflecting differences in the delivery of health services in the US and the UK.

We now look more formally at possible interactions between demographic variables and consumption, which could affect the age path of consumption, starting with a model of consumer preferences. Let utility in each period *t* for consumer *i* be given by

$$U_t = U\left(q_{i,t}, h_{i,t}, H_{i,t}, X_{i,t}\right) \qquad (1)$$

where $q_{i,t}$ is a vector of demand for non-medical consumption goods and services, $h_{i,t}$ represents the consumer's medical consumption, $H_{i,t}$ denotes health status and $X_{i,t}$ represents other characteristics.

Denoting $p_{q,t}$ as the vector of prices for non-medical goods, within-period demands for $q_{i,t}$ are determined according to the *conditional* demand function

$$q_{i,t} = f(p_{q,t}, c_{i,t}, h_{i,t}, H_{i,t}, X_{i,t}) \qquad (2)$$

where $c_{i,t}$is total real consumption budget in period *t*, conditional on medical consumption $h_{i,t}$, health status $H_{i,t}$ and other characteristics $X_{i,t}$. The presence of the medical consumption term $h_{i,t}$ allows for the possibility of non-separability between medical consumption and non-medical consumption, see Browning and Meghir (1991). Endogeneity of $h_{i,t}$ is addressed using the prices of medical consumption as instruments.

If we further assume that intertemporal preferences for allocating the consumption of non-medical consumption $c_{i,t}$ has the CRRA form

$$U_t = \exp\left(X_{it}\phi_1 + \phi_2 h_{i,t} + \phi_3 H_{i,t}\right)\frac{c_{i,t}^{1-\gamma}-1}{1-\gamma} \qquad (3)$$

then we can obtain the following (approximate) *conditional* Euler equation governing intertemporal spending allocations[14]

$$\Delta \ln c_{i,t} = \alpha \ln r_t + \Delta X_{it}\beta + \zeta \Delta H_{i,t} + \eta \Delta \ln p_{h,t} + u_{i,t} \qquad (4)$$

[14] See, for example, Blundell, Browning and Meghir (1994).

where Δ is the first difference operator (i.e. $\Delta x_t = x_t - x_{t-1}$), r_t is the real interest rate, ΔX_{it} the change in a variety of demographic and household characteristics, and $\Delta H_{i,t}$ is a measure of the change in health status by household members. By additionally conditioning on the change in real price of medical consumption $\Delta \ln p_{h,t}$ we allow for non-separability with medical consumption.[15] For example, this price term captures any substitution away from medical consumption as the relative price of medical consumption increases.

In the application we also allow for uncertainty in medical expenses that might induce precautionary saving. To do this we follow Banks et al. (2001), and incorporate an additional conditional variance term in the consumption growth equation (4) to reflect uncertainty over shocks to future medical expenses.

A. *Within-period expenditure allocations*

As the preceding discussion shows, non-separabilities may be present *within period* (affecting relative demands for particular goods but not the level of spending) or *across time* (affecting the inter-temporal allocation of consumption). In this section, we examine the shares of expenditure on different goods and looking for within-period non-separabilities. We turn to inter-temporal interactions in the next section.

We estimate an extension of the Almost Ideal specification of Deaton and Muellbauer (1980) that includes an additional quadratic term in income (see Banks et al. (1998)). Our interest is in establishing the nature of within-period non-separabilities between consumption and housing, health and employment in the two countries through the effect of these variables on household budget shares. By including total expenditure and prices, we control for differences in trends in relative prices and wealth across different birth cohorts in the two

[15] We could have conditioned directly on the change in medical consumption $h_{i,t}$ and used changes in medical prices as instruments. We decided instead to include the price term to directly capture the effect medical price inflation.

countries, which may otherwise confound our estimates. The precise specification of the model and the estimation results are presented in Appendix B.

In both countries, the demand system results show that those who rent not surprisingly spend a much smaller share of the budget on housing related expenditures. In the US the share spent on housing related expenses is 10 percentage points lower for renters than those who own. In the UK the equivalent number is 4 percentage points. The estimates in Table B1 of Appendix B indicate renters consequently devote higher shares to all other goods (except food at home in the US), with a particularly large effect for other nondurable spending. Owning a home outright (compared to owners who still have a mortgage to pay off) leads to small reduction in housing related expenses in both countries (though the effect is not significant in the UK).

Employment effects look as expected – in both countries when the head is employed less is spent on recreation and more is spent on food out and on transport, which is most likely associated with transport to work. Employment in the United States is associated with more food consumption both in and out of the home, but in the UK there is a substitution of food consumption to out of the home. When both head and spouse are working, there is a reduction in spending on food at home in the US.

Important differences emerge in the relationship between employment and health costs, however. In the United States where people bear more of the responsibility for paying their medical costs, the head's employment reduces out-of-pocket medical expenses, a much larger effect than in the UK where the effect is essentially zero. Although this could partly be explained by incomplete controls for health in the model, the key difference is the association between medical insurance and being in a job in the United States (as reflected in Figure 7). In the US, the head being employed reduces the proportion spent on medical spending by 1.7 percentage points but there is no similar effect in the UK. This could reflect employers

meeting some healthcare costs for their employees in the US (which in the UK would be met by the state). Whether the spouse works or not, does not appear to contribute to this effect.[16]

Due to the data limitations described above, our mortality and subjective health measures capture variations in health status that occur on average at the cohort level rather than individual level variation. A higher risk of mortality among the cohort increases medical spending in both the US and UK with, perhaps unsurprisingly in light of the differential financing of medical care in the two countries, a much larger effect in the US. In the UK reductions in subjective health controlling for mortality have little effect on the composition of total household consumption (except for a reduction in spending away from home). In contrast, a worsening of the cohort's subjective health status in the United States leads to an apparent (but statistically insignificant) *reduction* in medical expenses once the effects of mortality are controlled for. This likely reflects some difference in health spending among cohorts that we have not been able to control for (for instance, those caused by institutional changes in Medicare coverage or changes in the availability of expensive, technology-intensive health services over time).

Comparing the positive impact of mortality probabilities on medical spending with the zero or negative effects for self-reported health suggests that subjective measures of health may not improve even when objective measures of health do. One possible explanation for this is that people assess their health relative to others in their cohort (so self-reported health status would tend to vary within but not between cohorts), weakening its association with actual health conditions and so medical expenditures.

In Table B.2 of Appendix B we show coefficients from demand system excluding medical spending, additionally controlling for the quantity of medical consumption (defined

[16] When we exclude health insurance spending from medical expenditures the estimated impact of employment on the share of spending on medical in the US goes from -1.7 to -0.9. The value of this coefficient may seem surprising given discounts for employer-sponsored insurance, However, those leaving employment may still be covered by third parties as Figure 7 suggests (e.g. through retiree benefit plans).

as the volume of medical spending or expenditure divided by price). This is a model of *conditional* demands (using the language of Pollak (1969)), allowing us to test for the presence of non-separabilties in medical consumption over and above those associated with ill-health. In both countries, much medical consumption is publically provided and can only be obtained in rationed quantities. As a result, we instrument medical consumption with its price. To make our results easier to interpret, we also scale medical expenses by their standard deviation in both countries. We use a test of the significance of the medical quantity term to test the hypothesis of separability between medical and other demands. In both countries, we find evidence of non-separability. In the US, higher medical quantities are associated with significantly lower spending on other nondurables and recreation. Our results imply a one standard deviation increase in medical quantities in the US is associated with an increase in the US budget share on housing related goods by around 7 percentage points. The direction of effects for the UK are similar to those for the US, except that higher medical consumption in the UK is associated with lower (rather than higher) spending on housing and with higher (rather than lower) recreation spending. However, the latter of these effects is not significant in the UK.

VI. Inter-temporal Allocations of Consumption

The estimates from the previous sections have shown that health, labor supply, mortality and tenure do affect patterns of spending within any given period. Despite these factors displaying similar life-cycle profiles in the two countries, the effects on within-period spending are somewhat different in the two countries, especially in relation to medical expenditures. We now turn to our analysis of inter-temporal consumption changes controlling for such differences again tracking group level averages over time. In this section we split households into groups defined by education (whether or not the household head or their spouse completed high school), as well as year and 5-year birth cohorts.

A. *Growth Rates in Consumer Expenditures*

Our demand system estimates show that there is a much greater shift towards medical spending as age increases in the US than in the UK, and this is partly arising through non-separabilities with employment, perhaps due to the importance of employer-provided health insurance. This suggests a role for medical costs in explaining different age-profiles of total expenditure.

Table 4. Average Consumption Growth Rates

	UK	US	Country Difference
A. Expenditure			
Nondurable	-2.21%	-1.37%	-0.84%
Nondurable less medical	-2.28%	-2.05%	-0.23%
B. Equivalized Expenditure			
Nondurable	-0.65%	-0.05%	-0.59%
Nondurable less medical	-0.72%	-0.72%	0.00%

Notes: Observations weighted by cell size. Equivalized using the OECD scale. Equivalized using the OECD scale. The OECD scale is 1 for first adult, 0.5 for each additional adult and child 14 and over and 0.3 for each child under 14.

Table 4 shows the results from taking an average over the rates of decline in spending for nondurable goods, and nondurable goods not including medical spending for our different cohort-education groups. Nondurable expenditures decline by 2.21% a year on average for cohort-education groups in the UK compared to 1.37% in the US, giving a statistically significant difference of 0.84% between the countries (p-value 0.034). This difference in consumption expenditures before equivalization between the two countries falls by just under

three quarters when medical spending is taken out. This suggests that differing healthcare financing institutions may explain a significant part of the difference between the countries. [17]

Of course, one reason consumption declines at middle and older ages is that people leave the household for several reasons which include the exit of adult children into homes of their own, divorce and the death of a spouse. This pattern is illustrated for both countries in Figure 10 which plots by age and cohort the fraction of households who contain three or more adults. These fractions decline significantly with age in both countries, especially between ages 45 and 60 continuing at a somewhat slower pace after age 60.

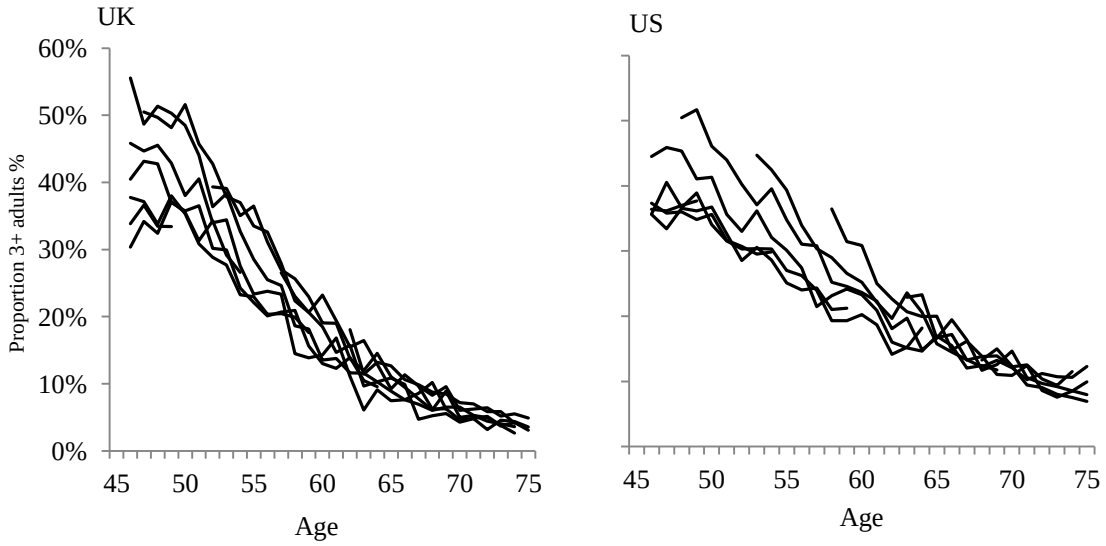

Figure 10. Proportion of Households with 3 or more Adults

Note: Data from LCFS in the UK and CEX for the US. Each line represents proportions of households with 3 or more adults (individuals over 16) for 5- year birth cohorts over the periods they are observed between ages 45 and 79.

Declines in the number of adults in the household will of course play a role in producing consumption declines at older ages. When we use equivalized consumption expenditures instead in part B of Table 4, not surprisingly we see that rates of decline in both

[17] Both surveys have seen declines in expenditure relative to aggregate measures of household spending as reported in the countries' respective National Accounts. This steady decline in coverage may have implications for cross-country differences estimated here. For the definition of spending we are considering however, changes in coverage over time do not appear important for our results. We discuss this further in Appendix D.

measures of consumption are significantly reduced in both countries. This indicates that reductions in the number of people in the household, primarily the exit of children and death of spouses, play an important role in the rates of decline in both measures of consumption among those ages 45 and above. However, the difference between the two countries in declines in total nondurable consumption remains large (at 0.59%). Once again this difference between the countries disappears when we examine nondurable consumption less medical expenses.[18,19]

In addition to the role of medical expenses, however, the results in the previous section also highlight the potential importance of other non-separabilities for instance relating to housing and employment. To see the extent to which controlling for differences in these and other demographic trends can explain the steeper decline in nondurable nonmedical consumption that we see in the UK we follow the discussion of consumption growth equation (4) and run a regression of the following form:

$$\Delta \ln c_{s,k,t} = \gamma_1 US + \gamma_2 UK + \alpha \ln r_{s,t} + \theta \ln m_{s,k,t} + \Delta X_{s,k,t}\beta + u_{s,k,t} \qquad (5)$$

where k denotes a cohort-education group, s denotes country and t year. $c_{s,k,t}$ denotes nondurable consumption (initially including medical expenses which we later remove), $m_{s,k,t}$ is the mortality rate, $\ln r_{s,t}$ is the log real interest rate, and $X_{s,k,t}$ is a set of demographic controls including family size, employment, health status, and housing tenure. *US* is a dummy for the United States and *UK* a dummy for the United Kingdom. The model contains

[18] For completeness we include a full decomposition of spending on different categories for a given cohort in Appendix C. Declines in expenditure for non-medical spending categories are remarkably similar across the two countries.

[19] In addition to considering differences in mean expenditure, we also examine growth across the 25th, 5th and 75th and 90th and 95th percentiles of the spending distribution. While the decline in spending growth in both countries is faster towards the bottom of the distribution, there is no clear evidence that cross-country difference in expenditure declines varies much across the spending distribution. This suggests that the UK-US differences are not driven by a few high spending individuals at the top of the distribution in the US.

no constant term. The difference between the coefficients γ_1 and γ_2 indicates the how much faster expenditures decline in the US relative to the UK once other factors have been controlled. We think of this as the unexplained component of the cross-country difference, and report it separately in the regression results that follow (multiplied by 100 to give a value in percentage point terms).

There may be some risk of endogeneity in estimates presented from OLS versions of equation (5). Households that move out of employment or change their tenure status may adjust their spending because these developments are responses to unexpected shocks that also lead households to reassess the value of their lifetime resources, rather than just because of non-separabilities in household preferences. For instance, estimating the average change in consumption when households change their employer statement may exaggerate the causal impact of employment on spending changes, if households did not already anticipate the change in job status. For this reason we also report results for IV models in which we instrument changes in employment, housing tenure, health and mortality with their first and second lags. Under standard rational expectations assumptions, these should be correlated with current realizations of these variables uncorrelated with unanticipated shocks that enter $u_{s,k,t}$.[20]

Results for different versions of model (1) are shown in Table 5. Column (1) shows results using Weighted Least Squares (using cohort cell sizes as weights) with no controls and including medical spending. These results are the same as those shown in Table 4 except that to maintain comparability across regression models, we use the same sample as we will use in subsequent regressions. The difference in the average rates of decline across the two countries is once again around 0.8 percentage points and significant at the 5% level. In column (2) we add demographic controls for the number of children and adults in the

[20] We calculate lagged means excluding observations from those interviewed in the following period for the CEX.

Table 5: Changes in Log Nondurable Expenditure

	Including Medical				Excluding Medical			
	WLS	WLS	WLS	W2SLS	WLS	WLS[a]	W2SLS	WLS[a]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
US	-0.014***	-0.004*	0.001	-0.008	-0.016	-0.036**	-0.042**	-0.025
	(0.003)	(0.003)	(0.011)	(0.017)	(0.011)	(0.016)	-0.019	(0.016)
UK	-0.022***	-0.011***	-0.007	-0.016	-0.017	-0.031**	-0.037**	-0.026*
	(0.003)	(0.003)	(0.011)	(0.018)	(0.012)	(0.014)	-0.017	(0.014)
Interest rate			0.037	0.181	0.049	0.101	0.183	0.206**
			(0.089)	(0.153)	(0.092)	(0.095)	-0.124	(0.097)
Log Mortality			0.001	-0.001	-0.001	-0.005	-0.005	-0.003
			(0.002)	(0.004)	(0.003)	(0.003)	-0.004	(0.003)
Δ Head employed			0.089**	-0.045	0.105**	0.101**	-0.006	0.093**
			(0.044)	(0.178)	(0.045)	(0.044)	-0.138	(0.045)
Δ Renter			-0.419***	0.031	-0.440***	-0.443***	-0.193	-0.404***
			(0.051)	(0.240)	(0.052)	(0.051)	-0.168	(0.052)
Δ Number of kids		-0.036	-0.017	-0.060	-0.007	-0.003	-0.029	-0.003
		(0.038)	(0.040)	(0.063)	(0.041)	(0.041)	-0.049	(0.041)
Δ Number of adults		0.244***	0.227***	0.248***	0.235***	0.232***	0.246***	0.220***
		(0.030)	(0.029)	(0.041)	(0.029)	(0.029)	-0.032	(0.030)
ΔSingle		-0.345***	-0.262***	-0.325***	-0.221***	-0.226***	-0.272***	-0.228***
		(0.057)	(0.055)	(0.084)	(0.056)	(0.056)	-0.067	(0.056)
ΔWorst health			-0.230***	-0.898	-0.226***	-0.224***	-0.412	-0.236***
			(0.073)	(0.608)	(0.075)	(0.074)	-0.409	(0.075)
$\pi^2_{s,k,t-1}\phi_{s,k,t}$						0.002*	0.003*	0.002*
						(0.001)	-0.002	(0.001)
ΔLog Medical Price								-0.388***
								(0.072)
(US-UK)× 100	0.843**	0.604*	0.745**	0.786	0.106	-0.479	-0.462	0.106
	(0.409)	(0.353)	(0.372)	(0.551)	(0.382)	(0.497)	-0.572	(0.543)
N	650	650	650	650	650	650	650	616
Sargan p-value				0.907	0.872	0.632		

* p<0.10, **p<0.05, ***p<0.01, Estimates presented are for Weighted Least Squares and Weighted Instrumental Variable regressions with weights given by cell sizes in each education-year-cohort cell. The dependent variable is log nondurable consumption (cols 1-4 with medical expenditure, cols 5-8 without). Additional controls for switch from GHS to HSE surveys in the UK, change in proportion of households reporting own health in US, and the change in proportion responding to subjective health questions. In columns (4) and (7) we instrument employment, renter, health and mortality (and GHS, self-report dummies) with their first and second lags. In columns (7) we additionally instrument $\pi^2_{s,k,t-1}\phi_{s,k,t}$ with $\pi^2_{s,k,t-2}\phi_{s,k,t-1}$.

[a]In columns (6) and (8) we instrument $\pi^2_{s,k,t-1}\phi_{s,k,t}$ only. All other variables are treated as exogenous

household and a dummy for whether the household head is single. Once these are controlled for, average rates of decline fall in both countries and the difference in rates of decline shrinks slightly but remains positive and significant.

Column (3) adds additional controls for employment, renter status, mortality and health, as well as the interest rate. These additional controls that capture possible non-separabilities and macroeconomic differences between the two countries once again do not appear to explain the different rates of decline. Declines in rates of employment and increases in the proportion of renters within each group are both associated with lower spending growth. The faster employment declines in the UK shown in Figure 4 therefore help account for some of the differences between the countries. However, the effect of this on the unexplained element of the cross-country difference is offset by the larger increase in the proportion of renters in the US which other things equal imply faster spending declines there than the UK. Overall the unexplained component of the spending difference with these controls is around 0.75 percentage points. Column (4) shows results for an IV version of the model in column (3). This reduces the size of the employment and renter coefficients but again only serves to increase the magnitude of the unexplained difference between the countries.

In column (5) take the specification used in column (3) but remove medical expenditures. While this does not have a large effect on individual coefficients, the unexplained difference in the spending growth between the two countries falls to 0.11 percentage points and is no longer significant.

B. *Precautionary Motives*

One omitted factor from our analysis so far is *uncertainty* over future medical expenditures. As we showed in Table 3, older households in the US still face a high risk of large OOP

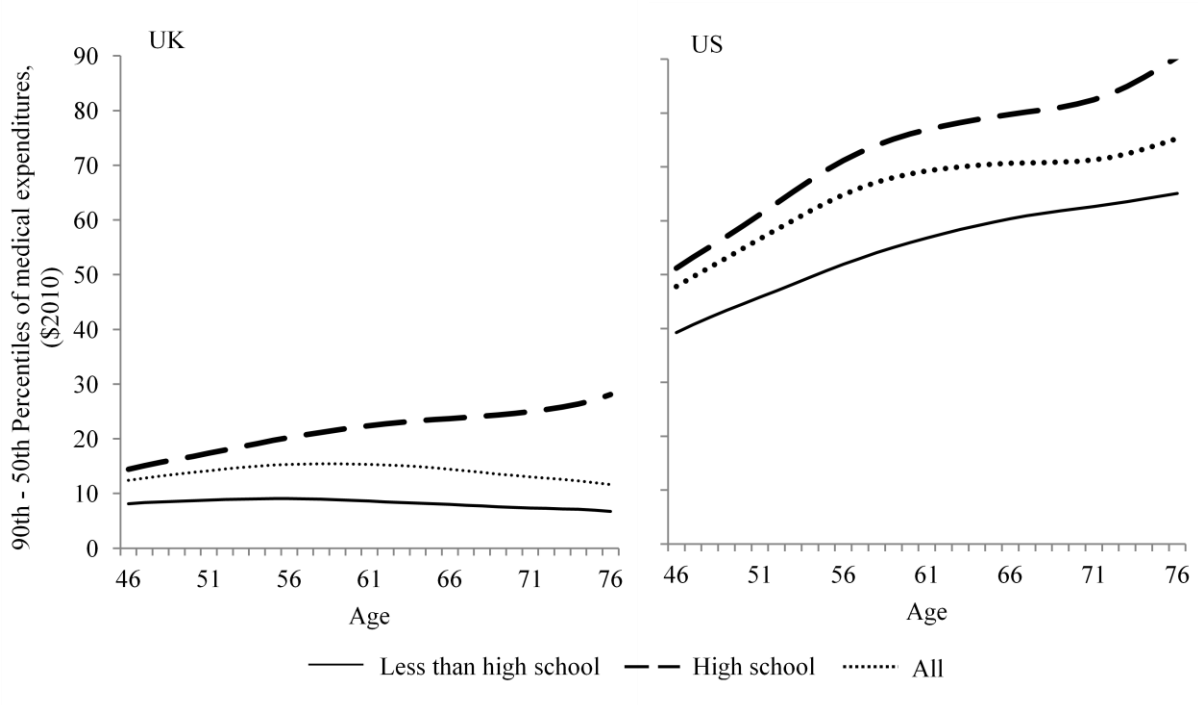

Figure 11. Dispersion in Medical Expenses

Note: Data from LCFS in the UK and CEX for the US. Each line represents averages in the 90th – 50th percentiles of the distribution of medical expenses within 5 year birth cohorts. Lines are smoothed using locally weighted regression.

medical expenses in spite of the Medicare and Medicaid programs. The important role these risks potentially play in wealth and consumption dynamics in retirement in the US have been emphasized in Palumbo (1999) and De Nardi et al (2010). The risks of such expenses are much lower in the UK where households effectively enjoy a much greater degree of health insurance coverage. The differences in the extent of risks of incurring high medical expenses are illustrated in Figure 11, where we plot the average differences between the 90th and 50th percentiles of the distributions of medical expenses in the two countries within cohort-education cells at different ages. We plot the 90th – 50th difference since, as we saw in Table 3, the distribution of OOP medical is highly positively skewed in both the US and the UK, and the main risk households in the US face is the relatively small but non-trivial probability of very high medical expenses. Figure 11 shows that in the UK this measure is roughly a

quarter of the size it is in the US. It also tends to increase with age and is larger for more educated households.

What implications might these differences in the dispersion of medical expenses have for consumption profiles? A simple theoretical analysis, such as that in Banks et al. (2001), suggests that the effect of uncertainty over shocks to future medical expenses on consumption growth will depend on the product of three factors $\kappa\pi^2_{s,k,t-1}\phi_{s,k,t}$ where κ is a constant scaling factor reflecting both the persistence of shocks and the consumer's risk aversion, $\pi_{s,k,t-1}$ reflects the contribution of uncertainty in medical expenses to uncertainty in overall wealth for group *k* in country *s* and period *t-1*, and $\phi_{s,k,t}$ is some measure of the dispersion in medical expenses conditional on information available to each individual consumer in period *t-1*.

Of the three factors, $\pi^2_{s,k,t-1}$ can be approximated by squared ratio of medical expenses to nondurable consumption excluding medical expenses in period *t-1*. This can be readily estimated from our cross-sectional data (which we do using cohort level averages by education group).[21] The choices of κ and $\phi_{s,k,t}$ are less straightforward. We take $\phi_{s,k,t}$ to be the period *t* 90th-50th range in medical expenses in each cohort education group as plotted in Figure 11. We then add $\pi^2_{s,k,t-1}\phi_{s,k,t}$ into the regression model in (1) and instrument it using its lag avoid the endogeneity of including a variable that includes *t-1* consumption spending. The coefficient on this term will then reflect the value of κ.[22]

This approach identifies the scale of precautionary effects using cohort variation in the importance of medical spending uncertainty. The effects of including this term in our

[21] Specifically, the approximation to $\pi_{s,k,t-1}$ is calculated as the square of the cohort-level ratio of medical expenditures to non-medical nondurable spending in each cohort-age-education cell.

[22] Ideally, $\boldsymbol{\phi}_{\mathbf{s,k,t}}$ should not include any predictable changes in medical expenses, as these do not generate precautionary motives. Calculating risk within cells defined by age, cohort and education eliminates important sources of this heterogeneity. Other sources of heterogeneity that lead to multiplicative differences between the conditional and unconditional risk (for example that might arise if lagged medical expenditures affect current spending through an autoregressive process) will be absorbed in the coefficient on $\boldsymbol{\pi^2_{s,k,t-1}\phi_{s,k,t}}$.

regression model are reported in columns (6) and (7) of Table 5.[23] In column (7) we instrument our demographic variables as well as the term reflecting medical expense risk, while in column (6) we only instrument medical expense risk. This does not make much difference to the results on the US-UK gap or on the estimate of the impact of medical expense risk.

The uncertainty term enters with the expected positive coefficient and is significant at the 10% level. The unexplained difference between the two countries falls from 0.15 to -0.48 percentage points: a difference which is not statistically significant.

In column (8) we allow for the possibility of intertemporal non-separability between medical and non-medical expenses by including the change in medical prices in the regression. Medical prices are made real (relative to non-medical nondurable consumption spending) using a Stone price index as described in Appendix B. This term enters significantly and indicates a negative gross substitution effect of medical consumption. Other things equal a 1% increase in real medical prices from one period to the next is expected to reduce consumption growth by 0.4 percentage points. Including this coefficient eliminates the remaining unexplained gap between the two countries.[24]

Our results allow us to estimate the scale of precautionary motives to save against medical expense risk in both countries. To calculate this we take the predicted spending profiles using our regression results and compare them with those predicted for a counterfactual world in which there was no medical uncertainty (using the results correspeonding to the model in column (6)). With medical uncertainty the expected average annual decline in spending (excluding medical) is 1.92% per year in the US and 2.22% in the UK. Without medical uncertainty the predicted declines are 3.04% in the US and 1.93% in

[23] To understand whether other sources of risk may generate create precautionary motives in the US, we have also run a specification (otherwise the same as that in column (7)) where we include a term for income risk that is analogous to the term we use for medical expense risk. This enters the regression insignificantly and does not greatly affect the magnitude or sign of the medical expense risk term.

[24] The sample size falls in this regression as we do not have medical prices for the US before 1988.

the UK. We therefore estimate that precautionary motives raise consumption growth in the US by around 0.80 percentage points per year on average for the ages we consider.

VII. Conclusions

For many years, debates surrounding the question of whether individuals' have saved enough to fund their consumption needs have focused on whether documented declines in consumption spending over the retirement period could be fully accounted for by optimal behavior within the framework of the life-cycle model. For instance, early work on the "retirement savings puzzle" attributed declines in spending between pre- and post-retirement periods to a failure of consumption smoothing that indicated a lack of preparedness for retirement (Bernheim, Skinner and Weinberg (2001)). More recent work has argued that those declines that are observed can be fully accounted for through a combination of home production and non-separable preferences (Hurst (2008)).

The work we have reported in this paper has emphasized how the interpretation of such profiles must be understood in terms of the institutional environment that individuals face, and in particular the extent to which individuals are exposed to uninsured risks and uncertainties. Relatively large and uninsured risks can generate modestly declining spending profiles on average which do not necessarily indicate sufficiency of resources.

We have compared consumption trajectories for older households in the UK and the USA. In the US, spending tends to remain relatively flat at older ages, while it declines quite steeply in the UK. These differences persist when we control for other variables including employment, health and so on that evolve differently in the two countries.

A key component in explaining this difference is medical spending, which rises in the US much faster than in the UK where medical expenses tend to be covered by the state. Taking out medical spending from our comparison reduces the gap in the average decline in consumption spending by roughly three quarters. Although other differences such as

inheritance taxes, house price movements, long-term care costs and risks and income risk may also play a role in explaining these differences, we find that greater precautionary motives to save in the face of greater medical risk in the US are more than sufficient to eliminate the remaining gap.

These findings have relevance for discussions of consumption behavior at older ages. It is often found that older households, particularly in the US, tend to continue to amass wealth as they age (see for instance Love et al. (2009)). In this paper, we point out and account for differences between US households and households in an environment where the risks of high medical expenses have been effectively eliminated and for whom spending declines by much more.

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Appendix A: Long Term Care Costs

Table A1: Distribution of Out-of-pocket Long-Term Care Costs, Non-institutional Population

HRS: United States	%	Mean	P25	P50	P75	P95	P99
All household population 60+	100	53	0	0	0	0	526
Any stays in institutions (past 2 yrs)	5.3	991	0	0	246	3768	29075
Any paid-for stays in institutions (past 2 yrs)	1.7	3085	263	645	2010	12975	38189
ELSA: England							
All household population 60+	100	30	0	0	0	0	0
Any stays in institutions (past 2 yrs)	1.1	3236	0	0	1257	15699	37704
Any paid-for stays in institutions (past 2 yrs)	0.6	6619	628	1782	10055	28278	37704

Note: Data from English Longitudinal Study of Ageing for England and the Health and Retirement Survey in the US for those not in institutional residences at the time of interview. Values are annual averages over the previous two years in US$ (2010). US spending is for 2012-2014. UK spending is for 2014-2016.

Appendix B: Within Period Demand Systems

A. *A Model for Demand*

We run the following consumer demand model in each of the two countries:

$$w_{ik} = \alpha_{ik} + \sum_{k}^{G} \gamma_k \ln p_k + \beta_k \ln\left\{\frac{x_i}{a_i(p)}\right\} + \theta_k \ln\left\{\frac{x_i}{a_i(p)}\right\}^2$$

where w_{ik} is the budget share of individual *i* for each of the *G* goods *k*, p_k is the price of good *k* and x_i is total expenditure on the goods included in the demands system by individual *i*. There are *M* demographic variables z_{mi} for each individual *i* including housing, employment, health and mortality are included in α_{ik}

$$\alpha_{ik} = \alpha_{k0} + \sum_{k}^{M} \alpha_{mk} z_{mi}$$

Expenditures are deflated using the price index

$$\ln a_i(p) = \alpha_O + \sum_{k}^{G} \alpha_{ik} \ln p_k + \frac{1}{2} \sum_{l}^{G} \sum_{k}^{G} \gamma_{lk} \ln p_l \ln p_k$$

This model differs slightly from the Almost Ideal specification of Deaton and Muellbauer (1980) in that it includes an additional quadratic term on income (although it is still only an approximation to the fully integrable QUAIDS model (Banks et al. (1998)). Our interest is in establishing the nature of within-period non-separabilities between consumption and housing, health and employment in the two countries through the effect of these variables on household budget shares. By including total expenditure and prices, we control for differences in trends in relative prices and wealth across different birth cohorts in the two countries which may otherwise confound our estimates. The use of the household specific

price index $a_i(p)$ means that income deflators can vary across groups according to their differing consumption patterns.

Prices for each of our categories are computed from the individual components and sub-indices of the UK Retail Price Index and the US CPI, which go back to 1978 and 1988 respectively.[25] Typically, sub-indices are not available for the particular category grouping we use (defined above in Table 1). For instance, in the UK RPI medical costs are split between "personal services", "chemists goods", "personal articles" and other categories. So in order to calculate price indices for these goods we calculate a Stone price index for a given category k

$$p_k = exp\left(\sum_{j=1}^{G_k} w_{jk} \log p_j\right)$$

where w_{jk} is the cohort-year budget share of good j within some spending category k for which there are G_k goods in category k for which we want a price (e.g. "other nondurables"). We plot the estimated series for medical costs in Figure A.1. This shows that real medical prices tended to increase faster in the US than they did in the UK over the period we are considering. This implies that the growth in medical consumption in the US may not have been as large relative to the UK as the growth in medical expenditures.

[25] The authors are grateful to Brendan Williams of BLS for constructing price indices that go back to this date.

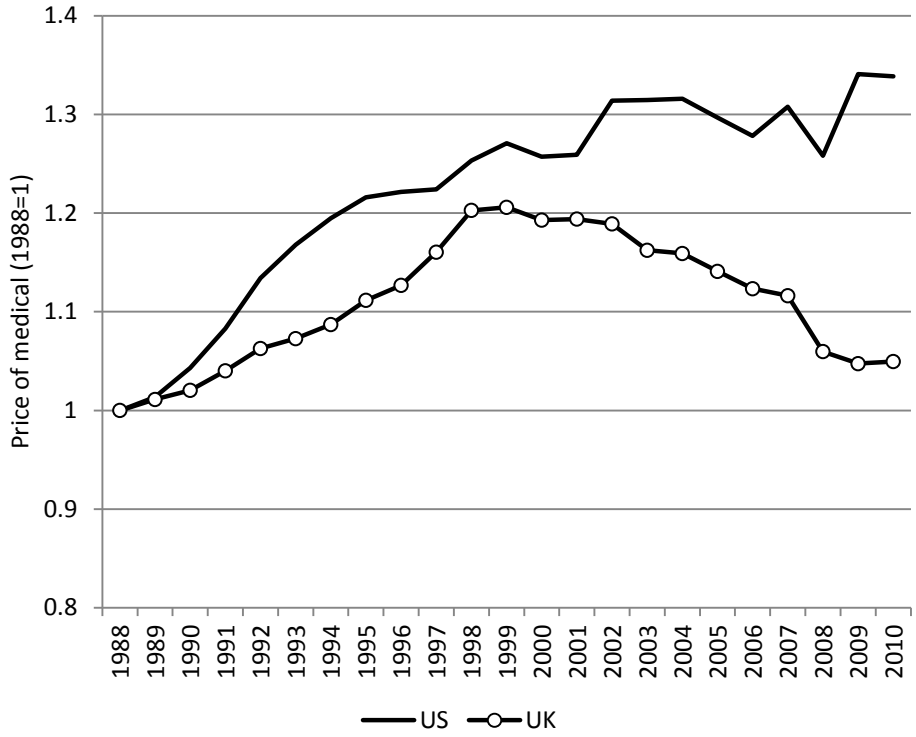

Figure B.1. Real Price of Medical Spending

Note: UK prices are a weighted geometric mean of the RPI categories that include medical spending. US prices are a weighted geometric mean of prices for medical care and hospital services. In both calculations the weights are shares of total medical expenditure. Prices are made real with a Stone price index for total nondurable spending.

Our demand system includes sex, number of children, number of adults, and linear and quadratic time trends as controls in all models reported below. We also include dummies for being over state pension age in the UK (60 for women, 65 for men) and for being over 65 in the US. These are included to control for the effects of Medicare (to which US households become eligible at 65) and benefits such as free-prescriptions, the Winter Fuel Payment, and transport subsidies which UK households become eligible for at state pension age. We do not otherwise control for age – our view is that age is usually included as a proxy for health and mortality effects, and these are affects that we are directly interested in (and include separately). The health and mortality variables are cell averages for the population (by age,

Table B.1 Estimated Demand System Coefficients α_{mk}

	Food in	Food out	OthND	Medical	Housing	Recrea	Transport
Mean Budget Shares (%):			**UK (1978-2010)**				
	24.36	*4.97*	*25.10*	*1.88*	*23.82*	*7.29*	*12.58*
Single	**-6.63**	**2.62**	**3.34**	**-0.26**	**-2.39**	**-0.08**	**3.40**
	(0.12)	(0.07)	(0.16)	(0.06)	(0.14)	(0.15)	(0.13)
Renter	**0.85**	**0.38**	**3.26**	**0.01**	**-4.17**	**0.43**	**-0.77**
	(0.09)	(0.05)	(0.12)	(0.05)	(0.11)	(0.11)	(0.10)
Own-outright	**0.14**	**-0.11**	**-0.75**	**0.16**	**-0.04**	**0.92**	**-0.31**
	(0.08)	(0.05)	(0.11)	(0.04)	(0.10)	(0.10)	(0.09)
Head-employed	**-0.03**	**0.61**	**-0.42**	**-0.05**	**-0.81**	**-0.40**	**1.11**
	(0.09)	(0.05)	(0.12)	(0.05)	(0.10)	(0.11)	(0.10)
Both work	**-0.67**	**0.23**	**0.71**	**-0.14**	**-0.47**	**0.43**	**-0.10**
	(0.09)	(0.06)	(0.13)	(0.05)	(0.11)	(0.12)	(0.11)
ln(mortality)	**0.85**	**-0.00**	**-1.81**	**0.36**	**0.78**	**0.17**	**-0.35**
	(0.06)	(0.04)	(0.09)	(0.04)	(0.07)	(0.08)	(0.07)
Worst health	**-0.53**	**-0.29**	**-0.16**	**0.28**	**-1.12**	**0.98**	**0.84**
	(0.46)	(0.28)	(0.63)	(0.26)	(0.55)	(0.55)	(0.48)
Mean Budget Shares (%):			**US (1988-2010)**				
	22.00	*6.50*	*17.82*	*12.61*	*19.99*	*4.26*	*16.81*
Single	**-4.74**	**3.02**	**2.17**	**-3.57**	**-0.54**	**1.33**	**2.34**
	(0.24)	(0.15)	(0.24)	(0.35)	(0.24)	(0.13)	(0.22)
Renter	**-0.28**	**2.14**	**4.86**	**0.83**	**-10.32**	**1.45**	**1.34**
	(0.26)	(0.17)	(0.26)	(0.37)	(0.26)	(0.14)	(0.24)
Own-outright	**0.08**	**0.53**	**-0.71**	**0.57**	**-0.33**	**0.09**	**-0.25**
	(0.13)	(0.08)	(0.13)	(0.20)	(0.13)	(0.07)	(0.12)
Head-empl.	**0.96**	**0.46**	**-0.60**	**-1.68**	**0.10**	**-0.32**	**1.05**
	(0.18)	(0.11)	(0.18)	(0.26)	(0.18)	(0.09)	(0.16)
Both work	**-2.18**	**0.45**	**1.33**	**-0.09**	**-0.90**	**0.31**	**1.09**
	(0.18)	(0.11)	(0.18)	(0.26)	(0.18)	(0.09)	(0.17)
ln(mortality)	**-0.53**	**-0.45**	**-1.80**	**2.72**	**0.99**	**-0.12**	**-0.81**
	(0.14)	(0.08)	(0.13)	(0.20)	(0.14)	(0.07)	(0.12)
Worst health	**-0.19**	**-0.30**	**2.28**	**-0.30**	**-1.90**	**-0.89**	**1.32**
	(0.65)	(0.39)	(0.63)	(0.94)	(0.63)	(0.33)	(0.58)

UK N=99,425; US N= 50,796, standard errors in parentheses. We take only data from the first interview in the CEX. Additional controls for log expenditure, log expenditure squared, number of children, number of adults, dummy for whether head or spouse has compulsory education, a quadratic time trend, being over state pension age and self-reported health missing. Expenditure is instrumented using income (with additional dummies in US model for year greater than 2001 and year greater than 2004, when changes to the survey income questions were introduced).

year and sex) based on the data we described in Section IV above. We instrument the expenditure and expenditure squared variables using income and income squared (dummying

out changes in the income question in the CEX that occurred from the 2nd quarter of 2001—introducing a bracketing question for those who failed to report their incomes—and income imputation which was introduced in 2004).

The coefficients on the taste shifters, α_{mk} are shown in Table B.1. The particular specification of the demographic variables, *z*, includes: (1) housing tenure with dummy variables for being a renter and housing owners with no mortgage so that the reference group are owners with remaining mortgages; (2) marital status represented a dummy variables for being single; (3) employment proxied by two dummies—household head employed and both partners working; (4) the log of mortality of the head (5) the health of head captured by the proportion of individuals in their cohort who have the worst health status.

Table B.2 shows results from a conditional demand system excluding medical spending. The results are discussed in the main text.

Table B.2 Estimated Conditional Demand System Coefficients α_{mk} (No Medical)

	Food in	Food out	OthND	Housing	Recrea	Transport
Mean Budget Shares (%)			**UK (1978-2010)**			
	24.81	*5.07*	*25.55*	*24.29*	*7.44*	*12.83*
Single	**-8.50**	**6.71**	**1.21**	**-3.37**	**0.01**	**3.79**
	(0.41)	(0.68)	(0.51)	(0.37)	(0.23)	(0.21)
Renter	**1.45**	**-0.89**	**3.91**	**-3.89**	**0.36**	**-0.88**
	(0.22)	(0.34)	(0.28)	(0.15)	(0.13)	(0.12)
Own-outright	**1.09**	**-2.09**	**0.25**	**0.50**	**0.84**	**-0.51**
	(0.24)	(0.38)	(0.30)	(0.19)	(0.13)	(0.13)
Head-employed	**-0.08**	**0.74**	**-0.49**	**-0.89**	**-0.39**	**1.10**
	(0.19)	(0.28)	(0.25)	(0.11)	(0.11)	(0.11)
Both work	**-2.11**	**3.41**	**-0.88**	**-1.31**	**0.57**	**0.21**
	(0.32)	(0.54)	(0.41)	(0.29)	(0.18)	(0.17)
ln(mortality)	**2.30**	**-2.99**	**-0.08**	**1.51**	**0.01**	**-0.64**
	(0.30)	(0.50)	(0.37)	(0.28)	(0.17)	(0.15)
Worst health	**-0.68**	**-0.23**	**-1.27**	**-0.64**	**1.46**	**1.36**
	(1.07)	(1.55)	(1.40)	(0.61)	(0.62)	(0.62)
Medical quantity	**-24.66**	**59.62**	**-30.00**	**-14.94**	**1.66**	**5.98**
	(4.73)	(8.44)	(5.71)	(5.09)	(2.52)	(2.16)
Mean Budget Shares (%)			**US (1988-2010)**			
	25.28	*7.38*	*20.31*	*23.07*	*4.80*	*19.15*
Single	**-6.33**	**3.12**	**0.68**	**0.38**	**-0.41**	**2.50**
	(0.52)	(0.31)	(0.42)	(0.47)	(0.30)	(0.38)
Renter	**0.10**	**2.46**	**5.66**	**-11.75**	**1.67**	**1.91**
	(0.30)	(0.19)	(0.27)	(0.31)	(0.19)	(0.27)
Own-outright	**0.18**	**0.65**	**-0.51**	**-0.55**	**0.54**	**-0.30**
	(0.18)	(0.11)	(0.15)	(0.18)	(0.11)	(0.15)
Head-employed	**0.60**	**0.41**	**-1.31**	**0.17**	**-0.67**	**0.76**
	(0.22)	(0.14)	(0.20)	(0.23)	(0.14)	(0.19)
Both work	**-2.78**	**0.57**	**1.30**	**-0.35**	**-0.39**	**1.64**
	(0.29)	(0.17)	(0.24)	(0.28)	(0.17)	(0.23)
ln(mortality)	**0.13**	**-0.34**	**-0.62**	**0.42**	**1.03**	**-0.56**
	(0.34)	(0.21)	(0.27)	(0.30)	(0.21)	(0.23)
Worst health	**-0.43**	**-0.23**	**2.23**	**-1.79**	**-1.61**	**1.84**
	(0.71)	(0.43)	(0.66)	(0.77)	(0.45)	(0.66)
Medical quantity	**-2.18**	**1.10**	**-2.99**	**6.98**	**-5.28**	**2.03**
	(1.75)	(1.08)	(1.31)	(1.47)	(1.04)	(1.08)

UK N=99,425; US N= 50,796, standard errors in parentheses. We take only data from the first interview in the CEX. Additional controls for log expenditure, log expenditure squared, number of children, number of adults, dummy for whether head or spouse has compulsory education, a quadratic time trend, being over state pension age and self-reported health missing. Expenditure is instrumented using income (with additional dummies in US model for year greater than 2001 and year greater than 2004, when changes to the survey income questions were introduced). Medical quantity is instrumented with its log price and scaled by its standard deviation in both countries.

Appendix C: Life-Cycle Profile of Expenditures

In this appendix, we consider how life-cycle profiles of spending vary across different spending categories in the two countries. Figures C1 and C2 show average spending on the eight different expenditure categories listed in Table 1 for those born in a particular cohort (those born in the years 1933-1937). We observe this cohort for almost our entire sample period, making it particular informative to look at. We observe similar patterns, for the portions of their later life that are covered by our data, when considering alternative cohorts.

Figure C1 shows spending in the UK. Average spending falls from around $700 per week at age 48 to just under $400 by age 74. Spending profiles are shown for the US in Figure C2. Average total spending falls less than in the UK, from $750 at age 48 to just under $500 by age 74.

There is some difference in spending patterns in the two countries. For instance, we see that, at all ages, UK households tend to spend more on recreation than American households. However, it is clear that the primary reason for the faster decline in total expenditure is the growth in medical expenditures in the US, which increase from $42 per week at age 48 to $91 by age 74. In the UK, medical spending at age 48 increases from $7 to $12 over the same period.

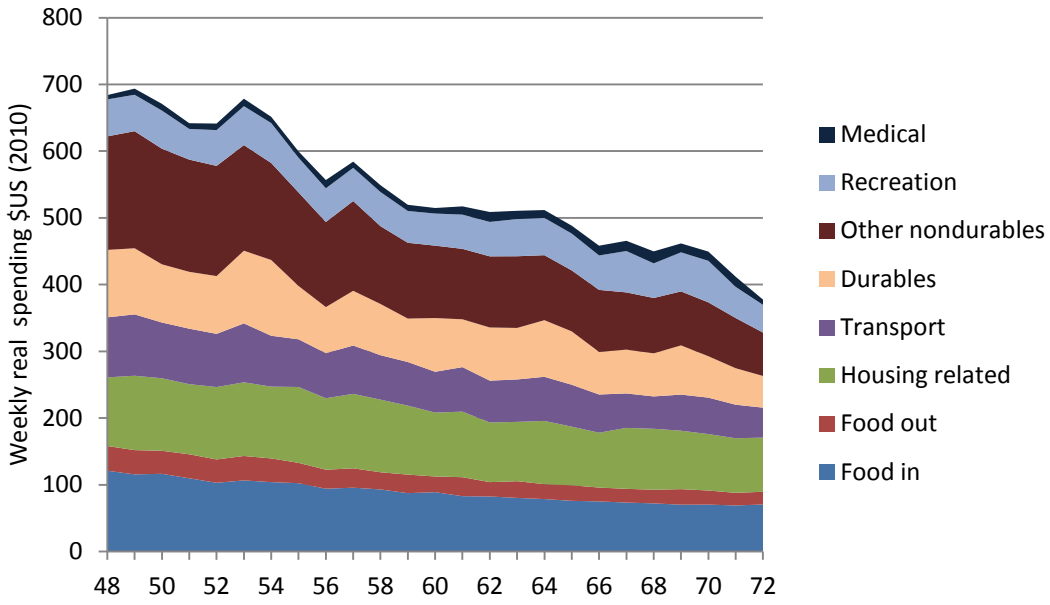

Figure C1. UK Weekly Spending on Different Categories by Age, 1933-37 Cohort

Note: Authors' calculations using BLS Consumer Expenditure Survey 1984-2010 and ONS Living Costs and Food Survey 1984-2010. Values are in US$ (2010).

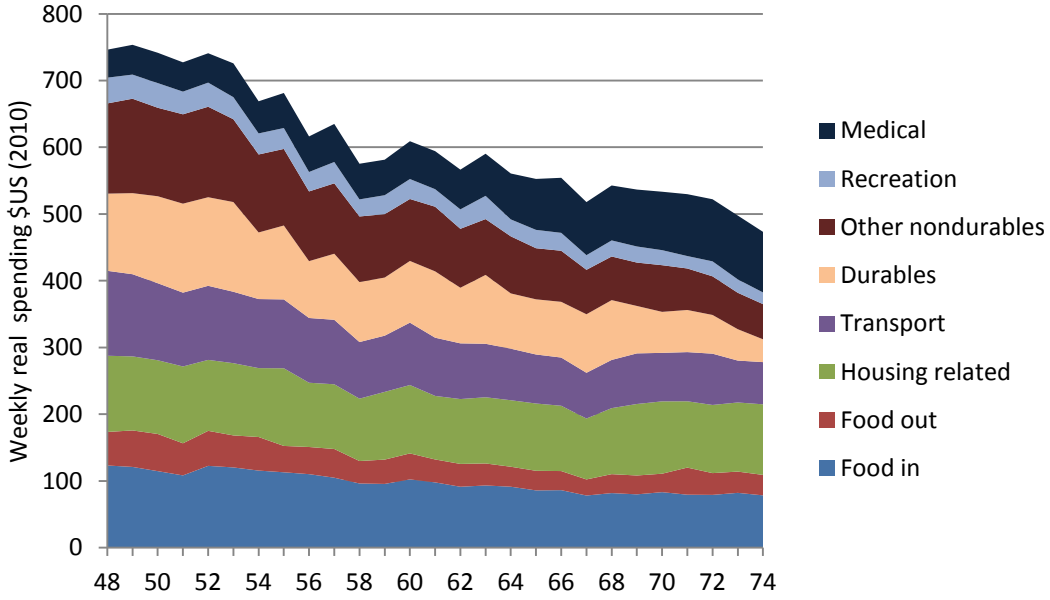

Figure C2. US Weekly Spending on Different Categories by Age, 1933-37 Cohort

Note: Authors' calculations using BLS Consumer Expenditure Survey 1984-2010 and ONS Living Costs and Food Survey 1984-2010. Values are in US$ (2010).

Appendix D: Coverage of Household Surveys

Comparisons of both the LCFS and the CEX to the aggregate National Income and Product Accounts (NIPA) in the respective countries have highlighted the possibility of increasing measurement error over time in the two surveys. It is now well-documented that coverage rates (the proportion of consumer expenditure in the national accounts that is accounted for by the household surveys) have been declining in both the US and UK (see for example Passero et al. (2015) and Attanasio et al. (2006)). This potentially has consequences for our estimates of consumption growth. In this appendix we compare trends in coverage rates for the two countries to understand better what the implications of this might be.

Any comparison of national account and survey data must take into account the fact that the two sources of information measure different spending concepts. For example, the two sources cover different populations. Both the LCFS and the CEX surveys exclude foreign residents and those in institutional residences whose spending is included in NIPA. In addition, some items of spending that may be thought of as taxes are included as expenditures in surveys but are counted as transfers rather than expenditures in the NIPA. Finally, there are items for which the definitions of spending differ. For example, the NIPA impute rental costs to owner-occupiers while not including the outgoings on for example mortgage interest payments. In the US spending on healthcare made on behalf of households by employers and the government (including the Medicare and Medicaid programs) are also counted as household spending in the NIPA but are not counted in the CEX. Many of these measurement differences might plausibly be thought to have been increasing over time, perhaps differentially so in our two countries.

In what follows, we calculate coverage rates after first making adjustments to both our survey data and to the NIPA to make them more comparable. We start by removing spending

by non-profit institutions on households' behalf from the personal consumption expenditures in both the UK and the US. We then exclude spending on imputed rent to owner-occupiers in the NIPA. In our surveys we remove the costs of mortgage interest, vehicle licensing costs, property taxes and (in the UK) TV licenses. We also show the consequences of removing health spending from both sources.[26]

Figure D.1 plots the coverage rates for total expenditure, nondurables, nondurables excluding medical expenditures and durables.

The first thing to notice is that there is still evidence of a steady decline in coverage in both countries. The top left panel shows coverage rates for total spending (including medical) which decline faster in the UK than the US.[27] These fall from 80% to 71% in the UK over the period 1985-2010 compared to a fall from 80% to 60% in the US. A decline in coverage of this magnitude would reduce annual spending growth as measured in surveys by around 0.5 percentage points in the UK compared to 1.2 percentage points in the US.[28]

[26] Passero et al. (2015) make more detailed adjustments to spending in the CEX and US national accounts in order to make a similar comparison. In particular they also make adjustments for the different treatment of used vehicles, financial service charges, owner-occupied shelter costs and certain insurance premiums. Without access to more disaggregated national account data we cannot make these adjustments in the UK however, and so leave the US data unadjusted in order to make the resulting coverage rates consistent. As a result the figures presented here will differ slightly from those in Passero et al.

[27] This differs from a similar figure (Figure 9.1) in Barrett et al. (2015). The primary difference is that medical spending is not removed from total spending here but is removed in Barrett et al.

[28] These figures are obtained by taking the proportional change in coverage (i.e. coverage in 2010/coverage in 1985) to the power 1/25. If the answer for this calculation is $1 - x$, this would tell us that a reduction in the amount of spending captured in the household survey of x% each year from 1985-2010 would result in the decline in coverage we observe.

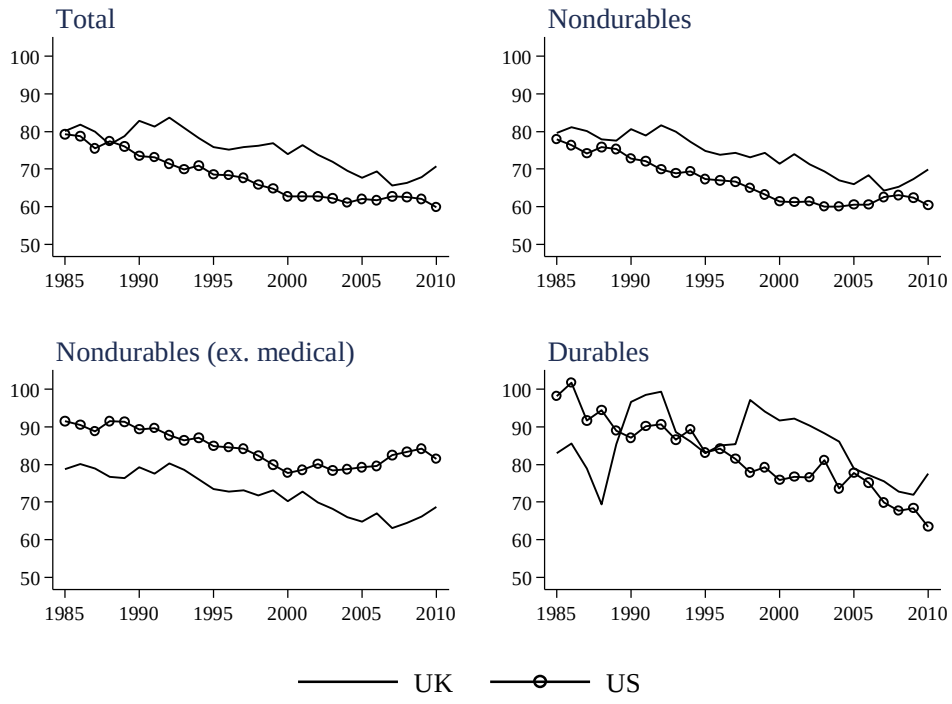

Figure D.1 Coverage Rates, 1985-2010

Note: Coverage rate is the proportion of consumer expenditure in the national accounts that is accounted for in the household surveys. Household survey data comes from the LCFS in the UK and the CEX in the US. National Income and Product Account (NIPA) data comes from the UK Office for National Statistics and the US Bureau of Economic Analysis.

The coverage rates of nondurable spending, which is the definition of spending examined in this paper, decline at similar rates. However, when we remove health spending in the bottom left panel, the picture is very different. Coverage rates are now *higher* in the US (where they fall from 91% to 82%) than the UK (where the fall is from 79% to 69%). The implied falls would now suggest a slightly larger understatement of spending growth in the UK (by 0.54 percentage points compared to 0.46 percentage points in the US). The difference that arises from excluding healthcare reflects the rapid growth of medical spending on US households by government and employers. As mentioned above these expenditures are not

included as household spending in the CEX survey but are included in the US NIPA. Passero et al. (2015) estimate that spending by government on behalf of households in the US increased by 271 percent from 1992 to 2010 and that this accounts for one fourth of the growth in the gap between the coverage of the CEX survey and NIPA consumption spending. An additional proportion is likely to be explained by growth in the proportion of health costs paid by employers. In the UK spending on the NHS is not attributed to households in the national accounts in the same way, and employer coverage is much less widespread. As a result, excluding health spending has a much smaller effect on coverage rates in the UK.

Durable spending in our household surveys has higher rates of coverage in both countries. The CEX accounted for roughly 100% of the durable spending in the national accounts by our measure in the US in 1985. This fell to just 63% in 2010. In the UK the decline was from 83% to 77% over the same period.