The determinants of household debt and balance sheets in the United Kingdom

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Abstract

Household indebtedness has grown sharply in the United Kingdom in recent years. This paper proposes a framework for understanding this based on a model in which households are assumed to plan their lifetime spending rationally, allowing for bequests to future generations. The model is set up to be consistent with both aggregate and disaggregated balance sheet positions as revealed in the British Household Panel Survey. The paper goes on to outline the effect on debt and balance sheets of changes in interest rates, house prices, preferences and retirement income.

Key words: OLG models, household debt, households' portfolios, debt to income ratio.

JEL classification: D14, D31, D91.

Summary

The outstanding debt of the UK household sector moved above £1,000 billion in 2004, equivalent to around 140% of household income (compared with around 105% ten years earlier). The rapid accumulation of debt has raised questions about the ability of people to repay what they owe, especially in the event of a sudden change in economic circumstances. This could have implications for both monetary policy, if the combination of high debt levels and a worsening economic outlook were to cause a slowdown in spending by households, and financial stability, if an increasing number of households were to default on their debts. It is therefore important to understand what lies behind the increase in debt and to assess its future sustainability.

Debt sustainability cannot satisfactorily be addressed by looking at the aggregate balance sheet of the household sector alone. There are substantial differences across households and shocks to the household sector are likely to affect different households in different ways. This paper proposes a framework for understanding aggregate indebtedness in terms of individual optimising decisions and adopts a model to explain the rise in borrowing. The model is set up to be consistent with the aggregate, cross-sectional and cohort experience of British households using information from the British Household Panel Survey. This process of calibrating the model reveals some inconsistencies between the basic life-cycle model of household behaviour used here and what is observed in practice. In particular, the level of debt is lower than expected at both extremes of the age spectrum. We therefore modify the basic model so that it can account for the observed cross-sectional balance sheet position of British households.

The model may be used to look at how balance sheets might develop in the future, on the assumption that it adequately captures current and future household behaviour and dependent on future trends in its determining factors such as real interest rates, house prices and incomes. This can be used as means of assessing the ‘sustainability’ of recent high debt levels. Sustainability of debt can be judged in two ways: whether debt will remain at or above current levels; and whether it is affordable. On the first test, this depends critically on the expected path for key determining variables. The paper shows that different future paths for the real interest rates could lead to a higher or lower debt-income ratio, suggesting that sustainability can only be assessed conditional on a view of how these determining factors are likely to develop. In neither case, however, do recent debt levels look unaffordable to the typical individual. Even if real interest rates were to revert to the higher levels seen in the late 1990s, the future consumption of even

the most indebted cohorts would exceed that enjoyed by older cohorts today, reflecting the impact of past and future economic growth. Of course, the emergence of unexpected shocks would have an adverse impact on households. We have illustrated the effect of higher interest rates, lower house prices and lower pension incomes. All would cause a contraction in household spending and change the equilibrium debt-income ratio. The more severe the shock the more likely that the sustainability of debt would become an issue. While we are unable to assess the likelihood of such shocks with the current model, it is nevertheless a useful tool for assessing the severity of their impact.

1 Introduction

The outstanding debt of the UK household sector moved above £1,000 billion in 2004, equivalent to around 140% of household income (compared with around 105% ten years earlier). The rapid accumulation of debt has raised questions about the ability of people to repay what they owe, especially in the event of a sudden change in economic circumstances. This could have implications for both *monetary policy*, if the combination of high debt levels and a worsening economic outlook were to cause a slowdown in spending by households, and *financial stability*, if an increasing number of households were to default on their debts. It is therefore important to understand what lies behind the increase in debt and to assess its future sustainability.

Debt sustainability cannot satisfactorily be addressed by looking at the aggregate balance sheet of the household sector alone. There is substantial heterogeneity among households and shocks to the household sector are likely to affect different households in different ways. Recent work in the Bank of England has attempted to understand changes in aggregate indebtedness in the context of simple models that take account of the different financial positions of households at different stages of the life cycle. Barnes and Young (2003) develop an optimising model to explain the increase in aggregate indebtedness in the United States. Their model is able to match a number of aggregate and cross-sectional features of US household consumption and asset-accumulation behaviour. Hamilton (2003) constructs a highly stylised model of UK mortgage borrowing based on assumptions about the amount households need to borrow to finance house purchase. It finds that the long-run increase in debt relative to income has mainly been associated with the rise in homeownership and the reduction in the level of inflation over the 1990s.

This paper applies the Barnes and Young (2003) approach to the United Kingdom. It proposes a framework for understanding aggregate indebtedness in terms of individual optimising decisions and adopts a calibrated model to explain the rise in borrowing. The model is calibrated to match the aggregate, cross-sectional and cohort experience of British households using information from the British Household Panel Survey (BHPS). The process of calibrating the model reveals some inconsistencies between the basic life-cycle model of household behaviour used here and what is observed in practice. In particular, the level of debt is lower than expected at both extremes of the age spectrum. We therefore modify the basic model so that it can account for the observed cross-sectional balance sheet position of British households.

We then draw out the implications of the modified model for the future development of the household balance sheet. We also analyse the effect of a range of shocks on households, emphasising that they affect different households in different ways.

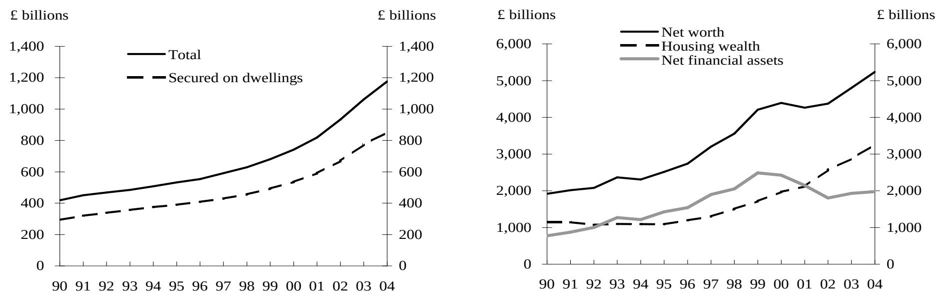
The paper is organised as follows. Section 2 provides an overview of the empirical evidence of indebtedness among British households. Section 3 establishes a theoretical framework for analysing borrowing and reviews alternative explanations from the existing literature. Section 4 calibrates the model to match aggregate and cross-section asset accumulation and consumption behaviour. Section 5 outlines the implications of the model for the future development of the household balance sheet and its sensitivity to different paths for the exogenous variables and parameters of the model. Section 6 concludes.

2 Stylised facts

2.1 Aggregate trends

Total household debt at the end of 2004 was around £1,000 billion of which 73% was debt secured on dwellings; in 1990 the equivalent figure was £419 billion with secured debt representing 70% of total household debt (see left panel in Chart 1). The debt-income ratio of UK households remained fairly constant at around 1.06 during the 1990s, but grew rapidly to 1.4 in 2003 and 1.5 in 2004 (see Chart 2).

Chart 1: Households' debt and assets

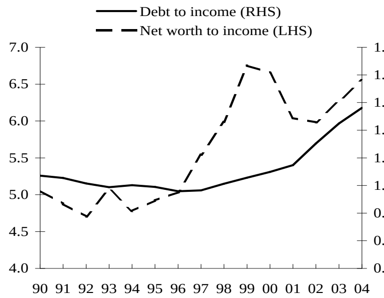


Source: *Financial Statistics,* Office for National Statistics.

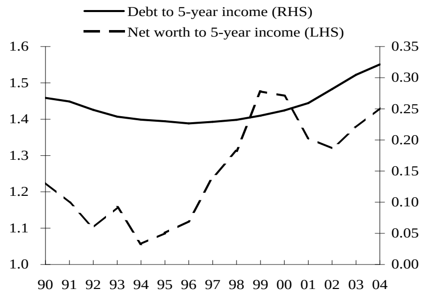
Source: *United Kingdom Economic Accounts,* Office for National Statistics.

Despite the fast increase in household debt, UK households in aggregate continue to have substantial net worth. At the end of 2004, their net worth — defined as the value of total assets minus secured and unsecured debt — was about £5,000 billion. Net financial assets, financial assets minus debt, were valued at about £2,000 billion, while their housing assets were worth around £3,200 billion (see right panel in Chart 1). The rapid increase in housing wealth since the second half of the 1990s has offset the decline in net financial wealth brought about by stock market weakness. Net worth oscillated around 5 times the annual value of household income between 1990 and 1996. Having grown to almost 7 times household income in 1999, it slipped back to 6.6 times annual income by the end of 2004 (Chart 2).

Chart 2: Debt and net worth to income ratios



Sources: *Financial Statistics* and *United Kingdom Economic Accounts*, Office for National Statistics.



Sources: *Monetary and Financial Statistics*, Bank of England and *United Kingdom Economic Accounts*, Office for National Statistics.

2.2 Cross-sectional evidence

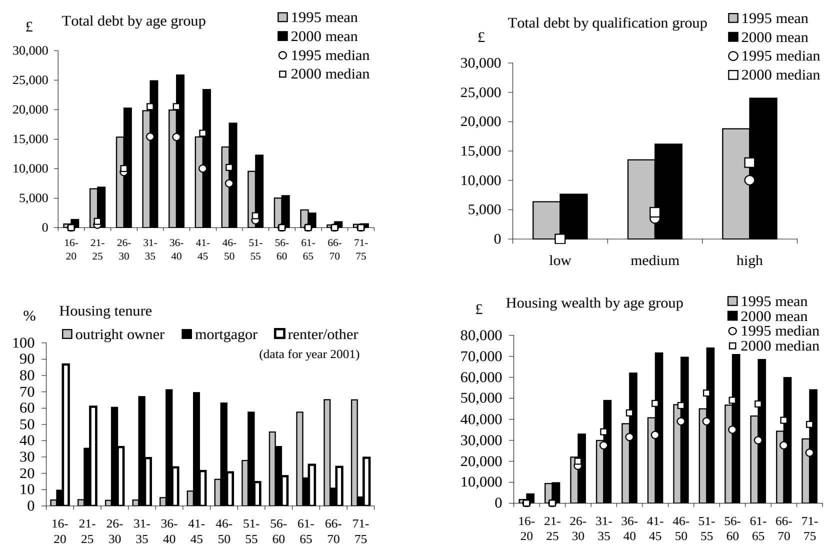
In this section we draw on some evidence from the British Household Panel Survey (BHPS) on the cross-sectional distribution of assets and debt across the population as a whole by age and qualification groups.[1] One of the key features of the distribution is that it is broadly determined by the life-cycle characteristics of the population, especially in relation to the finance of owner-occupied housing.

The BHPS provides information on the social and economic characteristics of the British population. It was constructed to be representative of the British household population and has been conducted every year since 1991. Information on households' balance sheets was gathered in the 1995 and 2000 waves only. The correspondence between these figures and the aggregate statistics presented above is not very close. In particular, no account is taken in the BHPS of the value of assets held indirectly in corporate pension schemes, whereas this is included in the aggregate figures. Also, Redwood and Tudela (2004) find that the BHPS population, like that of other surveys, significantly underreports financial assets and unsecured debt when compared with aggregate figures based on information provided by financial institutions.

(1) A summary of sample design and contents of the BHPS can be found in Buck, Burton, Laurie and Lynn (2002).

The first chart in Chart 3 shows how average debt levels vary across individuals of different ages in 1995 and 2000 (here the average is taken across all individuals in a particular age group whether they have any debt or not). In broad terms, debt levels peak for individuals who are in their thirties and then decline steadily. The decrease is more acute for median values than means; median debt levels are zero for individuals over 55. Individuals aged between 21 and 25 have an average debt of around £7,000 against the £20,000–£26,000 average debt of those between 26 and 55. This hump shape in average debt holdings as a function of age is closely related to housing tenure: the drop in average debt for those aged 56 and over is related to paying down of mortgages. The bottom-left panel in Chart 3 shows that the proportion of mortgagors declines with age from the mid-30s while outright ownership sharply increases.

Chart 3: Debt, housing wealth and tenure



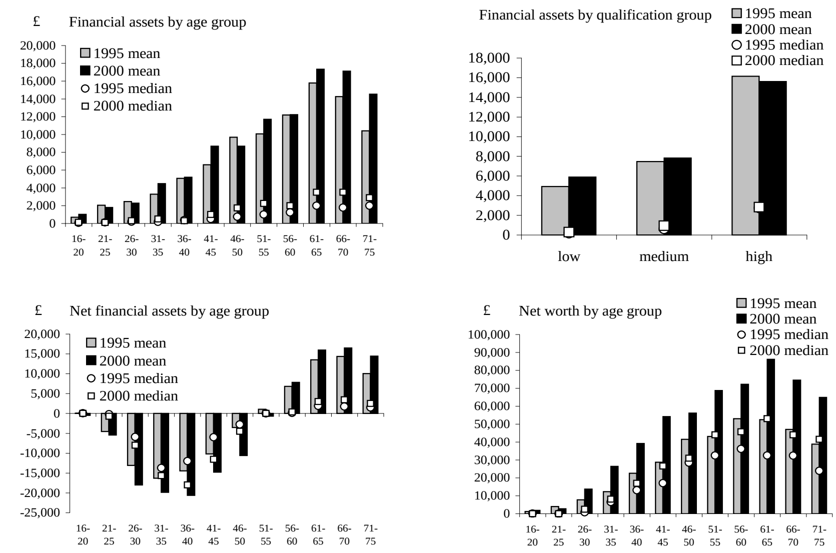
Sources: British Household Panel Survey and authors' calculations.
Note: Values in nominal terms.

Debt also appears to be increasing in the individual's qualifications.[2] Individuals with high qualifications have average debt of about £24,000 in 2000, whereas those with medium and low qualifications have average debt of £16,000 and £7,600 respectively. This reflects the higher borrowing by the highly qualified to fund housing: highly qualified individuals have housing wealth 1.5 times higher than those with medium qualifications

[2] Low qualifications covers those with no qualifications and those whose highest qualification is an apprenticeship, CSE, GCSE or commercial qualification; individuals with medium qualifications have A-level or nursing degree; high-qualified individuals are those with a teaching, first or higher degree.

and twice as much as those with low qualifications. It also partly reflects the age structure of the population as older cohorts tend to be less qualified.

Chart 4: Financial assets and net worth



Sources: British Household Panel Survey and authors' calculations.
Note: Values in nominal terms.

Average financial assets increase monotonically with age up to 65 from where there is a slight decrease. Differences between mean and median financial assets emphasise their uneven distribution. This is also true of the distribution across qualification groups (see top panels of Chart 4).

Consistent with the typical life-cycle pattern of mortgage borrowing, average net financial assets are negative roughly up to the age of 50. Beyond this age people typically have positive average financial assets reflecting their low levels of debt and the accumulation of financial assets during their working lives. Median net financial assets are zero or close to zero for individuals aged between 16 and 25 years, at older ages, the median is substantially smaller than the mean, again emphasising the uneven distribution of wealth (bottom-left panel of Chart 4).

Mean and median net worth are positive for all age groups but the values are very small up to age 30 and practically nil up to the age of 25. Higher average values of net worth are concentrated among older age groups (bottom-right panel of Chart 4). Around 11% of the UK population have negative net worth and 7% zero net worth.

In broad terms, British households tend not to hold a significant level of financial assets while they also have debt outstanding. Only 25% of individuals have both debt and financial assets greater than £500.[3] About 20% have debt but do not have financial assets of more than £500, while 30% have no significant debt and their financial assets are greater than £500; 25% have neither debt nor financial assets of more than £500.

3 An overlapping generations model to explain aggregate indebtedness

To understand the build-up of aggregate indebtedness by British households and its distribution we develop a simple overlapping generations (OLG) model where aggregate outcomes are the sum of individual maximised decisions. These types of model provide a clear framework for assessing the aggregate implications of individual saving and consumption decisions[4] and are widely used in this context, although we are not aware of any versions that focus on the implications for the balance sheet of British households.

As Miles (1999) points out, OLG models have several advantages for this type of analysis: 'they are theory-based; they can be used to undertake policy simulations; they can be used to assess the implications of varying degrees of myopia or of different degrees of rationality; and by varying a small number of parameters (elasticities summarising the degrees of substitutability between commodities, rates of time preference or attitudes to risk) they can be used to assess the aggregate implications of a rich class of individual behaviour patterns.' The disadvantage is that 'their properties are often sensitive to parameters about which there is considerable uncertainty (eg rates of time preference and degrees of intertemporal substitutability)'. This affects the interpretation of the results of this analysis which should be seen as drawing out the implications of a plausible model of the behaviour of British households rather than describing how they actually behave.

Our implementation of the OLG model is designed to account for the broad trends and cross-sectional facts discussed earlier. Partly because of the frequency of balance sheet information in the BHPS, we focus on behaviour over five-year periods (quinquennia). Consistent with this, the model includes twelve overlapping generations of homogeneous agents at any period of time, where each generation lives twelve five-year periods beginning at 16–20 years old. We model individual behaviour from age 16 to 75. We do not model the behaviour of the over-75s here, assuming that people expect to die at 75.[5]

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(3) All proportions are derived from wave 10 of the BHPS for 2000.
(4) See Blanchard and Fischer (1989) for a simple description of OLG models.
(5) This is because of the difficulties in modelling the balance sheet behaviour of this group (see Barnes and Young (2003)). Also, we are more interested in the years where individuals are accumulating debt. Moreover, the over-75s are a small proportion of the population as a whole.

Individuals are assumed to maximise their lifetime utility by choosing an optimal path for their consumption of housing and non-housing goods; they can re-optimise their choices if new information arrives.

Our model builds on the OLG model developed by Barnes and Young (2003) to explain the rise in US household debt. The main change from that model is that we allow certain parameters to vary by age so as to improve the fit of the model and we make a different assumption about wealth accumulation by the old. In particular, we drop the assumption that there is a capital market imperfection that prevents old people borrowing against the value of their house since the presence of equity release schemes contradicts this. We replace it with the assumption that old people derive utility from bequests. In addition, we do not allow individuals to borrow in their first period of life and assume no housing consumption in the first two periods of life (16–20 and 21–25 age brackets).

We assume a constant relative risk aversion utility function. Utility is derived in the first two periods from consumption of non-housing goods only, eg consumers do not buy a house until they are 26 years old. This is consistent with the low average levels of housing wealth held by individuals under 26 years old, and the nil values for median housing wealth (see Chart 3). From period three of their lives they derive utility from both housing and non-housing consumption and in the last period (when they are between 71 and 75 years old) also from keeping some money in the form of financial assets. Individuals are assumed to have Cobb-Douglas preferences over housing and non-housing consumption and utility is time-separable.[6] For an individual at the beginning of his life in period t his utility function to be maximised at that time t is:

$$\begin{aligned} U_t &= \beta_2 \frac{1}{1-\gamma} c_2^{1-\gamma} + \sum_{j=3}^{5} \beta_j \frac{1}{1-\gamma} \left(h_j^{\alpha} c_j^{1-\alpha} \right)^{1-\gamma} \\ &+ \sum_{j=6}^{11} \beta_j \frac{1}{1-\gamma} \left(h_j^{\tilde{\alpha}} c_j^{1-\tilde{\alpha}} \right)^{1-\gamma} + \beta_{12} \frac{1}{1-\gamma} \left(h_{12}^{\hat{\alpha}} c_{12}^{1-\hat{\alpha}-\rho} b q^{\rho} \right)^{1-\gamma} \end{aligned} \tag{1}$$

where c is non-housing consumption and h housing consumption. The subscripts represent a period in time: for the individual we are considering, eg aged 16–20 or in his first period of life at moment t, the subscript 2 means time $t+1$, eg when he is aged 21–25; subscript 3 means time $t+2$ and so on.

[6] The choice of a Cobb-Douglas preference over housing and goods implies a high degree of substitution between them and this has a bearing on the simulation results presented in Section 5.

The coefficient of relative risk aversion is denoted by γ. This is equal to the inverse of the intertemporal elasticity of substitution. We keep this parameter constant over the life of the individual. In order to improve the calibration, we allow some of the other parameters to vary by age. We discuss the interpretation of these varying parameters in the next section where we report on the calibration.

The rate of time preference at which utility is discounted is denoted by δ_x, the subindex represents the age of the household; the $\beta' s$ are the equivalent discount factors. This rate of time preference is allowed to vary depending on the age of the individual, x; we allow younger individuals (up to age 40) to be more or less patient than older individuals. For an individual aged 21–25, for example, the discount factor is $\beta_2 = \frac{1}{(1+\delta_y)^2}$, where δ_y is the rate of time preference for individuals under 41 years old. For an individual aged between 41 and 45 his discount factor is $\beta_6 = \frac{1}{(1+\delta_y)^5(1+\delta_o)}$ with δ_o being the rate of time preference for individuals 41 years old and over.

The parameter α denotes individual preferences between non-housing and housing consumption. The parameter α varies with the age of the individual: it takes three different values depending on whether the individual is aged less than 41 (α), between 41 and 70 (α') and between 71 and 75 ($\hat{\alpha}$).

Finally, bq is the amount of money (financial assets) from which the individual derives utility by not spending in the last period of life. The parameter ρ is the parameter associated with this preference. We can relate bq to precautionary savings held to take account of uncertainty about the time of death.

Individuals hold wealth in the form of financial assets and housing wealth. In our model financial assets, a, are either accumulated or borrowed at a single nominal interest rate, r. Individuals are assumed not to hold financial assets and liabilities at the same time, consistent with majority behaviour as noted in the previous section. The flow balance sheet constraint for time t is:

$$a_{i,t} = b_i y_t + (1 + r_{t-1})a_{i,t-1} + q_t(1 - d)h_{i,t-1} - p_t c_{i,t} - q_t h_{i,t} \qquad \textbf{(2)}$$

That is, at the end of period t net financial assets, $a_{i,t}$, are equal to the sum of:

(1) non-property income, $b_i y_t$, with y_t an income component related to aggregate income and b_i an age-related income premium;

(2) the accumulated/borrowed financial assets of last period, $a_{i,t-1}$, compounded at the prevalent interest rate r_{t-1}. Individuals have no initial endowments;

(3) the value of housing wealth at the end of the period: the number of useful housing units $(1-d)h_{i,t-1}$ times its price q_t, with d being the rate of physical depreciation of housing;

(4) minus non-housing consumption expenditure $p_t c_{i,t}$, p is the price of consumption goods; and

(5) minus housing consumption $q_t h_{i,t}$.

Non-property income has two components: one related to aggregate levels of income and another that is age dependent. Non-property income includes transfers, including pension payments. BHPS data shows that there is a peak in this measure of income for those aged 41–45. Younger and older individuals have lower incomes. Based on those differences we construct the age-related premium. For those in work, the premia reflect returns to experience and productivity as well as variations in labour supply over the life cycle. For the retired, they reflect lower incomes after retirement.[7]

In the first two periods of life, $i = \{16–20, 21–25\}$, h_i is imposed at zero, and for the first period a_i is also zero. When the individual is between 71 and 75 years old, ie $i =$71–75, we have to add to the balance sheet constraint those savings that enter into the utility function mainly as a precautionary motive. The budget constraint for this type of individual, with $i =$71–75, then looks like:

$$a_{i,t} = b_i y_t + (1 + r_{t-1})a_{i,t-1} + q_t(1-d)h_{i,t-1} - p_t c_{i,t} - q_t h_{i,t} - bq \quad \textbf{(3)}$$

Furthermore, individuals cannot die (we denote them by subindex d) insolvent but their debt can be paid with the proceeds from selling their house:

$$-(1 + r_{t-1})a_{d,t-1} = q_t(1-d)h_{d,t-1} \quad \textbf{(4)}$$

[7] The specific premia, normalised at 1 for 36–40 year olds, are: for the 16–20 group 0.21, for group 21–25 0.59, for 26–30 0.83, for 31–35 0.94, for 41–45 1.01, for 46–50 0.95, for 51–55 0.84, for 56–60 0.69, and for the three periods when the individual receives pension income 61–65, 66–70 and 71–75 the premia are 0.55, 0.46 and 0.42 respectively.

Individuals then maximise **(1)** subject to budget constraints **(2)-(4)** to choose their path of non-housing and housing consumption (and the amount of precautionary savings in the last period). This gives rise to a set of first-order conditions for intertemporal consumption and the intratemporal choice of housing and non-housing consumption.

Relative non-housing consumption and housing consumption in each period is then given by:

$$\frac{h_{t,i}}{c_{t,i}} = \frac{\alpha_i}{1-\alpha_i}\frac{p_t}{R_t} \tag{5}$$

where R_t is the user cost of housing and is given by $R_t = q_t\left[1 - \frac{(1-d)q_{t+1}}{(1+r_t)q_t}\right]$, essentially the user cost of housing depends on cost of borrowing, house depreciation and capital gains.

In the first-order condition **(5)** $1-\alpha_i$ is replaced by $1-\alpha_i-\rho$ for the last period of life (recall that ρ is the parameter associated with the precautionary savings that the individual might have when he is 71–75 years old).

The intertemporal non-housing consumption relationship is given by equations **(6)-(9)**. This relationship varies with age because we allow α and δ to vary with age, and in the last period the individual derives utility from precautionary saving. The relationship between consumption at ages 2 (21–25) and 3 (26–30) between two points in time, t and $t+1$, is given by:[8]

$$\frac{c_{t,2}}{c_{t+1,3}} = \left\{(1-\alpha)\frac{(1+r_t)p_t}{(1+\delta_y)p_{t+1}}\left[\frac{\alpha}{(1-\alpha)}\frac{p_{t+1}}{R_{t+1}}\right]^{\alpha(1-\gamma)}\right\}^{\frac{1}{-\gamma}} \tag{6}$$

This relationship between ages 3 and 4 to 10 and 11 (with the exception of the pair 5–6) is:

$$\frac{c_{t,i}}{c_{t+1,j}} = \left\{\frac{(1+r_t)p_t}{(1+\delta_x)p_{t+1}}\left[\frac{(1+r_{t+1})p_{t+1}R_t}{(1+r_t)p_tR_{t+1}}\right]^{\alpha_b(1-\gamma)}\right\}^{\frac{1}{-\gamma}} \tag{7}$$

[8] We do not explicitly show the relationship between non-housing consumption in the first two periods given the restrictions of no borrowing and no housing consumption in the first period: individuals spend all their income on non-housing items.

In equation **(7)** δ_x is δ_y and α_b is α for $i = 3$ and $j = 4$ and for $i = 4$ and $j = 5$. For i between 6 and 10 and j between 7 and 11, δ_x is δ_o and α_b is α'.

The intertemporal relationship on non-housing consumption between ages 5 and 6 is given by:

$$\frac{c_{t,5}}{c_{t+1,6}} = \left\{ \frac{1-\alpha'}{1-\alpha} \frac{(1+r_t)p_t}{(1+\delta_o)p_{t+1}} \left[\left(\frac{\alpha'}{1-\alpha'} \frac{p_{t+1}}{R_{t+1}} \right)^{\alpha'} \left(\frac{\alpha}{1-\alpha} \frac{p_t}{R_t} \right)^{-\alpha} \right]^{1-\gamma} \right\}^{\frac{1}{-\gamma}} \quad \textbf{(8)}$$

Between ages 11 and 12 the relationship between non-housing consumption has some parameters that capture the inclusion of precautionary savings in the utility function for individuals in age 12:

$$\begin{aligned} \frac{c_{t,11}}{c_{t+1,12}} \quad = \quad & \left\{ \frac{1-\hat{\alpha}-\rho}{1-\alpha'} \frac{(1+r_t)p_t}{(1+\delta_o)p_{t+1}} \left(\frac{\hat{\alpha}}{1-\hat{\alpha}-\rho} \frac{p_{t+1}}{R_{t+1}} \right)^{\hat{\alpha}(1-\gamma)} \right\}^{\frac{1}{-\gamma}} \\ & \left\{ \left(\frac{\alpha'}{1-\alpha'} \frac{p_t}{R_t} \right)^{-\alpha(1-\gamma)} \left(\frac{\rho}{1-\hat{\alpha}-\rho} p_{t+1} \right)^{\rho(1-\gamma)} \right\}^{\frac{1}{-\gamma}} \end{aligned} \quad \textbf{(9)}$$

Finally, the intratemporal relationship between non-housing consumption in the last period and the precautionary savings in the last period is given by:

$$\frac{bq_t}{c_{12,t}} = \frac{\rho}{1-\hat{\alpha}-\rho} p_t \quad \textbf{(10)}$$

The first-order conditions may be solved out to give explicit solutions for consumption of goods and housing as functions of the model parameters and expected future income and interest rates by repeated substitution in the intertemporal budget constraint. We can then derive borrowing and savings using the budget constraint. Individuals are able to re-optimise their choices period by period in response to new information. Aggregate figures are then derived summing up across cohorts.

4 Results of the calibrated model

We calibrate the model described in the previous section for the United Kingdom to match BHPS data at the aggregate and cross-section levels. It should be noted that the aggregated BHPS data does not match exactly with the aggregate data referred to earlier.[9] The data used is derived from the cohort averages in the BHPS.[10] We use the 1995 wave of the BHPS to provide initial values for stocks of assets and liabilities and then choose the different model parameters to get the best match for the 2000 wave. Table A summarises the value of the selected parameters.

Table A: Calibration values over a five-year period

Parameter	*Value*
Inverse of the intertemporal elasticity of substitution, γ	2.25
Time preference, δ	-0.32 up to age 40 and 0.33 for ages 41 and older
Taste parameter, α	0.10 for ages 16–40 0.15 for ages 41–70 0.09 for ages 71–75
Taste parameter, ρ	0.41
Housing depreciation, d	5%
Income growth, g	10%
Real interest rate, r	1991–1995: 15% 1996–2000: 19% 2001–2005: 13% 2006–onwards: 19%
Relative house prices, q	1991–1995: 1 1996–2000: 1.22 2001–onwards: 1.48

Some of the model parameters are selected in line with those reported elsewhere in the literature, while others have been selected to improve the fit of the model. In particular, the parameter representing the rate of time preference has been selected to show patience for those up to the age of 40 and impatience for those 41 and older. This is so that the model

(9) See Redwood and Tudela (2004) for a study of how BHPS grossed-up data compares with national aggregates.

(10) The BHPS does not explicitly contain any data on consumption. Here it is inferred using information on income and saving.

can replicate the hump-shape of consumption shown in the data. We do not believe that the young are more patient than the old and instead interpret this parameter as possibly reflecting a range of factors such as liquidity constraints, a precautionary saving motive or family size that are not allowed for in the model.[11] In the next section we outline the impact of changing this parameter. The long-term growth rate of income is set in line with estimates of UK productivity growth of a little under 2% per annum, while the physical depreciation rate of housing is set in line with the value used by Barnes and Young (2003) based on US national accounts.

Real house prices are taken from the Halifax series (value at the end of five-year period), relative to consumer prices (RPI all items excluding mortgage interest payments). The single real interest rate is set as an average of the interest rate on mortgages and time deposits for each five-year period.

Table B: Main parameter values[a]

	Parameter value							
Model	α	α'	$\hat{\alpha}$	ρ	δ_y	δ_o	γ	Index
Baseline model	0.10	0.15	0.09	0.41	-0.32	0.33	2.25	2,329
Other parameter combinations	0.10	0.15	0.10	0.40	-0.28	0.30	2.25	2,643
	0.10	0.15	0.10	0.30	-0.27	0.29	2.25	2,954
	0.10	0.15	0.10	0.46	-0.27	0.29	2.25	2,821
	0.10	0.15	0.10	0.46	-0.25	0.28	2.25	2,928
	0.10	0.15	0.10	0.46	-0.24	0.28	2.25	3,112
	0.10	0.15	0.11	0.46	-0.23	0.26	2.25	3,312
	0.10	0.15	0.11	0.45	-0.22	0.24	2.25	3,786
	0.10	0.15	0.11	0.49	-0.22	0.24	2.25	3,829
	0.10	0.15	0.11	0.49	-0.22	0.24	2.50	7,825
	0.10	0.15	0.09	0.41	-0.32	0.33	1.50	2,561
	0.15	0.15	0.09	0.41	-0.32	0.33	2.25	2,504
	0.10	0.10	0.09	0.41	-0.32	0.33	2.25	10,087

(a) The index summarises how well the model fits 2000 BHPS data: the lower its value the better the fit. Specifically the index is constructed as:

$$0.75 * 10^{-6}\left[\sum_{i=1}^{12}(nfa^i_{bhps}-nfa^i_{ca})^2+\sum_{i=1}^{12}(c^i_{bhps}-c^i_{ca})^2+\sum_{i=1}^{12}(hc^i_{bhps}-hc^i_{ca})^2\right]+$$
$$0.50 *$$
$$10^{-19}\left[(AC_{bhps}-AC_{ca})^2+(AH_{bhps}-AH_{ca})^2+(AD_{bhps}-AD_{ca})^2+(AFA_{bhps}-AFA_{ca})^2\right]$$

where nfa is net financial assets, c consumption, hc housing consumption; the subindex $bhps$ refers to BHPS data and the ca to calibrated results; the superindex i the age of the consumer from 1 to 12; AC aggregate non-housing consumption, AH aggregate housing consumption; AD aggregate debt and AFA aggregate financial assets.

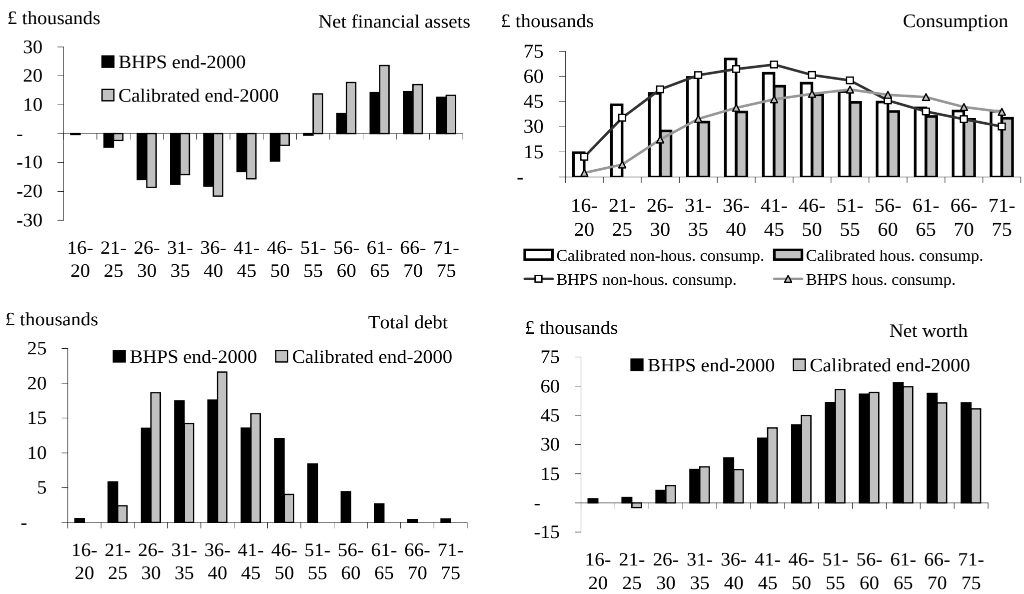
Table B outlines the impact of changing some parameters on the overall fit of the model.

[11] Becker and Mulligan (1997) discuss the possibilities of preferences changing in response to economic conditions, but this is unlikely to be the explanation for the parameterisation adopted here.

Here the fit is represented by the weighted sum of squared deviations of actual from predicted values of certain key variables. These are aggregate housing and non-housing consumption, debt and financial assets and disaggregated housing and non-housing consumption and net financial assets. Clearly, the fit of the model can be improved by judicious choice of parameters, although we do not search for the values giving the best fit.

In practice the real rate of interest varies according to whether the individual is a borrower or a lender and on the types of assets held. Partly for this reason, the budget constraint **(2)** does not hold exactly for any of the cohorts in the model. In particular, the net financial assets of each synthetic cohort are higher in 2000 than would be predicted on the basis of the initial balance sheet position and observed income and expenditure flows. This is likely to arise when individuals in responding to the BHPS are not consistent in providing information about stocks and flows. We have dealt with this by adding a residual category to the budget constraint equation **(2)**. This means that the model's prediction of net financial assets for each synthetic cohort in 2000 would be exactly correct were the predictions of consumption of housing and non-housing goods also exactly correct. This residual is held constant as a share of GDP in the base projection.

Chart 5: Cross-section of assets, consumption and net worth



The left panel in Chart 5 shows the calibrated model's estimates of net financial assets alongside the observed values derived from the BHPS at the survey date in 2000. The pattern of under and overestimation in the net financial assets profile reflects errors in predicting consumption of goods and housing shown in the right panel. The value of consumption shown is that of spending over the five-year period between 1995 and 2000. The model picks up the broad cross-sectional pattern of expenditure, although it tends to underestimate spending by the young and overestimate it by the old.

Non-housing consumption increases with age to reach a maximum for individuals in age group 36–40 and decreases thereafter, in line with the empirical hump-shape of household consumption inferred from the BHPS data. This affects the calibrated cross-section pattern of net financial assets: net financial assets are in general smaller than observed for individuals aged 45 years or less and larger than observed for older individuals. The age-related housing consumption (housing wealth) pattern is also replicated in the calibrated model, with housing consumption increasing with age until the individual reaches middle age and remaining constant or slowly decreasing around retirement age.

The bottom-right panel in Chart 5 shows the actual and estimated net worth(12) distribution across age groups. Only the cohorts of individuals between 16 and 25 years have nil or negative net worth in the model and no cohorts are in this position in the data.(13) The distribution across age groups matches quite well with the observed data derived from the BHPS: net worth increases with age up to the retirement age to decrease in the last two periods.

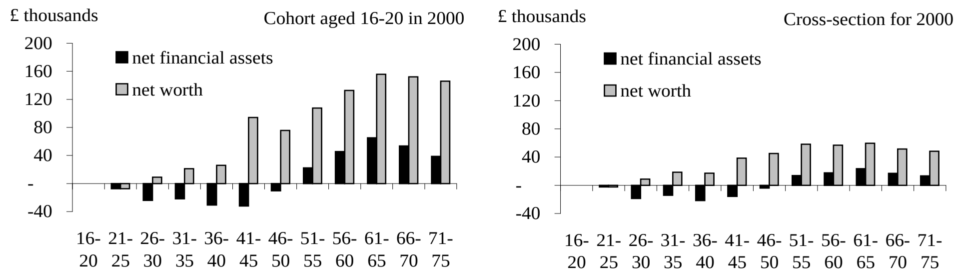
Chart 6 clarifies the distinction between the life-cycle asset accumulation of an individual cohort and the pattern of wealth holding across cohorts in a cross-section. The left panel shows a projection of net worth and financial assets going forward of the cohort that is between 16 and 20 in 2000. Its net worth and financial assets are projected to peak at the age of 61–65 at a substantially higher level than that of those of this age in 2000.

The calibrated model matches well the aggregated BHPS figures for 2000. Aggregate figures are derived by multiplying the synthetic cohort averages described above by the number of individuals in each cohort. Estimates of the numbers in each cohort with forward projections are shown in Table C.

The top-left panel in Chart 7 compares the aggregate levels for income, consumption, housing wealth, total debt, financial assets and net worth generated from the calibrated model for the years 1996–2000 with those derived using BHPS data. The calibrated model is able to reflect quite closely the actual aggregate levels for our variables of interest except

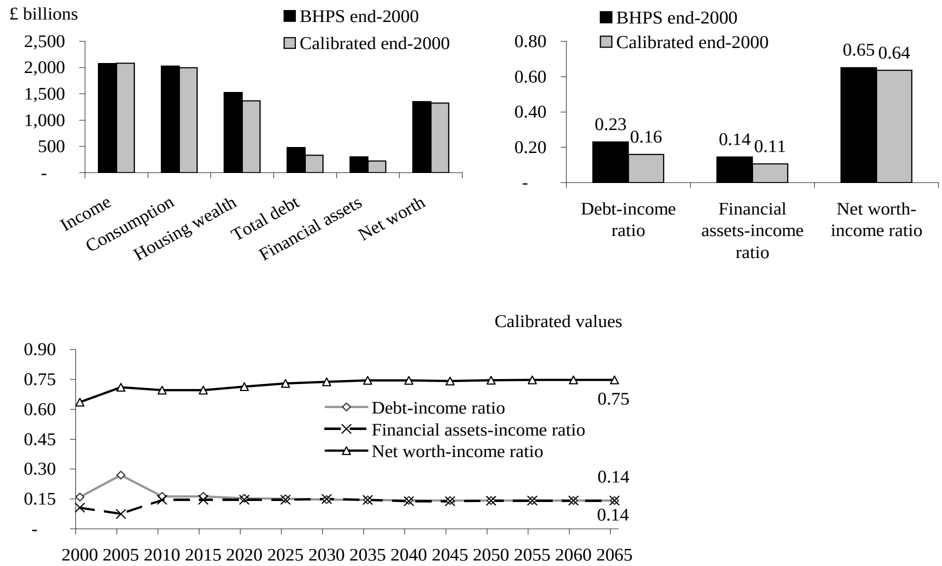
(12) Average net worth values are calculated as average net financial assets plus average housing wealth.
(13) While no cohort has negative net worth, 18% of UK individuals had negative or zero net worth in the 2000 BHPS.

Chart 6: Cohort profile of net financial assets and net worth



for total debt and financial assets. Note that the BHPS figures for total debt and financial assets are gross figures whereas the one derived in the calibrated model is derived under the assumption that a single individual will not hold both liabilities and assets at the same time. In practice, as noted previously, some people hold both financial assets and liabilities and this can account for the higher level of assets and liabilities in the data than in the model. Calibrated net worth matches very well with the BHPS equivalent reinforcing the previous statement.

Chart 7: Aggregate values



The top-right panel in Chart 7 plots the debt, financial assets and net worth to (quinquennial) income ratios. We compare the BHPS figures for 2000 with those that the model predicts for 2000. Again the difference between the calibrated and BHPS figures

Table C: Population numbers by age groups[(a)]

Age group	*1995*	*2000*	*2005*	*2010*	*2015*	*2020*	*2025*	*2030*	*2035*	*2040*
16–20	3.30	2.95	3.20	3.23	3.00	2.78	2.82	2.88	2.94	2.94
21–25	3.44	2.93	3.14	3.41	3.44	3.22	3.01	3.04	3.10	3.18
26–30	4.03	3.48	3.10	3.34	3.61	3.65	3.42	3.20	3.25	3.31
31–35	4.32	4.06	3.77	3.24	3.48	3.76	3.80	3.52	3.36	3.40
36–40	3.81	4.38	4.42	4.04	3.53	3.77	4.05	4.03	3.81	3.65
41–45	3.64	3.83	4.22	4.32	3.94	3.43	3.67	3.96	3.93	3.71
46–50	4.23	3.58	3.80	4.24	4.34	3.97	3.47	3.73	3.99	3.96
51–55	3.22	4.22	3.95	4.41	4.59	4.69	4.33	3.86	4.09	4.35
56–60	2.80	3.20	3.81	3.57	3.75	4.19	4.29	3.81	3.48	3.71
61–65	2.69	2.62	2.74	3.40	3.17	3.36	3.78	3.81	3.42	3.11
66–70	2.76	2.65	2.76	2.90	3.54	3.34	3.52	3.99	3.96	3.59
71–75	2.73	2.50	2.52	2.63	2.78	3.37	3.19	3.43	3.80	3.78
16–75	40.98	40.42	41.43	42.48	43.18	43.54	43.38	43.25	43.15	42.71

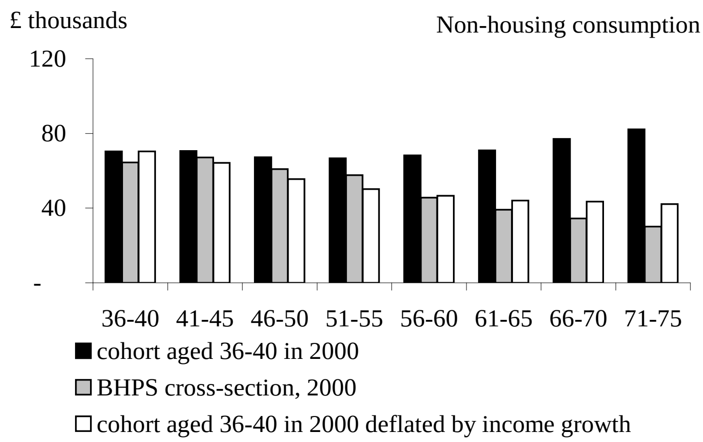
(a) Population numbers are derived using the population projections by the Government Actuary and BHPS grossed-up sample numbers. Figures are in millions.

reflects the fact that in practice some people hold both financial assets and liabilities, not allowed for in the model. The net worth to income ratio generated from the OLG model is almost identical to the actual figure derived for the five-year period ending in 2000 using BHPS data.

The bottom panel in Chart 7 plots the above ratios from 2000 until the the steady-state equilibrium is reached on the basis of stylised assumptions about future interest rates and house prices. The increase in the debt-income ratio (and decrease in the financial assets to income ratio) observed in 2005 is due to temporaily lower real interest rates assumed in the model for the period 2001–05. Once interest rates recover to higher values, the debt-income ratio decreases. The net worth to income ratio increases over the period plotted in the graph to reach a steady-state value higher than its value in 2000, this is partly accounted for by the assumed increase in house prices. These long-term projections are extremely sensitive to the underlying assumptions as shown in the next section of the paper.

Chart 8 provides some evidence on the sustainability of the debt levels seen in 2000 and addresses the concern that such levels of debt can only be paid for by very low levels of future consumption. It shows the projected non-housing consumption of the most indebted cohort in 2000: those aged between 36 and 40. This consumption path is consistent with the initial balance sheet position and the terminal condition that all debts are paid. This suggests that high levels of household debt in 2000 are affordable in that the feasible future path of consumption is higher at every age than that enjoyed by those of equivalent age in 2000. This is partly dependent on assumed future economic growth that may not materialise. But even if the projected level of consumption of the 36–40 cohort is discounted by the assumed future growth rate of productivity, the path of consumption is still superior in most years to what past cohorts receive today. This reflects economic growth that has already occurred, raising the lifetime income of each cohort above those preceding it.

Chart 8: Cohort profile and cross-section



5 Simulations

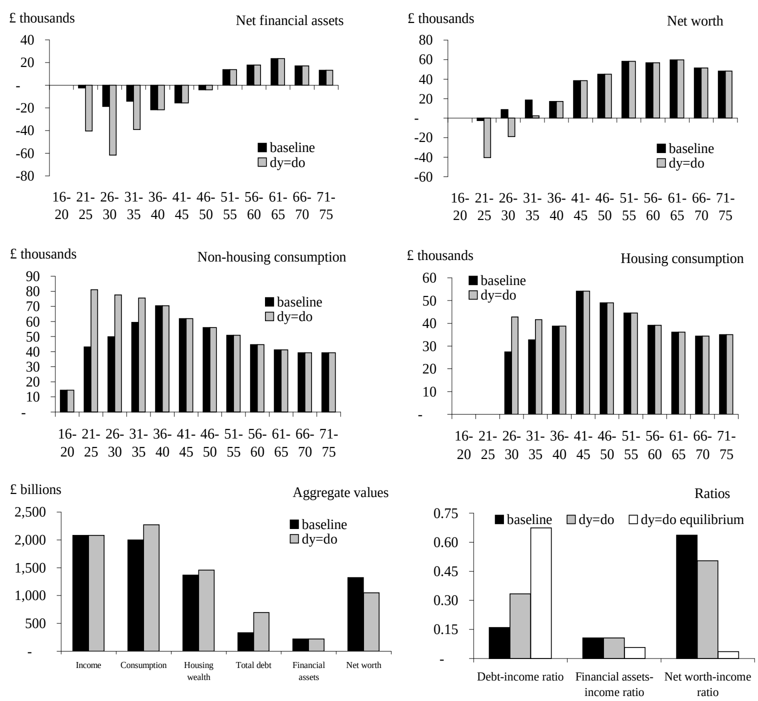
The model may be used to assess the partial impact of a number of exogenous shifts in the determining variables and parameters of the model. As a partial equilibrium model, this takes no account of how any change in the demand for goods, housing and financial assets might be supplied. As such it does not show how the economy might develop under these conditions, only the change in the demand side of the economy.

5.1 Preferences

We begin by outlining the effect of changing preferences. As noted earlier, the fit of the model relies on a different time preference parameter for young and old people. This is consistent with people being more patient when they are young, but in practice it is more likely to reflect borrowing constraints or precautionary saving not accounted for by the model. The first simulation outlines the impact on the calibration and long-run ratios of changing this assumption so that time preference is the same for young and old. The results are shown in Chart 9 for the 1996–2000 period.

Consumption of both goods and housing is substantially higher for those aged between 26 and 35, with consumption of goods 88% higher for those between 21 and 25. The effect is for the cross-sectional profile of consumption to become downward sloping, with each cohort consuming more than its predecessor, rather than hump-shaped. This is consistent with growth in lifetime incomes. The immediate impact on aggregate debt and net worth is dramatic. The debt-income ratio rises from around 0.16 to 0.33 and the net-worth income ratio falls from 0.64 to 0.50. There is no immediate effect on financial assets holdings as the shift in preferences is confined to the young cohorts who do not hold financial assets in this model. In the long run, of course, consumption by older age groups will be reduced as a consequence of the greater build-up of debt when they are young. This is reflected in the steady-state ratios, with the net worth-income ratio falling to close to zero as a consequence of substantially lower saving (see bottom-right panel in Chart 9).

Chart 9: Model solutions for impatient individuals: $\delta_y = \delta_o = 0.33$

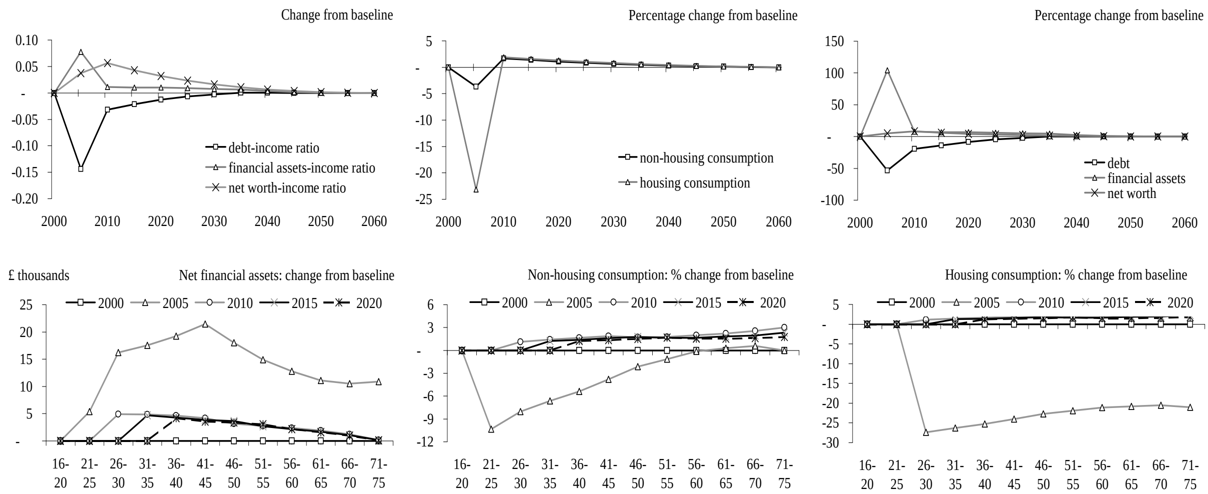


Note: dy=do refers to the model with the same discount rates for old and young people and equal to 0.33. dy=do equilibrium is the steady-state values for the model that assumes the same discount rates for old and young individuals. All values are for the period 1996-2000.

5.2 Interest rates

We now consider the effect of interest rates remaining at the levels of the 1996–2000 period (19% per quinquennium (pq) or equivalently 3.5% per annum), instead of going down to 13% pq in the 2001–05 period. We assume that individuals always expect interest rates to remain permamently at their current levels.

Chart 10: Higher rates in the 2001–05 period



Note: Interest rates are set to 19% for the 2001-05 period. Individuals expect interest rates for next period to be as the current period. Interest rates were 13% for the 2001-05 period in the baseline model.

The immediate impact of a higher interest rate in 2001-05 is to raise the user cost of housing and to encourage consumers to substitute future for current consumption. The impact on overall consumption is shown in the middle-top panel in Chart 10. Non-housing consumption is lower by around £90 billion (about 3.6%) relative to base, while housing consumption is lower by £484 billion (about 23%). The substantially larger effect on housing consumption reflects both a substitution effect towards goods from housing and an intertemporal substitution effect to future consumption. The lower level of non-housing consumption indicates that in aggregate the substitution effect towards goods is outweighed by the substitution effect towards future consumption. The positive impact on future consumption is shown as decaying as the cohorts affected by the shock are replaced over time by new ones.

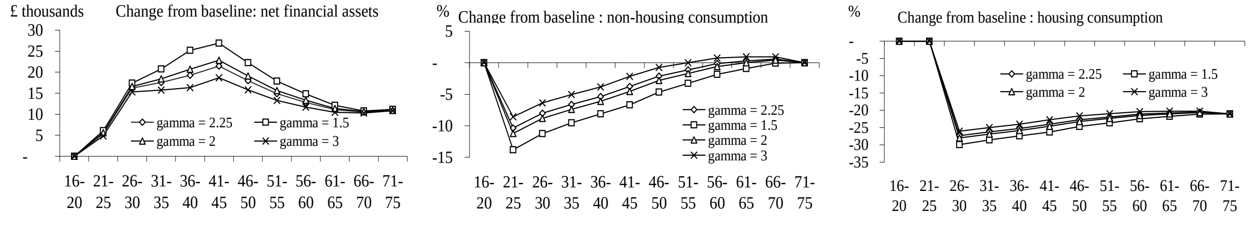
The new path of interest rates has different effects on different cohorts of individuals as shown in the bottom panels of Chart 10. The reduction in consumption of both housing and goods in the 2001–05 period is largest for young cohorts and the oldest cohorts increase their goods consumption. This is because intertemporal substitution is less important for the old and so does not outweigh the substitution of goods for housing. This depends on the value the intertemporal elasticity of substitution, with older cohorts more likely to increase goods consumption at lower values of the intertemporal elasticity of substitution. The effect on net financial assets is largest for the middle-aged groups for whom the percentage change in spending is largest in absolute terms.

Overall, the immediate impact of the higher level of interest rates is to reduce the debt stock in 2005 by £335 billion relative to what it would otherwise have been, largely because of the fall in housing demand, and to raise financial assets by about £182 million. Net worth (including housing) is higher by around £90 billion reflecting lower goods consumption during the period of higher interest rates.

In terms of welfare, the initial impact of a higher real interest rate path is a loss of utility that is greater for younger cohorts because of the effect on the cost of housing finance. Once the initial period of lower consumption is over, this effect quickly reverses turning positive as the individuals age reflecting the benefit of deferred consumption. In the long run, aggregate utility levels return to their initial values as those affected by the shock die.

Chart 11 plots the changes in net financial assets, housing and non-housing consumption for different levels of the intertemporal elasticity of substitution (the inverse of gamma in the charts). The higher the intertemporal elasticity of substitution (ie the lower the gamma) the bigger the reduction in consumption (especially goods consumption) and increase in net worth when interest rates rise. Nevertheless, the broad pattern of response across different age groups is largely unaffected by the precise value of this elasticity.

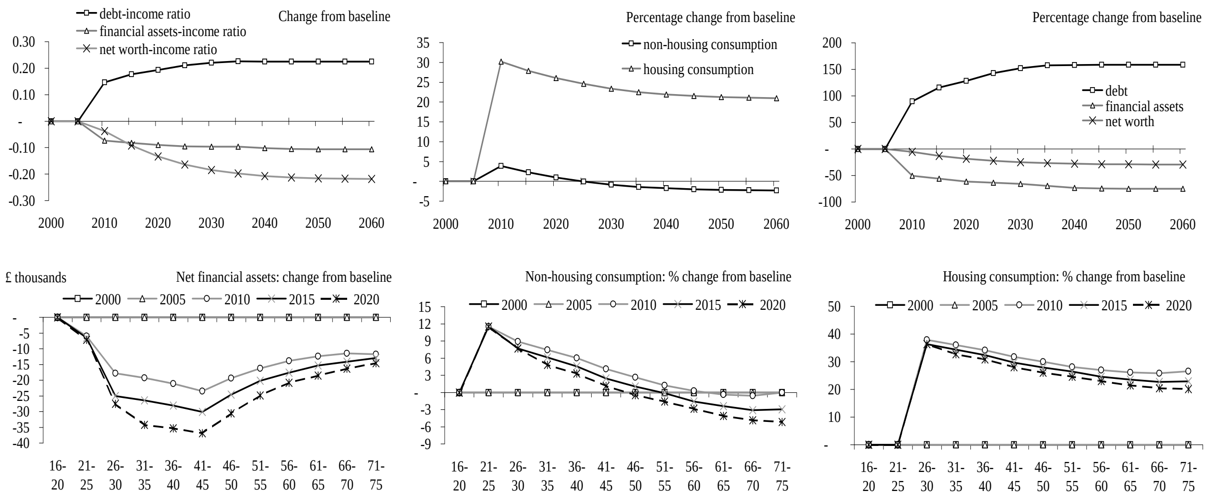
Chart 11: Sensitivity to the intertemporal elasticity of substitution, 2005



As an alternative way of gauging the response of the model to changes in interest rates we consider the effect of interest rates remaining at 13% pq level from 2006 onwards according to the assumed expectations of individuals in 2001-05, rather than reverting to

19% pq as illustrated in the baseline. The results are plotted in Chart 12. The lower path of interest rates has a permanent effect on consumption of goods and housing and consequently on the balance sheet. Lower rates encourage both substitution towards housing and intertemporal substitution of consumption towards the present. The new steady-state debt-income ratio is 37% (up from a baseline value of 14%).

Chart 12: Rates at 13% from 2006 onwards according to expectations



Note: Interest rates are set to 13% (2.5% annual rate) from 2006 onwards as individuals expected. Individuals expect interest rates for next period to be as the current period. In the baseline model interest rates increased in 2006 to 19% (3.5% annual rate).

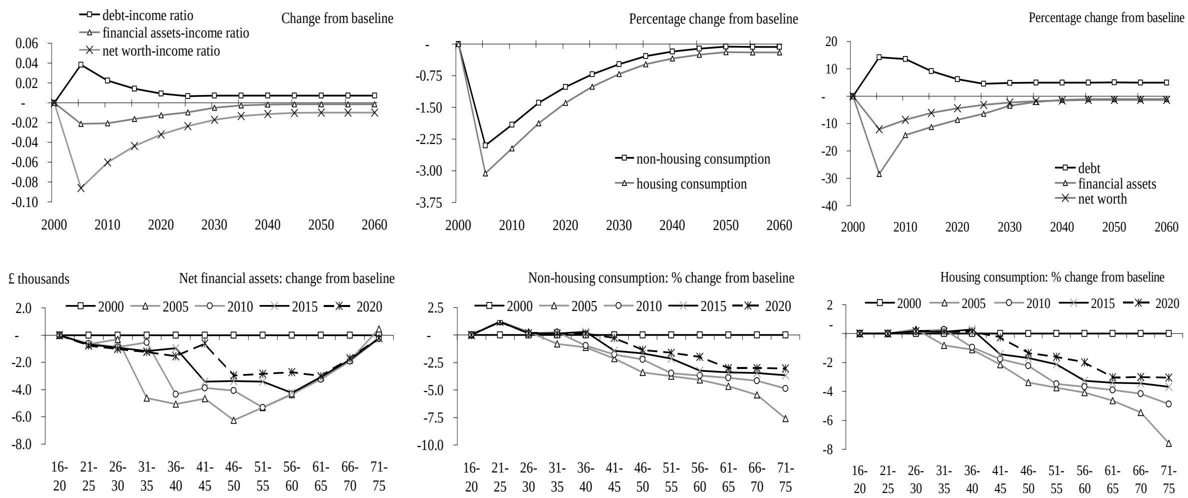
Total housing consumption increases by 30% due to a substitution effect towards housing consumption given the lower user cost of housing and the intertemporal substitution effect to the present. Goods consumption increases in the short run by approximately 4% but the long-run effect is for it to fall by just over 2% relative to the baseline.

The effect on debt and consumption of different cohorts are similar to the aggregate effect. Younger cohorts benefit most from the low interest rate scenario since they can afford a higher housing path due to the lower cost of finance. As they age, the increase in the utility levels is smaller and eventually their utility is lower because they have spent their income when they were young. The older the generation the smaller the increase in utility due to the smaller weight of housing finance in their budget. In aggregate terms, there is an initial increase in welfare that gradually vanishes.

5.3 House prices

The next simulation is of a fall in house prices relative to the baseline projection. Specifically, from 2001 onwards current and expected real house prices are kept at their average for the 1996–2000 period, 1.22, instead of increasing by 17.6% to 1.48 as in the baseline model. This may be thought of as the effect of an increase in housing supply. The results are plotted in the panels of Chart 13, where note that the middle figure in the upper panel shows the change in the *value* of housing consumption.

Chart 13: Permanent drop in house prices



Note: Relative house prices remain at the expected levels (1.22) from 2001 onwards instead of rising to 1.48.

Lower house prices raise the volume of housing consumption but not by enough to prevent the value of housing consumption falling initially by 3%.[14] Similarly goods consumption is reduced by 2.4%. This is because net worth is lower than in the baseline model: with house prices not increasing, there is no capital gain that boosts net worth. This is more evident in the differential effect by cohort: the youngest cohorts are less affected in terms of net financial assets and consumption because they do not own a house; homeowner cohorts are more affected because they are not going to enjoy those capital gains but still wish to increase their housing consumption. This accounts for the initial 14% increase in debt predicted by the model: while the value of housing consumption by homeowners is reduced, it is not reduced by as much as the decline in the value of their housing assets and higher borrowing is needed to bridge the gap.

[14] The Cobb-Douglas preferences of households between housing and goods suggests that the share of spending on housing is unaffected by changes in relative prices, see equation **(5)**. The reason that the value of spending on housing is reduced following this shock is that overall spending by existing homeowners is lower than it would have been had the value of their houses risen.

The negative impact effect of lower house prices on the value of the existing housing stock is gradually offset by a higher volume of housing consumption by new cohorts of individuals responding to lower prices. In the long run, the value of aggregate variables return to base [15] as new cohorts are introduced who have not been hit by the loss of capital gains compared to the baseline model.

The predicted impact of lower house prices on debt is much different to that suggested by Hamilton (2003) who shows debt increasing in response to higher house prices. This largely reflects different assumptions about the source of the house price shock. Here the shock is effectively a positive housing supply shock that mainly affects the amount borrowed by existing homeowners. Whereas in Hamilton's model, the shock can be thought of as a positive demand shock that causes house prices to rise without affecting the volume of housing consumption. The main effect in that model is on new cohorts who have to borrow more to finance a higher value of housing consumption.

From the effects on consumption it is clear that younger generations increase their utility in a lower house prices scenario, whereas older generations (those aged 51 and over in 2000) lose. In aggregate terms there is initially a slight increase in welfare. This rise in welfare is increasing once older generations die and eventually stabilises at a higher level than in the baseline model.

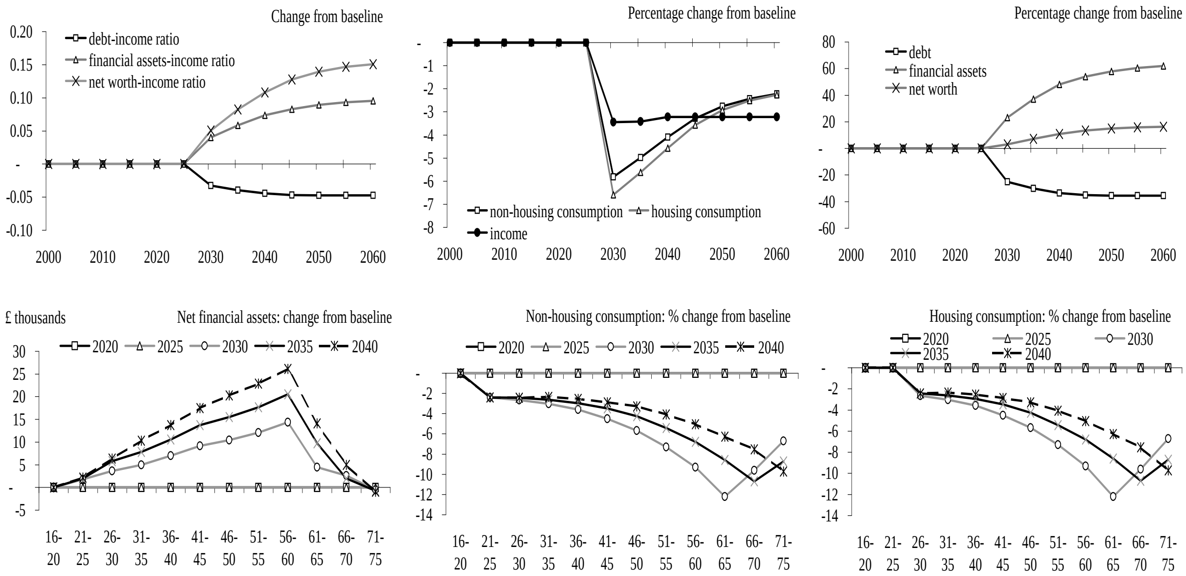
5.4 Income

The model may also be used to assess the impact of changes in the income process. The first simulation we consider is an unanticipated decline in the non-property income of pensioners (see Chart 14). This could be thought of as arising from a cut in the state pension or a worsening in payouts from company pensions. It is modelled as 20% point decline in the age premium in old age that is assumed to be permanent and occurs unexpectedly in the 2026–30 period (it reduces the non-property income of those over 60 by 20%).

When the shock occurs, all cohorts reduce their consumption of goods and housing, but those who will have just retired reduce their consumption the most as they experience the largest proportionate decline in their lifetime income. The decline of around 12% (for those aged 61–65) in their immediate spending is smaller than the decline in their non-property income because their spending is also dependent on wealth which is not

[15] Strictly speaking the new steady state is not exactly as the baseline steady state due to the effect of housing depreciation and its definition as a fixed proportion of the value of the house.

Chart 14: Permanent drop in pension incomes



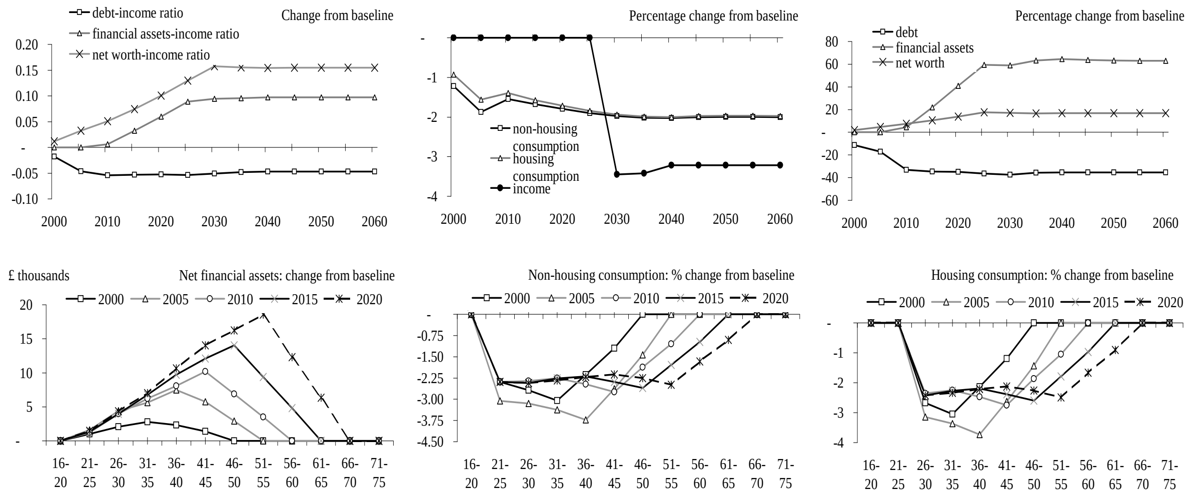
Note: Unanticipated permanent drop in pension income premia: new values are 80% of their values in the baseline model. The decline in premia is from 2006 onwards.

affected by the change in income.

All cohorts build up their net financial assets in response to the new lower pension income levels so as to smooth consumption over their life span. The increase is largest for the 56–60 age group who are about to retire and have less time to build up savings, but all groups increase their saving. The debt-income ratio falls as a result of increased saving by younger cohorts. In the steady state, this is reduced by about 5 percentage points. Net worth is increased in the long run by 15 percentage points.

It is also possible to examine the impact of this change in future pensioner income when it is anticipated. Chart 15 shows its effect when the change is announced 25 years earlier. The largest effects are on the spending of the cohort aged 31–35 at the announcement since this group is the oldest to lose income throughout its 15 years of retirement. Older cohorts will either be completely unaffected or affected for only part of their retirement, while younger cohorts have more years in which to save for the change. This is reflected in the relatively small change in household balance sheets in this first period. This though builds up over time since the policy change impacts on a larger proportion of the population and the increased saving of different cohorts accumulates. It is interesting that in this case, adjustment to the policy change is virtually complete when it comes into effect.

Chart 15: Permanent and anticipated drop in pension incomes



Note: Anticipated permanent drop in pension income premia: new values are 80% of their values in the baseline model. The decline in premia is from 2006 onwards.

6 Conclusions

This paper has described a framework for the analysis of the household balance sheet that is consistent with both aggregate and individual-level data. The framework assumes forward-looking optimising behaviour on the part of individuals and, with modification, can account for cross-sectional differences in the balance sheet of different age cohorts.

This paper confirms the well-known empirical finding that the basic life-cycle model needs to be modified to fit the facts. In our case it needs to be modified to explain under-consumption and low levels of debt among households at either end of the age distribution. To account for under-consumption by the young we parameterised the basic model in such a way as to make people appear to be more patient when they are young than when they are older. We doubt whether this is the true explanation and believe that this parameterisation is reflecting factors which are more complicated to model such as liquidity constraints, precautionary saving and life-cycle demographics. To account for under-consumption by the old we introduced a bequest motive that explains in an *ad hoc* way why old people do not consume more of their wealth. Thus the model is capturing complicated behaviour in a relatively simple way. Should this change in any way then the model would need to be reparameterised to reflect new modes of behaviour.

The model may be used to look at how balance sheets might develop in the future, on the assumption that it adequately captures current and future household behaviour and dependent on future trends in its determining factors such as real interest rates, house prices and incomes. This can be used to assess the ‘sustainability’ of recent high debt levels. Sustainability of debt can be judged in two ways: whether it will continue at current levels and whether it is affordable. On the first test this depends critically on the outcome for key determining variables. For example, if real interest rates return back up to the levels seen in 1996–2000 and relative house prices show no further change, then the model suggests that the debt-income ratio would fall back to just below its 1995–2000 levels. But, by contrast, if real interest rates remain at low levels, then the debt-income ratio would be expected to rise substantially further from current levels. In neither case do recent debt levels look unaffordable to the typical individual. Even if real interest rates revert to higher levels, then the future consumption of even the most indebted cohorts will exceed that enjoyed by older cohorts today, reflecting the impact of past and future economic growth.

Of course, the emergence of unexpected shocks would have an adverse impact on households. We have shown the effect of higher interest rates, lower house prices and lower pension incomes. All would cause a contraction in household spending and change the equilibrium debt-income ratio. The more severe the shock the more likely that the sustainability of debt would become an issue. While, we are unable to assess the likelihood of such shocks with the current model, it does enable us to assess the severity of their impact.

There are a number of possible directions for future research that emerge from this work. One is to extend the model to take account of an endogenous response of house prices to changes in housing demand. Another is to consider in more detail the interaction between different generations. As currently set up, younger generations do not receive gifts or bequests from their older forebears. Modelling this, together with endogenous movements in house prices, would considerably enrich the dynamic response of the household balance sheet to its underlying determinants.

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