The rise in US household debt: assessing its causes and sustainability

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Abstract

This paper considers the causes of the rise in US household debt since the early 1970s using a calibrated partial equilibrium overlapping generations model. The model explains indebtedness in terms of a consumption-income motive, associated with consumption smoothing, and a housing-finance motive. A credit constraint on borrowing by the old is also introduced to explain why they do not borrow to finance homeownership late in life. Shocks to real interest rates and income growth expectations, combined with demographic changes, are considered to explain the rise in US household debt. The calibrated model is found to be able to explain many features of US household borrowing, both in aggregate and cross-section. In particular, it predicts that the debt to income ratio would have increased substantially during the 1990s and would be expected to continue to grow in coming years. However, the model is unable to account for rising indebtedness during the 1980s when high interest rates, lower income growth and an ageing population would have tended to reduce aggregate borrowing. Alternative explanations, possibly associated with financial liberalisation, may account for borrowing growth during that period.

Key words: Consumption, household debt, housing.

JEL classification: E21, G11.

Summary

US households' debt relative to their income has increased to new highs in recent years, posing questions about the likely economic effects of this growth in indebtedness. This paper assesses possible causes of this rising indebtedness and considers how sustainable such borrowing behaviour might be.

The paper uses an overlapping generations model where differences between cohorts, ie households of different age, give rise to household sector borrowing and asset accumulation. Households borrow both because of a consumption-income motive, where young households with low current incomes borrow to raise their current consumption, and a housing-finance motive, where households borrow to fund owner-occupation of housing. Only the youngest households would choose to borrow due to the consumption-income motive but housing finance causes them to borrow more and later in their lives.

The model is calibrated to match a number of features of the US experience, both in aggregate and in the cross-section of the population. We also introduce an old-age borrowing constraint, which provides an alternative explanation for why older people choose not to borrow to finance owner-occupation towards the ends of their lives, even though this would allow them to consume more.

The debt to income ratio would have been stable if the economy were in steady state. So, we consider a number of shocks to the US economy that might possibly account for the rise in household debt over the past 30 years. Shocks to real interest rates and income growth expectations would affect the behaviour of individual households. Even with no change in household-level behaviour, demographic change such as the 'baby boom' might have affected total borrowing by altering the numbers of those most likely to borrow, ie the young, in the economy.

Combining observed shocks, we find that the rise in indebtedness during the 1990s is similar to that predicted by the calibrated model. However, the rise in debt during the 1980s is difficult to explain, as a number of factors suggest that it should have fallen during that time. This could reflect shortcomings in the model or the influence of other factors such as financial market liberalisation.

What does this imply for the sustainability of US household debt? The model suggests that household borrowing would be expected to increase further over coming years, reflecting the gradual adjustment to shocks during the 1990s, albeit at a slower rate. However, the sustainability of current behaviour depends critically on the realisation of the expectations on which households have made their borrowing decisions.

1 Introduction

American households were never as indebted as they are today. After a sustained increase in borrowing in the post-war era, the aggregate debt to income ratio stands at over 100%. This paper proposes a framework for understanding aggregate indebtedness and adopts a calibrated model to explain the rise in borrowing. We then consider to what extent current levels of debt are sustainable and what shocks could lead to a change in behaviour.

Many have raised the question of whether families will be able to repay the high and rising level of debt they have been accumulating. If they cannot, difficulties may lie ahead for both indebted US households and their creditors. From a macroeconomic perspective, increased personal sector borrowing is perceived as an 'imbalance' that, coupled with strong corporate borrowing, fuelled the US current account deficit at a time of fiscal surplus. If expectations have been overoptimistic or past behaviour too spendthrift, the retrenchment of the household sector could depress consumption. In testimony to the Joint Economic Committee of Congress on 17 April 2002, Alan Greenspan commented:

> 'Another factor likely to damp the growth of consumer spending in the period ahead, at least to some extent, is the change in overall household financial positions over the past two years…[although] the overall levels of debt and repayment delinquencies do not, as of now, appear to pose a major impediment to a moderate expansion of consumption spending going forward.'

Furthermore, it has been argued that the length of the 1990-91 recession was prolonged by the overhang of consumer debt accumulated in the late-1980s expansion (Carroll and Dunn (1997)).

Many of the concerns about increased household borrowing have their roots in representative agent models of consumption where it is obvious that rising borrowing as a share of income is unsustainable; each household knows that it cannot plan to increase its debts indefinitely. However, a more explicit framework for analysing aggregate household indebtedness is not well developed in the existing literature. This is dominated by empirical studies of the disposition of household debt and its determinants (Maki (2000)). Furthermore, the broader literature on consumption often excludes consideration of debt either explicitly, by the assumption that asset holdings cannot be negative, or implicitly, by choosing parameterisations, utility functions, income processes or frameworks that give agents no motive to borrow (such as buffer stock models with standard utility functions, as Gourinchas and Parker (2001)). Some recent work has modelled debt explicitly within a buffer stock framework (Carroll and Dunn (1997)).

This paper adopts an overlapping generations framework, in which debt arises where households consume more than they earn and from the need to fund owner-occupation of housing. The model is specified in terms of net financial positions, so that households are in debt if their net financial assets are negative. As such, it is not possible to determine the gross amount of financial assets and

liabilities that would be chosen for any given net financial position as there is no difference in the model between the rates of interest at which agents can borrow and lend. Thus, the model does not allow for individual households who have both debt and financial assets. Nevertheless, the personal sector as a whole can have both financial assets and liabilities due to the heterogeneity of agents.

Furthermore, we introduce a new type of capital market imperfection. We consider a constraint on the borrowing behaviour of the old. This is offered as an alternative explanation of the apparent puzzle of why older households do not borrow to finance owner-occupation of housing, despite the likelihood that this will result in their leaving substantial net assets in the form of housing as bequests. Without this or a similar constraint, it would be optimal for older households in many circumstances to take on debt to finance owner-occupation towards the end of their lives, contrary to the observation that households generally do not die in debt. As such, this constraint gives an alternative to bequest motives as an explanation for why households dis-save less than expected in old age and can account for the bequests of those without children. In contrast to the literature more generally, this is a borrowing constraint that impinges on the behaviour of the old rather than the young.

We calibrate the model to match both the aggregate, cross-sectional and cohort experience of US household behaviour. As the debt to income ratio would be constant in steady state, we consider changes and shocks to economic conditions that could account for the rise in the debt to income ratio over recent decades. We find that the actual rise in indebtedness during the 1990s has been in the same direction and of a similar magnitude to that suggested by the model, taking into account changes in real interest rates and income growth, and demographic effects. However, it is less easy to explain why indebtedness did not fall in the 1980s.

In terms of our understanding of the sustainability of US household debt, we would expect the rise in the aggregate debt to income ratio to continue over future years but at a slower pace, as household sector behaviour continues to adjust to the effects of lower real interest rates and higher expected income growth. Shocks to income growth expectations and the level of real interest rates could have a significant impact on the level of US household debt relative to income. Indeed, the importance of unobservable expectations generally in determining the appropriate level of debt makes it difficult to assess the sustainability of household debt. The difference between the path of household debt in the simulated model and the actual rise in indebtedness poses wider questions about the sustainability of the debt level and the factors on which it depends.

The rest of this paper is organised as follows. Section 2 provides an overview of the empirical evidence of US household indebtedness. 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 considers how far the model can explain the rise in debt using identified shocks and the issues that this raises for our understanding of the sustainability of US household debt. Section 6 concludes.

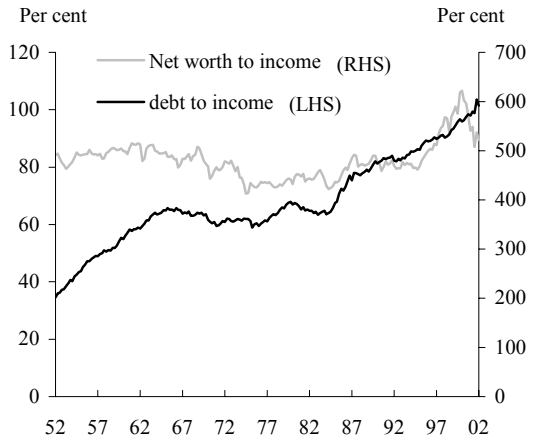
2 Stylised facts

US households had over $7,800 billion of financial liabilities at the end of the first quarter of 2002, equal to over 70% of annual GDP.[1] The median debt holding, for the 74% of households with some debt, was $33,000 in 1998.[2] This follows an increase in indebtedness in the post-war era, particularly since the mid-1980s. The young and lower-income households are more indebted relative to income. Most debt is associated with housing.

2.1 Aggregate household sector debt

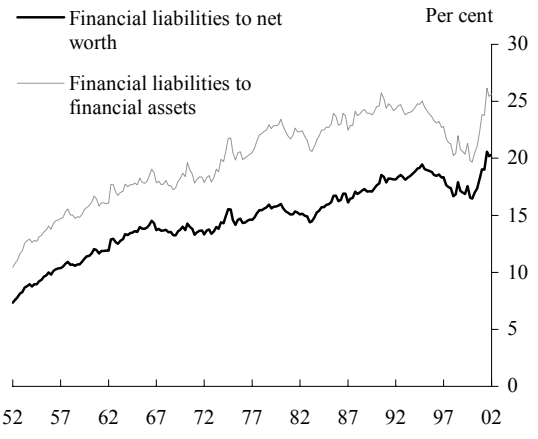
The personal sector's debt to income ratio has risen from 36% in 1952 to over 100% in 2002 (see Chart 1). The ratio rose sharply from the 1950s to the early 1960s and then remained fairly stable until around 1985. In the past 15 years, the ratio has again increased, from about 65% to the current level of over 100%. The rise in indebtedness has not been associated with a fall in overall net worth. Over the 50-year period from 1952, net worth, the sum of financial and tangible assets less financial liabilities, has fluctuated around a level of about 5 times income as liabilities and overall assets have grown broadly in line with each other, but faster than income. Indebtedness has risen relative to financial asset holdings: Chart 2 shows that liabilities were equivalent to over 25% of financial assets in 2002 compared with about 10% in the early 1950s.

Chart 1: Household debt and net worth to income ratio



Source: US Federal Reserve.

Chart 2: Household financial liabilities relative to wealth



Source: US Federal Reserve.

Partly, the increase in indebtedness is likely to have been brought about by a fall in saving, although the precise link between dissaving and borrowing depends on the accounting conventions used. The sharp fall in the personal savings ratio since the early 1980s shown in Chart 3 is consistent with growing indebtedness. As households save less from income, they might be expected to hold a

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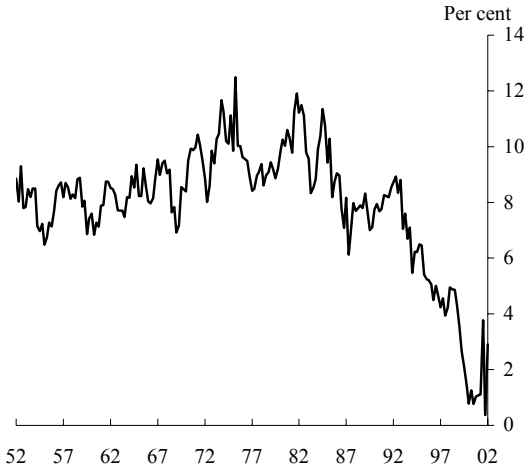
[1] *Flow of Funds of the United States*, 6 June 2002. 'Household sector' includes non-profit organisations.
[2] 1998 dollars, *1998 Survey of Consumer Finances.*

greater proportion of liabilities relative to assets. This effect is reinforced by the finding that capital gains, rather than saving, played the major role in raising net worth in the 1990s (Maki and Palumbo (2001)) and this may have driven some of the rise in borrowing as a way of releasing wealth held in various asset forms. Together, these patterns suggest that there has been some move towards indebtedness.

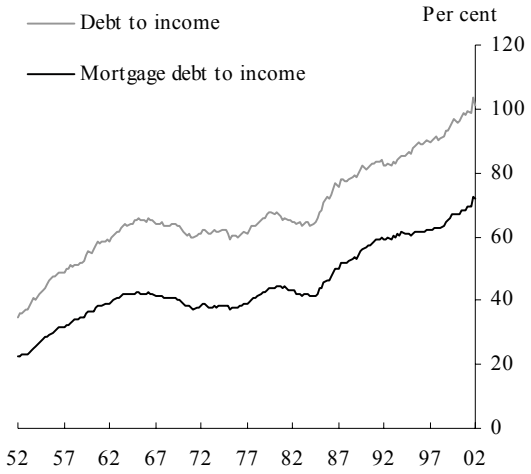
Chart 3: US personal savings ratio



Source: Bureau of Economic Analysis.

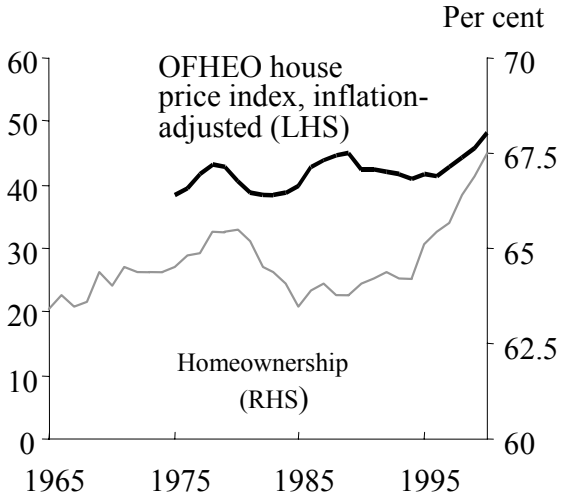
The rise in the debt to income ratio since the early 1980s is closely associated with an increase in mortgage debt. As Chart 4 shows, this represents a large share of total liabilities. Furthermore, mortgages have followed a similar trend to aggregate debt. This is also consistent with the rise of the US homeownership rate and some increase in the real price of housing (Chart 5). By contrast, consumer credit, a substantially smaller part of household liabilities, has fluctuated in a narrow and much lower band relative to income (Maki (2000)).

Chart 4: Household debt and mortgage debt to income ratios



Source: Federal Reserve Board.

Chart 5: Home ownership and real house prices



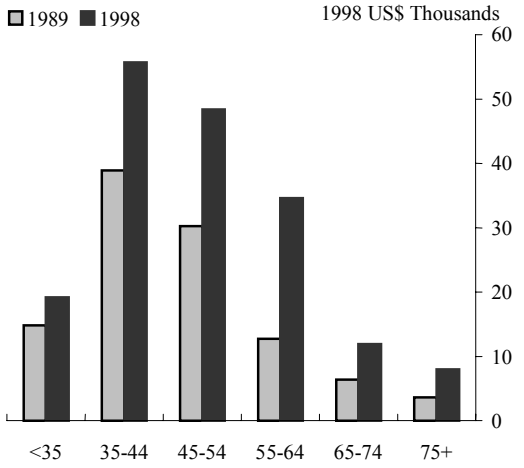
Sources: US Census, Bureau of Labor Statistics and Office of Federal Housing Enterprise Oversight (OFHEO).

2.2 Cross-sectional debt holdings

The distribution of asset holdings varies markedly across age and income groups, according to cross-sectional disaggregated evidence from the *1998 Survey of Consumer Finances* (SCF). This can be understood in terms of the standard life cycle model (as outlined in Attanasio (1999), for example).

Young households tend to borrow more than older households. The median value of debt (see Chart 6) for those with debt peaks for the 35 to 44 age category, falling steadily through middle age before dropping off more sharply for those aged over 65. The fall in debt for the over 65s is related to paying down of mortgages on primary residences (Kennickell, Starr-McCluer and Surette (2000)). Similar patterns of indebtedness across age groups can be seen in the proportion of households with debt. Households headed by under 35s borrow less than others of working age, although their lower income and net worth are likely to translate into relatively high leverage. The median value of debt for 65 to 74-year olds with debts, $11,700, is perhaps surprisingly high but this age category of households accounts for a low proportion of aggregate borrowing due to the relatively low proportion of such households having debts. Credit cards are the most widespread form of borrowing for older households.

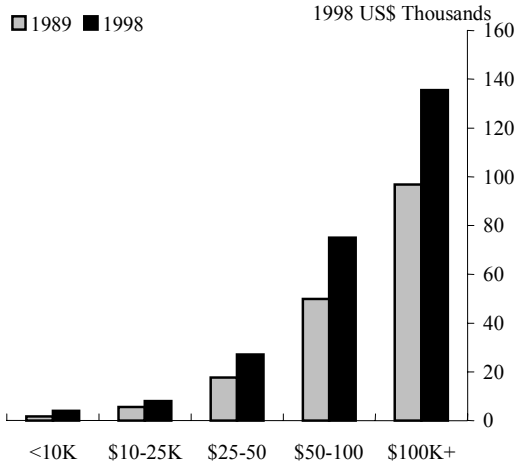
Chart 6: Median debt of debtor households by age



Percentage of debtor households

Age	<35	35-44	45-54	55-64	65-74	75+
1989	80	89	85	71	50	21
1998	81	88	87	76	51	25

Chart 7: Median debt of debtor households by income



Percentage of debtor households

Income $000s	<10	10-25	25-50	50-100	100+
1989	46	57	80	90	88
1998	42	64	80	90	88

Source: *1998 Survey of Consumer Finances*.

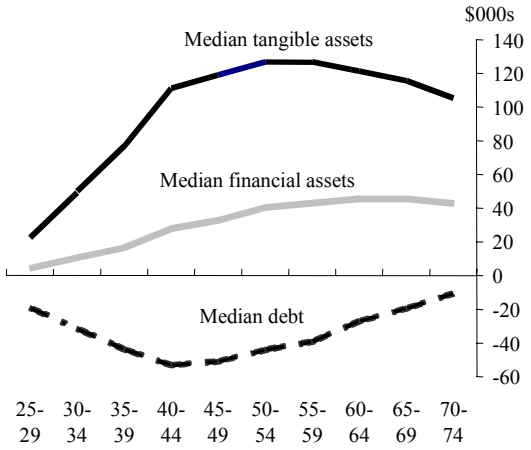
The proportion of households with debt generally rises with income, although it is slightly lower for those with incomes over $100,000 than for those with incomes of $50-100,000. By contrast, the median value of debt holdings for those with debt rises smoothly across income groups, reflecting considerable borrowing to fund tangible assets by high earners (Kennickell, Starr-McCluer and Surette (2000)). In both cases, the lowest income group and the lowest quartile of the household net worth distribution are the least indebted, although their leverage might not be so low. The distribution of debt is significantly more even across income and wealth groups than net worth, where the wealthiest 5% of households hold 57% of net worth (Bertaut and Starr-McCluer (2000)). Chart 8 shows the cross-section of overall asset accumulation behaviour, which is also consistent with greater borrowing by the young and accumulation of wealth later in the life-cycle.

Levels of debt at different points in the life-cycle correspond to both the observed pattern of household saving and with some elements of the standard life-cycle hypothesis model (see Section 2). Data from the *1999 US Consumer Expenditure Survey* (CES) show that the young dis-save, as they acquire debt. In middle age, households save, which would contribute both to debt repayment and asset accumulation. Older households dis-save, although it is generally accepted that asset decumulation is less than life-cycle models predict.[(3)] Although there are both conceptual and

[(3)] Banks and Rohwedder (2000) show that saving rates in the UK are *highest* among the elderly.

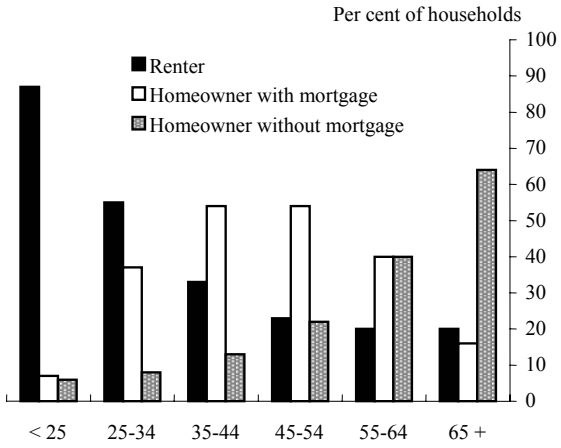
practical reasons to treat this evidence with caution,[4] this is consistent with debt holdings that rise early in life and then fall away as households age.

Chart 8: Cross-section of household portfolios



Source: *1998 Survey of Consumer Finances.* Data interpolated by authors to match age categories used in calibrated model.

Chart 9: Housing tenure by age



Source: *1999 Consumer Expenditure Survey.*

Household debt is largely related to housing: home-secured debt accounted for 71.9% of families' debt in 1998 according to the 1998 SCF compared to the second largest category, instalment loans, which accounted for 12.8%. Furthermore, the relationship between property and loans is not simply a matter of providing collateral. Households report that a majority of debt, 68.1%, is motivated for home purchase (see Table A). In general, the pattern of homeownership and having mortgages over the life-cycle (Chart 9) matches the observed pattern whereby debt peaks for the 35 to 44 year old group (Chart 6). Other motivations for borrowing include funding other residential property, to purchase vehicles, and for goods and services. Education and non-property investments are less important motives, each accounting for less than 4% of household debt. Thus, borrowing by households is primarily related to home purchase, but is also connected to investment and general consumption.

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[4] Conceptual issues relate to the classification of household budget items between expenditure, income and saving. For instance, interest income can be thought of as a form of income or a form of dis-saving. Practical issues concern the quality of the data. For example, there is an argument that the CES fails adequately to capture intergenerational transfers to young households and so the degree of dis-saving implied by expenditure and measured income may be excessive (see Gourinchas and Parker (1999) for a more detailed discussion).

Table A: Amount of debt of all families distributed by purpose of debt (per cent)

Purpose of debt	1989	1992	1995	1998
Home purchase	63.5	67.4	70.4	68.1
Other residential property	9.8	10.8	8.2	7.8
Investments, excluding property	3.8	1.8	1	3.2
Vehicles	10.4	7	7.5	7.5
Goods and services	5.9	5.6	5.7	6
Education	2.3	2.8	2.7	3.4
Other	4.2	4.7	4.4	3.9

Source: *1998 Survey of Consumer Finances*.

Repeated cross-sections also provide some suggestion of the household-level trends that are behind the increase in the aggregate debt to income ratio. It is apparent from Charts 6 and 7 that debt holdings have increased most for those aged 35 to 64 and those with the highest incomes. In addition, Table A shows that the purpose of debt has shifted towards home purchase and away from vehicles and other residential property.

Household borrowing and investment behaviour has a number of other important features and puzzles. Most households have relatively simple portfolios (Bertaut and Starr-McCluer (2000)). Around a tenth of households neither borrow nor hold financial assets (Lupton and Stafford (2000)). Household level data also show that many families have *both* assets and liabilities (Bertaut and Starr-McCluer (2000)). Some families may use debt to purchase financial assets, such as margin debt. However, households who primarily hold debt, such as a mortgage, to finance a homeownership but also have a small pool of financial assets, for liquidity reasons, is likely to be a more common pattern.

Some household debt is accounted for by 'phoney debt'. This is debt that arises for reasons other than the desire to borrow. For instance, non-interest bearing credit card balances are essentially held for transactions purposes rather than as credit. Equally, instalment loans on consumer goods with '0%' finance may represent a form of discounting rather than necessarily satisfying a desire to borrow.

Although many households have debts, only around 9% of households have negative net worth. These are characterised as households that are credible enough to borrow but too financially weak to repay their debts immediately (Lupton and Stafford (2000)). There is also widespread use of relatively costly forms of borrowing, such as credit card debt (Bertaut and Starr-McCluer (2000)). Although credit card use and debt have risen rapidly, credit card debt still only accounted for 3.8% of total household debt in 1998. Credit card use has also spread to a wider range of social groups

during the 1990s (Durkin (2000)). There has been a rise in revolving debt, through credit cards and home equity lines of credit, relative to non-revolving debt (Maki (2000)).

3 Model

A number of possible models for household debt are given or suggested by the existing literature. Standard representations of life-cycle models of consumption suggest that, in smoothing their consumption, households borrow early in their lives when current income is below the desired level of consumption expenditure. This concept of borrowing often corresponds to households having negative net worth in their early years. This explanation for debt is discussed in the model presented below as the consumption-income motive.

Household debt may also be motivated by the desire to finance the ownership of durable goods, especially housing. This borrowing has no effect on net worth but increases households' leverage as both assets and liabilities are increased. This motive depends not only on households consuming durable goods but also the absence of a rental market or alternative means of financing asset ownership. In the model discussed below, this is captured by a housing-finance motive whereby households cannot rent housing.

In addition to the reasons discussed in the model below, a number of other explanations for household debt have been suggested. First, buffer stock/precautionary saving models suggest that borrowing could provide liquidity to smooth consumption over uncertain temporary income shocks (see for example, Ludvigson (1999)).

Second, debt may be motivated by the desire of households to undertake investment. The human capital investment literature discusses the role of borrowing (see Han and Mulligan (2001)). University students, for example, borrow to fund their studies, expecting returns in the form of higher income.

Third, there is a 'portfolio motive'. Under uncertainty and with several assets having different returns, it may be optimal for households to short sell some assets, which amounts to 'borrowing' them. In a model of household portfolio decisions (Brooks (2000)), young households short sell the risk-free asset to buy equities. As equities are weakly correlated with human capital (future earnings) in this model, this creates an optimal portfolio. Combined with a no rental housing-type constraint of the type in the model set out below, a similar argument shows why households borrow to finance houses (Flavin and Yamashita (1998)).

Fourth, debt and the composition of portfolios may be motivated by the nature of household preferences and problems of self-control. Households with so-called 'hyperbolic' preferences have a short-run preference for instantaneous gratification and a long-run preference to act patiently. This can lead them to attempt to bind their future selves by investing in illiquid assets while borrowing on

credit cards (Angeletos *et al* (2000)). While there is evidence that at least some households are affected by such time-inconsistent consumption, it is unlikely on its own to account for changes in aggregate indebtedness over time.

Finally, existing literature suggests that liquidity constraints play an important role in determining household borrowing by limiting the supply of lending under asymmetric information and limited enforcement of contracts (Fernandez-Corugedo (2002)). Credit constraints can either exist as restrictions on the quantity that households are able to borrow at the prevailing interest rate or through a 'wedge' between the borrowing and lending rates (King (1986)). The empirical relevance of this problem has been suggested by considering whether households are able to smoth consumption effectively over time (Hall (1978)). To the extent that there are binding credit constraints, this implies that the equilibrium quantity of borrowing depends on the terms on which agents can obtain credit and may also depend on wealth, if lenders demand collateral when making loans. We do not allow for credit constraints in the formal model described below although the effect of any relaxation of lending restrictions is discussed in relation to the simulation results.

3.1 Theoretical model

We adapt a conventional rational expectations life-cycle model of household consumption behaviour with standard constant relative risk aversion (CRRA) preferences in a partial equilibrium overlapping generations model framework consumption-income and housing-finance motives for borrowing are introduced. To do this, we make three additional assumptions that affect the household borrowing decision: (1) an age-related income premium, (2) a no rental housing constraint and, (3) an old-age borrowing constraint.

3.2 Framework

There are ten overlapping generations of homogeneous agents, households, in each period t. Each lives for a total of ten five-year periods, corresponding to households that live from age 25 to age 74. Agents have no initial endowments. Agents have rational expectations of future variables, although they re-optimise when shocks cause their expectations to shift. Each generation is indexed so that the youngest generation at t takes the number 1 up to the 10th generation. As each cohort ages, it takes a higher index number so that, for instance, the cohort that is generation 1 at time t becomes generation 2 at time t+1. We suppress notation identifying cohorts by describing the behaviour of a cohort with N future periods to live.

3.3 Household consumption

The path of desired consumption over the life-cycle is derived from a standard CRRA utility function. Utility (U) is derived from two non-durable goods, housing services (proportional to the stock of housing, h) and non-housing consumption goods (c), over which households have Cobb-Douglas preferences with taste parameter α. Utility is time-separable and discounted at a

constant rate (δ) for each period, which could vary over time in response to changes in household composition; the discount factor is $\beta = 1/(1+\delta)$. It is assumed that households derive no utility from past consumption. γ is the coefficient of relative risk aversion (the inverse of the intertemporal elasticity of substitution). Thus the utility at date t of a household with N future periods to live is:

$$U_t^N = \sum_{i=0}^{N} \beta^i \frac{1}{1-\gamma} \left(h_{t+i}^{\alpha} c_{t+i}^{1-\alpha} \right)^{1-\gamma} \qquad \textbf{(1)}$$

3.4 Housing-finance motive

The housing-finance motive for borrowing arises from households' need to fund the ownership of the housing they live in. This is introduced using a 'no rental housing' (NRH) constraint which requires holdings of housing wealth to be sufficient to generate the desired flow of housing services (h). In addition, we assume that households cannot purchase or short-sell housing, except for owner-occupation.[5]

Such a constraint could be derived from information problems in the housing market which render it impossible for a rental market to exist (Flavin and Yamashita (1998)). Alternatively, owner-occupation may reflect high incentives to own rather than rent housing due, for example, to tax advantages because derived rental services are not taxed and capital gains on residential property receive favourable treatment (Maki (2001)).

Hence, in this model, households may hold their wealth in the form of financial assets or housing wealth. The financial asset (with end-of-period holdings, a) is a *net* asset that may be either accumulated or borrowed (but not both simultaneously) at a single fixed nominal interest rate r.[6] The value of housing wealth at the end of each period is equal to the number of units of housing (h) multiplied by their price (q).[7] d is the rate of depreciation of housing assets. The price of consumption goods, c, is p. Household disposable non-property income is y. The flow balance sheet constraint at date $t+i$ is given by:

$$a_{t+i} = y_{t+i} + (1 + r_{t+i-1}) a_{t+i-1} + q_{t+i}(1-d) h_{t+i-1} - p_{t+i} c_{t+i} - q_{t+i} h_{t+i} \qquad \textbf{(2)}$$

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[5] This is a non-trivial condition to the extent that it prevents households from investing in property if the return on housing is different from the rate of interest on financial assets (r).
[6] Borrowing is given by $a < 0$.
[7] At the end of each period, the quantity of housing is reduced by d and is revalued at the new price of housing.

3.5 Consumption-income motive

The consumption-income motive arises from differences between the timing of household income and consumption over the life-cycle. To smooth their consumption, households adjust their stock of net wealth by saving and dissaving. The underlying difference between current income and desired expenditure arises from both the path of desired consumption over the life-cycle and the pattern of income. Household labour income is made up of two components, an age-related premium and a component related to aggregate income. Cross-section data from the US *Consumer Expenditure Survey* show that young and retired households have low labour income compared to the peak for the 45 to 54 age group.[8] This premium could be a reward for experience, productivity or seniority. A similar hypothesis on wages across age groups has been used for the United Kingdom (Miles 1999)).

3.6 Old-age borrowing constraint

In the absence of uncertainty or a bequest motive, households would commonly choose to be indebted but solvent at death, financing late-in-life homeownership through borrowing and allowing their estates to repay the debt with the proceeds from selling the house.[9] This, however, does not fit the observed low debt levels in old age and the fact that household debt does not rise during old age (see Chart 5).[10] The old-age borrowing constraint is an alternative explanation to bequest motives for the large observed asset holdings of the old and their relatively limited dissaving. Bequests can arise due to altruism towards future generations. Alternatively, 'accidental bequests' (Abel (1985)) are the result of self-insurance by older households, which is more in the spirit of this model where asset holding in old age exists because of constraints rather than through altruism towards descendants.

As a result, we introduce an old-age borrowing constraint which precludes households from borrowing in the final period of their lives:

$$a_{t+N} \geq 0 \qquad \textbf{(3)}$$

Although borrowing constraints are more often associated with the young, low and declining net worth, as well as low future labour incomes, may make lenders unwilling to extend credit to older households in the presence of credit market frictions. In practice, the number of reverse mortgages held by older households has been low, despite the possibilities for higher consumption they offer (Caplin (2001)). The lack of borrowing captured by this constraint could also be motivated by a

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[8] We include wages, salaries and self-employment income but exclude other forms of income, such as interest payments, as these represent returns on saving.
[9] As net worth late in life is likely to be lower than the value of desired owner-occupied housing, there is a motive to borrow.
[10] Those early in retirement would be expected to have substantial net worth, to finance their future consumption, so this could offset the need to finance homeownership to satisfy the no rental housing constraint. However, as such households aged, net worth would decline, gradually forcing households into mortgage debt. It is important to note this possible heterogeneity among retired households.

number of other factors. This includes difficulties insuring against longevity or late-in-life medical costs, bequest motives, home equity not being regarded as substitutable with other wealth (Venti and Wise (2000)), or market conditions that have prevented the development of an effective reverse mortgage market (Caplin (2001)).

3.7 Household behaviour

Households' optimal non-housing consumption is derived by maximising **(1)** subject to **(2)** and **(3)**. Relative consumption of goods and housing services in each period is then given by:

$$\frac{h_{t+i}}{c_{t+i}} = \frac{\alpha}{1-\alpha}\frac{p_{t+i}}{R_{t+i}} \qquad \textbf{(4)}$$

where R_{t+i} is the (nominal) user cost of housing. In every period apart from the last period of life, it is given by:

$$R_{t+i} = \frac{q_{t+i}}{(1+\rho^q_{t+i})}(\rho^q_{t+i} + d) \qquad \textbf{(5)}$$

where $1+\rho^q_{t+i} = (1+r_{t+i})q_{t+i}/q_{t+i+1}$, is (one plus) the real interest rate where inflation is measured by expected house price inflation. In the last period of life, the nominal user cost of housing is simply given by the stock price of housing $R_{t+N} = q_{t+N}$. As households have no motive to hold assets to yield utility in the future, the no rental housing constraint imposes a real cost from having to hold housing assets to enjoy housing services. This change in costs implies that households will modify their behaviour.

Intertemporal consumption of non-durables is given by:

$$\frac{c_{t+i+1}}{c_{t+i}} = \left(\frac{p_{t+i}/R_{t+i}}{p_{t+i+1}/R_{t+i+1}}\right)^{-\frac{\alpha(1-\gamma)}{\gamma}} \left(\beta(1+\rho_{t+i})\right)^{1/\gamma} \qquad \textbf{(6)}$$

where the real interest rate is defined here in terms of inflation in non-durable goods. Repeated substitution of the Euler equations into the intertemporal budget constraint gives consumption in each period as a function of preferences and costs for both goods. This then determines borrowing through the budget constraint.

3.8 Aggregation

The aggregate pattern of household behaviour can be derived by aggregation across generations (n_i) as we take a partial equilibrium approach. Each cohort's weighting in the aggregate is determined by the variation in the formation of new young households (m):

$$n_{1,t} = m_t n_{1,t-1} \quad \textbf{(7)}$$

Aggregate debt holdings are then given by:

$$D_t = \sum_{i=1}^{i=10} n_{i,t} d_{i,t} \quad \textbf{(8)}$$

where aggregate debt (D) depends on the structure of the population and the debt (d) of each cohort, where d is the absolute value of the negative asset holdings of each cohort. This captures the heterogeneity of different cohorts in so far as it differs from the sum of net asset holdings across all generations.

4 Calibrated model

In this section, we calibrate the model for the United States, matching both aggregate and cross-section data, and discuss its steady-state and dynamic properties. Table B compares the steady state of the model with long-term averages for corresponding aggregate variables in the US economy. It shows that there is quite a close match between the calibrated model and the actual US economy. Within this framework, we are able to simulate a debt to income ratio close to the aggregate US measure.

Table B: 'Steady-state' aggregate behaviour*

Ratio[11]	'Steady-state' value	Base-model estimate
Debt to income	0.65	0.75
Net worth to income	3.85	4.15
Housing (tangible assets) to income	3	3.14
Gross financial assets to income	1.5	1.76
Income gearing	0.22	0.22

* Steady-state values based on long-term averages for the United States.

[11] All ratios are expressed in terms of the stock over the *annual* flow of income.

Although most measures in the calibrated model are close analogues of their observed values, some measures used in this simple model are not directly comparable to observed data. In particular, 'debt' in the model measures the sum of individual negative net financial assets holdings under the assumption that no household owns both financial assets and liabilities.[12] To the extent that individual households do hold both, this drives a wedge between the observed aggregate data, which would measure aggregate 'gross' assets and liabilities, and what the model measures, which nets out financial assets and liabilities at individual household level. This is likely to be more of a problem when incentives to hold both financial assets and liabilities change over time.[13]

The calibration uses long-term US averages to set the 'steady-state' values to be matched and observable parameters, such as growth and interest rates (Tables B and C). Unobservable parameters are set to be consistent with empirical estimates for the United States or those adopted previously in the literature. The range of estimated parameters for the intertemporal elasticity of substitution and time preference is large, particularly for the rate of time preference which 'is probably positive but could actually be negative' (Elmendorf (1996)); there is no accepted view, empirical or theoretical, as to whether consumers behave relatively patiently or impatiently. In the calibrated model, it is necessary for households to be quite patient relative to values assumed in some other models to replicate the difference between observed net worth and debt. Given the assumed real interest rate, income growth and intertemporal elasticity of substitution, a gap between the real interest rate and time preference equivalent to around 7 percentage points annually is postulated.[14]

Table C: Calibration values

Parameter value	Estimated values for United States	
Intertemporal elasticity of substitution of 0.5 ($\gamma = 2$)	0 to 0.2	Campbell & Mankiw (1989)
	-1.46 to 1.92	Zeldes (1989)
	0.3 to 0.6	Runkle (1991)
	0.81 to 1.8	Lawrance (1991)
	0.1	Dynan (1993)
	0.3 to 0.6	Attanasio & Weber (1995)
$\delta = -0.15$	Equivalent to -3% annually	
	0.03	Gourinchas & Parker (1999)
	0.1 to 0.15	Carroll & Samwick (1997)*
$g = 0.2$	Equivalent to 3.5%-4% annually	
$r = 0.3$	Equivalent to 5% annually	
$d = 0.05$	Equivalent to 1% annually[15]	

* Cited in Gourinchas and Parker (1999).

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[12] As discussed in the previous section.

[13] For example, in the early 1980s borrowing to make contributions to IRAs (Individual Retirement Accounts) was tax deductible, providing sophisticated households with the incentive to gross up both sides of their balance sheet. Rules were subsequently tightened up in the 1986 Tax Reform Act that reduced this incentive. We are grateful to a referee for this information.

[14] 0.45 over a five-year period.

[15] The average annual rate of depreciation on housing is 1.4%, as estimated in the national accounts.

The model can be used to generate a *cross-section* of balance sheet positions across the population, showing how aggregate liabilities and assets are distributed across age groups. Furthermore, it can be used to a derive a *cohort profile* showing how an individual household's balance sheet evolves over their lifetime.

Chart 10: Model cross-section of (net) financial asset holdings

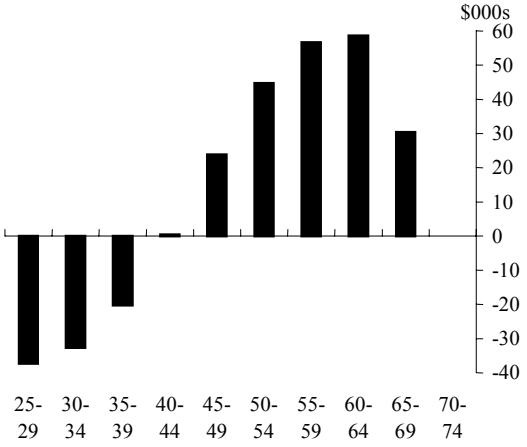
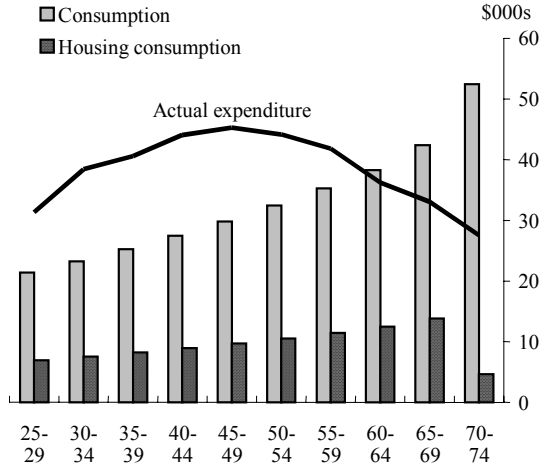


Chart 11: Model of cross-section of consumption



The calibrated model's estimates of asset accumulation and borrowing behaviour depend on how effectively it captures underlying *consumption* behaviour. The model replicates the share of expenditure devoted to housing services, estimated as one-third from the *1999 Consumer Expenditure Survey*, and the stock of housing relative to consumption and income is close on average to the rule of thumb of three times income, cited in Carroll and Dunn (1997). As Chart 11 shows, the model captures the rise in cross-section consumption from youth to middle age. However, the simulated consumption profile does not capture the 'hump-shape' of consumption observed in cross-section and fails to capture lower expenditure by older generations, even with the old-age borrowing constraint. This inability to match the observed cross-section of consumption is a feature of this class of consumption model.[(16)]

The *cross-sections* of housing and financial asset holdings generated by the calibrated model shown in Charts 10 and 12 are similar to the observed cross-section in the SCF data (Chart 6) in a number of respects. Younger households borrow the most. Middle-aged households accumulate positive assets holdings and older households liquidate their financial asset holdings during retirement. In terms of indebtedness, the calibrated model implies that households are indebted for the first 15 years, progressively repaying their debt until the age of 40. Furthermore, the distribution of homeownership is weighted more to the young than for financial assets. The result that few households have negative net worth matches the finding that only 10% of US households are in such

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[(16)] Such models with the specified utility function imply linear consumption profiles over the life-cycle rather than the observed 'hump-shaped' profile. Precautionary savings models are generally better able to capture this.

a position.[17] However, there are also a number of differences, which partly reflect differences between the actual and observed consumption profiles discussed above.

The *cohort profile* shows the path for household portfolios over the life-cycle, which is less easy to observe directly (Chart 13). The consumption-income motive, which as discussed in the previous section determines net worth, leads net worth to be initially negative as consumption is greater than income in the first period. However, net worth quickly becomes positive as households begin to save: this motive does not in itself explain most borrowing by households. The housing-finance motive plays a crucial role in generating debt over the life-cycle, as it tends to reduce financial asset holdings, increasing or leading to debt at low levels of net worth. This constraint implies that households not only have larger debts but also that they remain in debt for one period longer. This effect is reinforced by the fact that housing consumption increases with age, so that the required level of housing assets also increases. A further consequence of the interaction of the consumption-income and housing-finance motives is that financial asset holdings increase relatively rapidly during middle age due to the increase in net worth relative to housing consumption.

Chart 12: Model cross-section of asset holdings

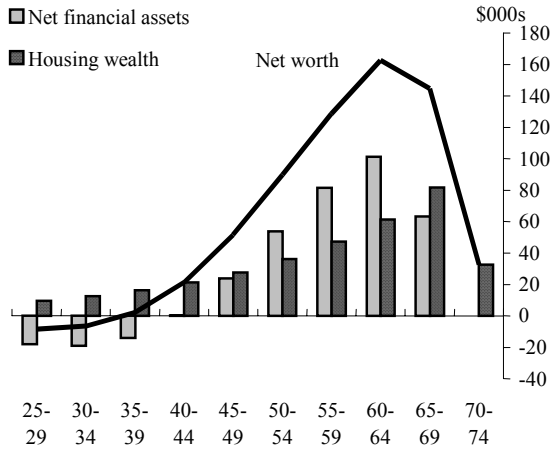
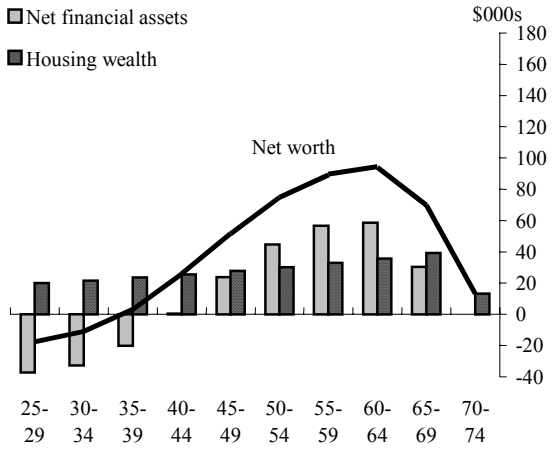


Chart 13: Model cohort profile of asset holdings



The old-age borrowing constraint binds in the final period causing households to substitute from housing to non-housing consumption, sharply reducing their homeownership. The constraint improves the ability of the calibrated model to match observed consumption profiles and to explain the phenomenon of older households owning housing assets without having large borrowings.

Comparing the cross-section and cohort profiles of asset holdings shows how aggregate debt depends, in an overlapping generations framework, both on the path each cohort chooses and the economic weight of each generation in the economy (see Charts 12 and 13). In the calibrated model, younger cohorts have relatively greater weight because their lifetime wealth is greater than for older

[17] Lupton and Stafford (2000), see Section 1.

generations due to economic growth.[18] As a result, borrowing is larger relative to assets in cross-section than for an individual cohort across the life-cycle.

Income growth thus plays a dual role in determining aggregate borrowing, influencing both how much individuals want to borrow through the relationship between desired consumption and current income and in weighting different generations in cross-section. The interest rate also has a central role in determining indebtedness, working through three different mechanisms: the relationship between preferences over time and interest rates, the present value of the gap between consumption and income at any point in the life-cycle, and the user cost of housing.

In steady state, the aggregate debt to income ratio is constant. The aggregate equilibrium path in overlapping generations (OLG) models is determined by income and population growth, which determine the weight of new cohorts relative to those they replace (Diamond (1965)), rather than the behaviour of individuals over the life-cycle. In steady state, debt and financial assets thus rise at the same rate as the economy grows and the debt to income ratio remains constant.

Transition between steady states in response to shocks is not immediate because, although agents adjust their expectations immediately, the effect of shocks persists for the 45 years it takes for 'shocked' cohorts to be fully replaced by younger cohorts. This generates dynamics under which the debt to income ratio changes and remains out of equilibrium for prolonged periods as it adjusts to steady state. These dynamic properties of the model are common to this class of OLG model with forward-looking behaviour.

Cohorts who experience a shock find that *ex post* they were not following an equilibrium path. As a result, the path they choose in response to the shock will differ from that they would have chosen in the new equilibrium. The possibility of borrowing adds to the possible dynamic responses in two ways. First, the possibility of borrowing and hence negative net worth widens the range of these responses. Second, debt has a dynamic role because of balance sheet effects. These occur either if financial assets are re-valued or if house prices change; households are 'leveraged' to the extent that they borrow financial assets at a fixed interest rate to finance housing whose price may change over time. For a household with precisely equal borrowings and housing assets, an unexpected rise in the house price yields a 'windfall' gain.

5 Assessing the causes of the change in aggregate indebtedness

As the rise in US household debt in the past 30 years is incompatible with steady-state behaviour, we consider whether identifiable shocks can explain the rise in debt. The increase in debt (Chart 1) can e interpreted as two distinct phases of rapid growth separated by a period of steady indebtedness in the 1960s and 1970s, or as an underlying steady trend increase with prolonged deviations from this.

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[18] Population growth has similar effects.

We consider first in general terms how the effects of observed shocks to the US economy could account for the rise in debt. We consider the role of demographic change, changes in the real interest rate and shifts in the rate of income growth and growth expectations. Second, we develop a scenario that combines the effects to see how far the model is able to explain the increase in the debt to income ratio. To the extent that this scenario cannot account for observed behaviour, we discuss how this influences our interpretation of the stability of US household debt.

5.1 Demographic changes

Chart 14: Effect of simulated demographic change on asset ratios

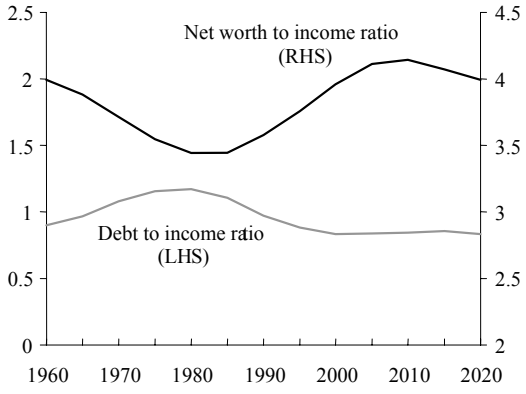
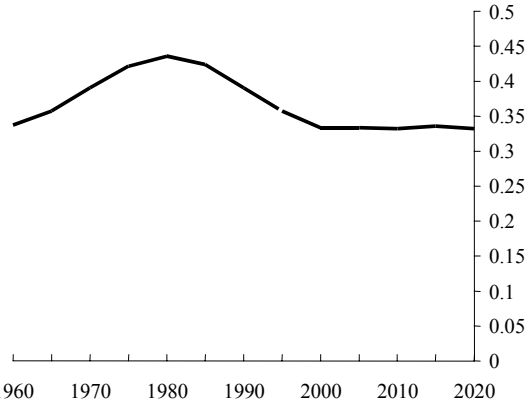


Chart 15: Proportion of debtor (under 40 years old) households



We begin by analysing the effects on aggregate debt of changes in the demographic structure, specifically the birth rate. As explained earlier, demographic effects can, in overlapping generations models, change aggregate indebtedness *without* any change in individual behaviour by altering the weight of each cohort in the economy.

In the post-war era, the main demographic changes have been variation in the birth rate, the 'baby boom' and its echoes, and increased longevity (Elmendorf and Sheiner (2000)). By varying the size of new cohorts entering the model using the lagged birth rate as a proxy, we simulate a 'baby boom'. This raises the proportion of young and indebted households in the population to a peak in the first half of the 1980s (Chart 15), where these correspond to children born at the height of the baby boom in the late 1950s and early 1960s.

The effect of the simulated 'baby boom' is large: the debt to income ratio would have risen from 90 to almost 120% between 1970 and 1980 (Chart 14).[(19)] However, indebtedness would have fallen below 85% of income by 2000 as the baby boom generation moved out of its most indebted period in life.[(20)] Some modest rise in debt would now be expected as a result of the baby boom 'echo'

[(19)] The debt to income ratio starts at a higher level due to demographic effects prior to the 'baby boom' not captured in the calibrated model.

[(20)] Per capita income in our model depends on the demographic structure of the economy due to use of fixed income premia but this does not lead to a large distortion in the aggregate debt or net wealth to income ratios.

(households whose heads were born in the 1980s). This suggests that the rise in debt cannot be explained by demographic changes alone. It also suggests that the background against which indebtedness increased was not demographically neutral: explanations of the rise of indebtedness since the 1980s must explain not only why debt rose but also why it did not *fall* due to demographic effects.

5.2 Unexpected real interest rate shocks

We consider the effect of a shock to real interest rates that is expected to be permanent. Spending plans in the model are determined by *ex-ante* real interest rates, while shocks to rates cause plans to be revised because the previous spending plan is no longer optimal and also, once net asset positions have been affected, because it may no longer be feasible. By contrast to a demographic shock, this has its effects entirely through changes in individual behaviour with no direct impact on how different cohorts are weighted in the aggregate.[21]

We simulate an unexpected increase in the level of US annual real interest rates in 1980 until 1995 by around 1 percentage point, which then unexpectedly return to their pre-1980 level. This is broadly consistent with the pattern of US *ex-post* real rates in recent decades (Chart 17), allowing for some effects of unanticipated inflation in the 1970s.

We find that such a shock would have reduced the aggregate debt to income ratio in the 1980s by around 13 percentage points but that the debt to income ratio would have recovered rapidly in the late 1990s towards their 1970s levels (Chart 16). Aggregate net worth would have increased while debt was falling, but would be expected to fall in the years ahead.

Chart 16: Impact of observed changes in interest rates on indebtedness

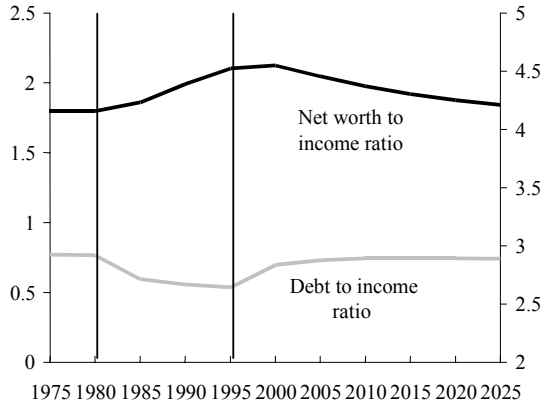
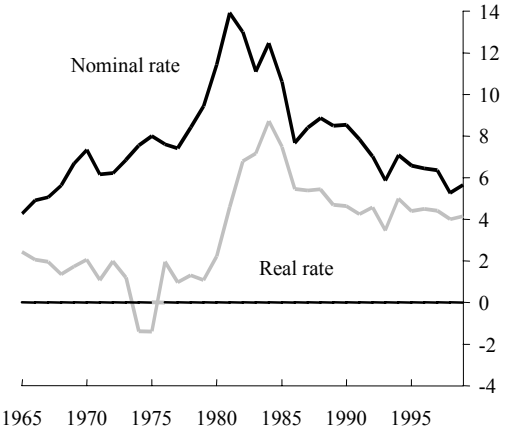


Chart 17: US real interest rates[a]



(a) Real *ex-post* 10-year interest rates.

[21] There is an indirect effect as a change in interest rates alters the relative present value of future labour income across generations.

The calibrated model allows the aggregate effects of shocks to be decomposed into their effects at the disaggregated level. There are three types of effect to consider: (a) the change in the steady state, (b) the effect on cohorts whose consumption plans must be revised after the shock (whose behaviour differs from either steady state), and (c) the composition of the population in terms of those who experienced which shocks at which periods in their lives.

Changes in interest rates imply a change in steady-state household behaviour. Higher interest rates imply that households borrow less and have higher asset holdings in cross-section (Chart 18) and over the life-cycle. Furthermore, they would also tend to borrow for a shorter period of their lives.

There is also an effect from households whose consumption plans must be revised following the shock, taking into account the *ex-post* sub-optimal consumption and portfolio path they had been pursuing. These households reduce borrowing relative to their original plans after the unexpected rise in interest rates. For example, a cohort reaching 25 in 1975 would borrow less than anticipated after the shock but more than they would had they always been in the mid-1980s high interest rate state, due to higher consumption prior to the shock (Chart 19). In the 1990s, as interest rates unexpectedly returned to their 1970s steady state, this cohort would have held more assets than if this state had always prevailed.

The change in aggregate indebtedness depends both on the response of individual cohorts and the evolution of the population between 'shocked' cohorts and others. As the interest rate is set *ex ante*, first-period behaviour is never 'shocked': such individuals always adopt steady-state behaviour. However, cohorts at all other periods in their lives are surprised by the change in interest rates and this effect remains until the last cohort to have experienced the shock dies 45 years later. In the case considered of two interest rate shocks taking effect only 15 years apart, there is only one period, 10 to 15 years after the shock, when aggregate borrowing corresponds to the new lower level implied by the high interest steady state. In other periods, aggregate borrowing partly reflects the responses of shocked cohorts. By contrast, in this example, aggregate net wealth never attains the high interest rate steady state because of the continued presence of 'shocked' cohorts.

Overall, the adjustment of aggregate borrowing to the new steady state is gradual, as shocked cohorts have debts that are smaller compared to the old steady state but larger than in the high interest steady state. The opposite effect holds when the economy returns to a low interest rate state. The rate of adjustment is fastest initially because in the period of the shock all debtors change their borrowing, compared to later periods where the adjustment represents the effect of 'shocked' cohorts being replaced by those who have always anticipated the new steady state.

Chart 18: Cross-section of net assets

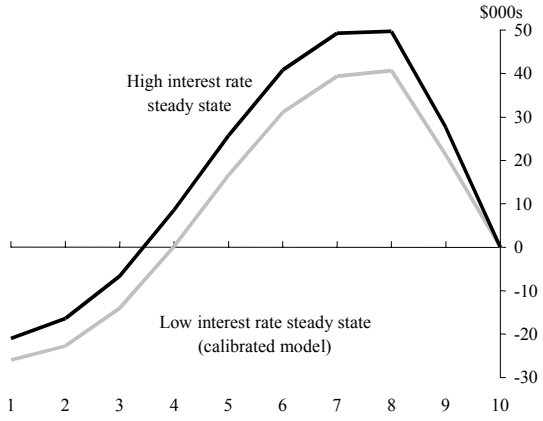
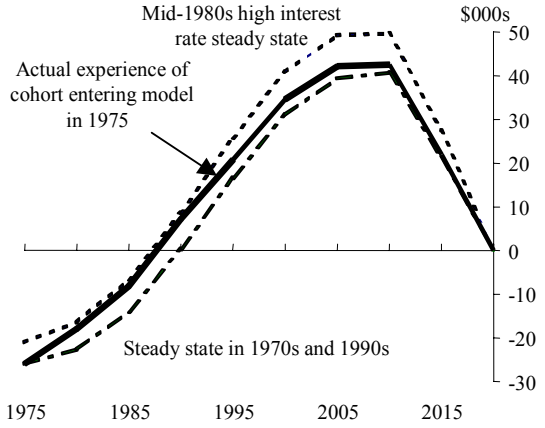


Chart 19: Net asset profile for cohort aged 25 in 1975



5.3 Unexpected income growth and expectations shocks

We consider the effect of changes to income growth and growth expectations. Income growth, as discussed previously, has a number of effects on aggregate borrowing. As well as changing the timing of a given level of income over the life-cycle, it also influences the relative economic weight of younger (borrower) cohorts in the population.

We consider the effect of shifts in income growth similar to those observed in the United States over recent decades. We then consider the role of expected versus unanticipated changes in income growth.

We consider the effects of an unanticipated 'permanent' fall in income growth in the early 1980s equivalent to 1 percentage point on the annual growth rate and then an unanticipated recovery since 1995 which is expected to persist. In this scenario, the debt to income ratio would have fallen by around 33 percentage points by 1995 (Chart 20). Indebtedness would then have recovered to its previous level, overshooting the new steady state slightly.

Chart 20: Effect of slowdown in personal income growth in early 1980s with recovery in late 1990s

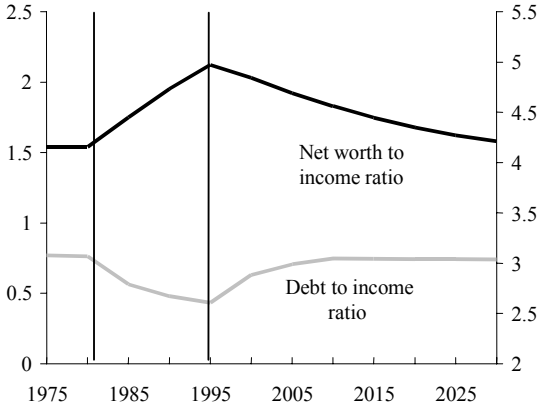
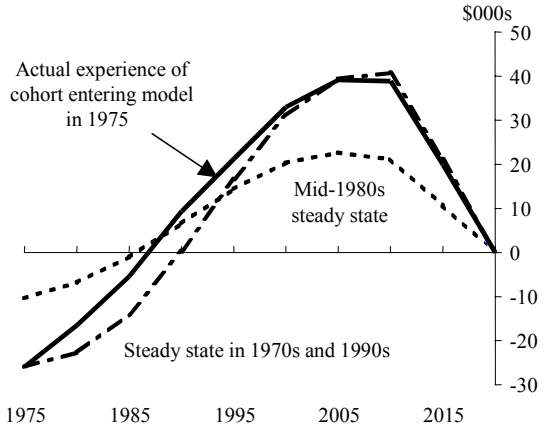


Chart 21: Net asset profile for cohort aged 25 in 1975



The effect of this shock and its dynamics are similar to those discussed above for interest rate shocks, although there are differences and an additional effect due to lower economic weight implied for the young in the population. Again taking the example of a cohort starting in 1975, Chart 21 shows that they would have reduced borrowing in 1980 by more than anticipated as current income was reduced by less than consumption. However, borrowing would be higher than if the fall in the growth rate had been anticipated (or the mid-1980s steady state had always prevailed). Conversely, Chart 22 shows the experience of a cohort starting in 1990. The positive shock to its income growth expectations increases borrowing in 1995 relative to what was planned but still implies less borrowing than in the high income growth steady state (Chart 22).

Chart 22: Net asset profile for cohort aged 25 in1990

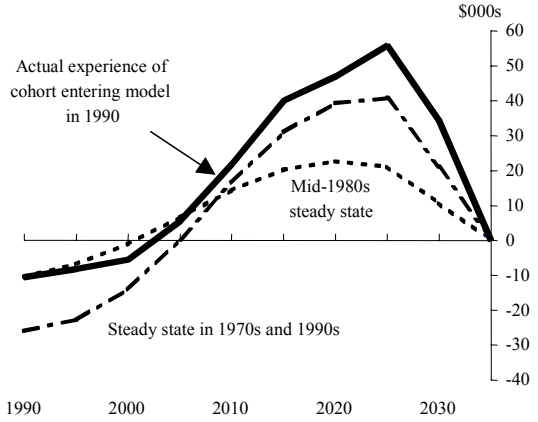
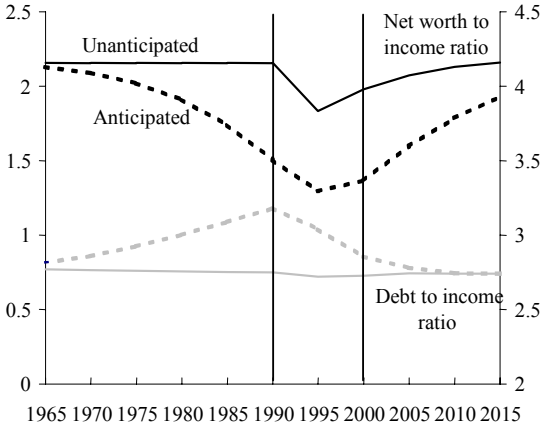


Chart 23: Anticipated and unanticipated income shocks



Expectations play an important role in how changes in the economic environment translate into changes in borrowing behaviour. This is discussed in the UK context by Attanasio and Weber (1994). The effect of unanticipated shocks has been discussed above for both interest rate and income growth shocks. Here we compare hypothetical perfectly anticipated and completely unanticipated shocks, each equivalent to a *temporarily* higher annual growth rate of 1 percentage

point during the 1990s (Chart 23). The anticipated shock has an earlier and larger overall effect than the unanticipated shock. The anticipated shock is factored into household expectations 45 years before it occurs. The aggregate debt to income ratio converges at an increasing rate to its full effect during the beginning of the high income growth period, as debtor cohorts are replaced by those for whom the shock occurs earlier in life and hence has a broadly greater impact on permanent consumption. The debt to income ratio declines during the period of higher income growth as debtor households at that period have *both* higher current income and higher consumption. To the extent that their permanent income is also higher, their weight in the economy is also raised.

By contrast, the effect of the unanticipated shock only begins when the shock occurs. Furthermore, the effect on aggregate borrowing and saving is smaller, particularly in terms of indebtedness. In essence, such a shock increases the resources households currently have available for consumption and permanent income by the same measure. Households respond by saving some of their windfall. The magnitude of the aggregate effect is less than in the case of the anticipated shock.

The direction of the effect on the debt to income ratio is different in the two cases: the anticipated shock offers the young more income later but the same now, increasing debt, but the unanticipated shock increases the current income of the young now relative to later in life, with the opposite effect.

An interesting thought experiment is to consider the effects on aggregate behaviour of two different 'new economy' scenarios. In both cases, households assume that there has been an unanticipated permanent 1 percentage point increase in the annual growth rate. However, in the permanently higher growth case, this expectation is vindicated while in the one-time level shift case the economy only actually experiences a temporarily higher rate of growth. The difference between the two cases is informative for thinking about the sustainability of borrowing.

Chart 24: Permanently higher income growth

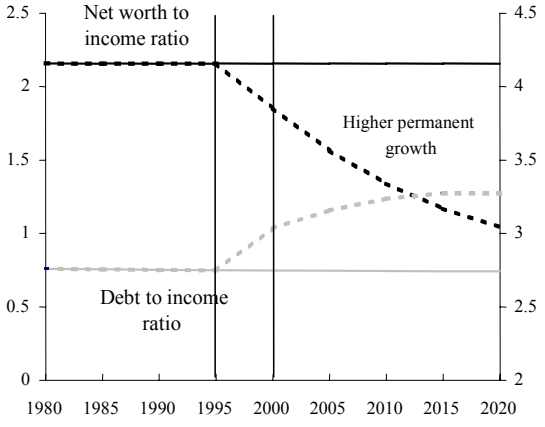
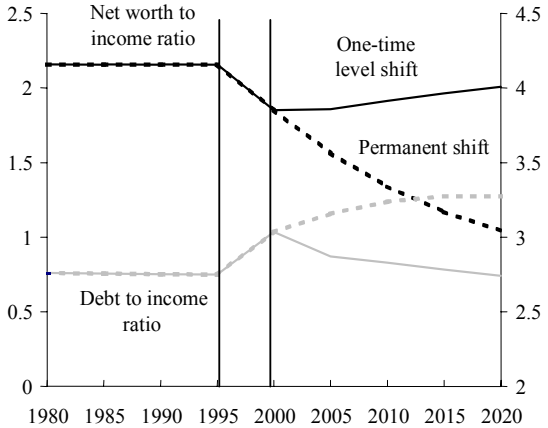


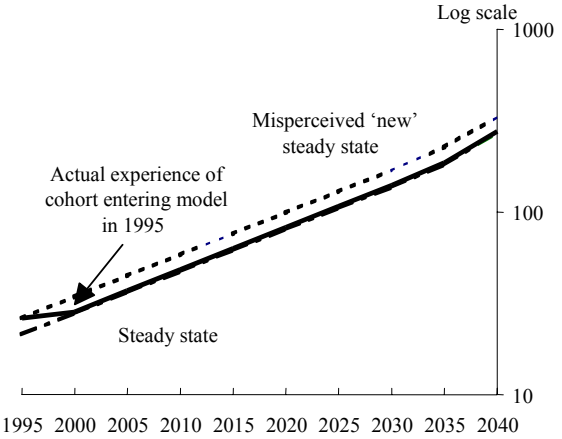
Chart 25: One-time level shift in income



In the first case, where the increase in income growth is revealed to be permanent, aggregate borrowing increases relative to income, while net worth falls. Adjustment towards the new steady state is gradual (Chart 24). In the second case, the shock was expected to be permanent but is

identified at the end of period as a one-off shift in the level. As a result, the necessary adjustment to the aggregate debt is less than if the economy were moving from the new steady state (Chart 25). As debt is unevenly distributed across different cohorts, some households will choose to adjust debt more than others in this situation. In particular, young households will have the greatest effect from a shock on their consumption, reducing rather than increasing their consumption between the first and second periods (Chart 26).

Chart 26: Cohort non-housing consumption profile for cohort aged 25 in 1990



5.4 Explaining the rise in US household indebtedness

In this subsection, we examine how far the calibrated model can account for observed movements in the debt to income ratio. As the debt to income ratio has increased over time, we consider what shocks could have generated this. We compare a simulated path for the debt to income ratio, combining several of the factors discussed above, with the US experience. The scenario embodies the unexpected slowdown in growth and higher interest rates in the 1980s and early 1990s and unexpected recovery (as discussed above), as well as demographic effects. This scenario implies that, as observed, borrowing would have been expected to rise in the 1990s and this would be expected to continue. This would also be consistent with the 'new economy'-type effects of the late 1990s, discussed above. However, it also suggests that aggregate debt should have fallen significantly during the 1980s, which contrasts with actual experience.

Table D decomposes differences in the debt to income ratio compared to the base case of the calibrated model for shocks to each of the three variables (interest rates, population growth and income growth). Columns 3 to 5 show these effects individually. This shows that, for the shocks considered, income growth would have the largest effect on the debt to income ratio with interest

rates also having large effects in the same direction. The path of the debt to income ratio incorporating the sum of these three effects is given in column 6.[22]

Table D: Combined effects on debt to income ratio of demographic, interest rate and income growth shock

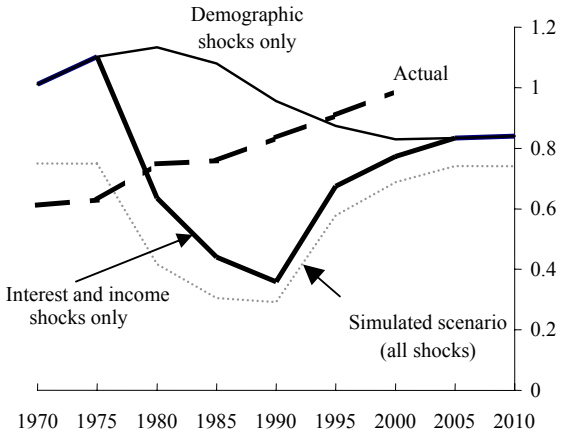
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Period starting	Base scenario	Shock relative to base			Scenario with sum of effects	Simulated scenario
		Demographic	*Interest rate*	*Income growth*		
1970	0.78	*0.33*	*0*	*0*	1.11	0.89
1975	0.78	*0.20*	*0*	*0*	0.98	1.01
1980	0.78	*0.12*	*0*	*0*	0.90	1.10
1985	0.78	*0.07*	*-0.16*	*-0.20*	0.49	0.63
1990	0.78	*0.08*	*-0.20*	*-0.28*	0.38	0.44
1995	0.78	*0.09*	*-0.22*	*-0.32*	0.33	0.36
2000	0.78	*0.10*	*-0.05*	*-0.12*	0.71	0.67
2005	0.78	*0.08*	*-0.02*	*-0.04*	0.80	0.77
2010	0.78	*0.05*	*0*	*0*	0.84	0.83
2015	0.78	*0.02*	*0*	*0*	0.80	0.84

Column 7 shows the overall effect of the scenario that combines these individual changes to key variables. This differs from the sum of the individual effects because of the non-linearity of the debt to income ratio in these variables, and the interaction of the effects with each other. For example, the effect of the first interest rate and income growth shocks would be different from the second shocks both because of the gradual adjustment of aggregate variables, the differential impact of 'shocked' cohorts, and the fact that there were fewer young people (debtor households) in 1995 compared to 1980. Equally, the effects on the timing of income over the life-cycle due to variation in income growth depend on the rate of interest so that changes in the rate of interest at the same time have a complex effect on overall behaviour.

Chart 27 shows evolution of the debt to income ratio under the simulated scenario compared to the actual experiences, as well as what would have emerged under demographic shocks or interest rate and income shocks alone. This shows the importance of the interaction of the different effects. Furthermore, it illustrates the relative importance of interest and income growth shocks relative to demographic changes, although even these also would have had an appreciable effect.

[22] This is only indicative because income is not the same under the three scenarios and because the demographic 'shocks' compare to a base line case of no population growth while the population size is growing on average in the calibrated model for the period considered.

Chart 27: Debt to income ratio under simulated scenario



The difficulty in explaining the rise in the debt to income ratio in the 1980s is problematic to the extent that the model and simulations here are intuitive: a rise in interest rates and fall in income growth would be expected to have lowered indebtedness. We consider two hypotheses to explain this difference between the simulated scenario and actual behaviour, and their implications for the model and our understanding of the sustainability of US household debt.

The first hypothesis is that the simulation fails to match some of the features of the US economy over recent decades that would have an impact in the model. We evaluate this by comparing it to actual US household behaviour from the *Survey of Consumer Finances* over the period 1989 to 1998 (Table E). This suggests that the increase in aggregate debt was principally due to increases in debt by families headed by 35 to 54 year olds. Furthermore, demographic effects played a role but, as in the simulated scenario, this is somewhat secondary to changes in borrowing by individuals in given circumstances.

Table E: Decomposing changes in US household indebtedness between 1989 and 1998[23]

Age of head of family	Share of total families		Median debt holdings		Contribution of changes in:		Contributions to TOTAL change
	1989	1998	1989	1998	Weights	Debt holdings	
<35	28.1	23.3	14.8	19.2	-3.5	6.1	1.9
35-44	21.5	23.3	38.9	55.7	3.8	19.6	24.3
45-54	15.1	19.2	30.2	48.4	6.5	14.4	25.7
55-64	13.9	12.8	12.7	34.6	-0.6	13.2	13.1
65-74	12.5	11.2	6.4	11.9	-0.3	2.11	1.8
75+	8.9	10.2	3.6	8	0.0	0.5	0.8
TOTAL	100	100	-	-	6.0	55.8	67.5

Sources: *Survey of Consumer Finances* and authors' own calculations.

Table E suggests that the aggregate real value of debt increased 67.5% between 1989 and 1998 under the maintained assumptions. It also reveals some differences between the assumptions in the simulated scenario and some changes in observed behaviour. In particular, actual experience seems to show that the increase in aggregate debt is mostly attributable to households headed by those aged 35 to 44. This differs from the calibrated model in which most of these households are not debtors. Thus, it is the shortcomings of the model in capturing this feature of behaviour, as discussed in Section 3, that raises this difficulty combined with the growing weight of such individuals in the economy, which the model broadly captures.[24] However, this is re-assuring in that it tends to indicate the empirical relevance of the underlying mechanisms in the model. The simulated scenario is also sensitive to the correct identification of expectations, which we have assumed to be entirely forward looking and to treat all shocks as permanent (all shocks are unanticipated). It may also fail fully to capture the effect of unanticipated inflation in the 1970s, which may have raised the *ex-ante* cost of borrowing, tending to reduce the level of borrowing in 1970s below that suggested here. The second hypothesis is that there is a divergence between the modelled scenario and actual US experience because the model fails to capture some important features of US household borrowing behaviour. There are a number of reasons for which this could be the case.

First, financial liberalisation in the United States in the 1980s may have increased effective borrowing demand. This has previously been identified in the literature, through for instance lower requirements for deposits since the 1980s (Carroll and Dunn (1997)). The 1986 Tax Reform Act[25] and the increased availability of home equity credit lines (Canner, Durkin and Luckett (1998)) have

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[23] This table is derived from the *Survey of Consumer Finances* using constant 1998 dollars. These calculations assume that median debt holdings are equal to mean debt holdings. The change in the total incorporates these demographic effects, changes in median debt holdings for those with debt and the share of each demographic group holding debt (not shown). Contributions to changes in demographic weights and debt holdings are calculated assuming that all other variables kept their 1989 variables.

[24] The model also ignores net migration (this may be important if the age distribution of migrants differs from the population as a whole).

[25] Tax deductibility on other forms of household debt was phased out over a five-year period.

increased the incentive to use secured credit, which is less costly (Maki (2000)),[26] and so may have lowered the rate of interest paid by households relative to policy rates.[27] Financial liberalisation may have offset the tendency for debt to fall as interest rates rose and income growth fell.

Second, it has been shown that younger cohorts are *ceteris paribus* more likely to borrow than their predecessors (Poterba and Samwick (1997)). One explanation for this is that preferences may have shifted. For example, there has been a small increase in owner-occupation over the past 30 years (see Chart 4). An alternative hypothesis is that younger generations are less reluctant to take on debt. Although house prices have risen more slowly than incomes, increased spending on owner-occupied housing would have raised the amount of borrowing required to finance house purchases, affecting first-time buyers and those moving to larger dwellings the most (Maki (2001)).

Third, the calibrated model cannot fully capture the heterogeneity of US households, as it is limited to differences *between* rather than *within* cohorts. In abstracting from intra-cohort heterogeneity, the model ignores the fact that cohorts hold both assets and liabilities, and the effect of the 'super rich', who hold a disproportionate share of assets and whose behaviour is unlikely to be captured by conventional models (Carroll (2000)). This may address the apparent puzzle that net worth and debt relative to income have risen together, while the model tends to imply a negative relationship.[28] It may also be explained by equity revaluation gains, which the calibrated model cannot fully analyse due to its specification of financial assets. There has been some suggestion that the rise in indebtedness in the 1990s has been disproportionately attributable to higher-income households.[29]

5.5 Implications for the sustainability of US household borrowing

How does this inform our understanding of the sustainability of US household debt? The model has several implications for the sustainability of US household debt, by which we mean whether current high debt levels have negative consequences for the future of consumer spending, or will lead to a higher rate of personal bankruptcies. In particular, the level of debt chosen by a household is sustainable whenever the expectations about income growth, house prices, interest rates and other determinants of borrowing that underlie that choice are not falsified or revised. Once circumstances change, however, then a level of borrowing that had appeared optimal would need to be changed by altering spending plans.

Thus, the model implies that shocks to interest rates and income growth expectations are likely to be important contributors to changes in debt. For example, if households had believed in a permanent 'new economy' and this turns out not be sustained, the debt to income ratio would be expected to fall considerably, although by less than if it had been fully anticipated. As such it is very difficult to

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[26] As it has greater duration and offers a greater degree of protection to the lender.
[27] This is supported by the relative stability of the debt-servicing ratio, despite the rise in the debt stock.
[28] Except during some phases of dynamic response.
[29] See Alan Greenspan's testimony to the Joint Economic Committee of Congress on 17 April 2002.

judge the sustainability of debt as it depends on whether the expectations that underlie it are sustainable. Furthermore, demographic developments are likely to reduce the aggregate debt to income ratio in the years ahead absent further changes in other variables.

To the extent that the model does not fully explain the rise in indebtedness, this has further implications for our understanding of the sustainability of the US debt to income ratio. This model describes equilibrium movements in borrowing – the difference between the behaviour implied by the model and actual developments may be indicative of an unsustainable disequilibrium 'borrowing spree'. Alternatively, if it reflects a relaxation of credit constraints, the current level of the debt to income ratio would be sustainable provided that lenders continue to be willing to lend on the same terms as at present.

6 Conclusion

This paper examines the rise in US household borrowing within an overlapping generations framework that captures both aggregate and cross-sectional behaviour. The model relates life-cycle consumption behaviour and the need to finance housing consumption, incorporating an old-age borrowing constraint. The old-age borrowing constraint is introduced as a new form of capital market imperfection that prevents the old from borrowing. It is similar in effect to a bequest motive in that it implies that households have positive net worth when they die.

The model is able to match a number of aggregate and cross-sectional features of US household consumption and asset-accumulation behaviour. We show that aggregate dynamic adjustment is gradual and prolonged, although individual cohorts adjust their behaviour instantaneously. We also show important differences between shocks that are fully anticipated and those that are unanticipated.

As the sustained increase in the household debt to income ratio is not a steady-state phenomenon, even in an overlapping generations model, we consider whether a scenario embodying shocks to interest rates, income growth and demographics can explain the rise in indebtedness. Although this scenario suggests that the debt to income ratio should have risen quite sharply in the 1990s, in line with the data, it cannot explain the rise in indebtedness in the 1980s. This is, however, consistent with significant financial liberalisation during the 1980s, which the model does not capture, as well as some other hypotheses.

The implications for the sustainability of the current level of debt, following the increases in the 1990s, are therefore somewhat tentative. In the scenario developed above, the continued adjustment to lower interest rates and higher income growth implies that the debt to income ratio would be expected to increase in the next years in the absence of further shocks, with demographic effects broadly neutral. But if there has indeed been a misperception about a 'new economy', we would expect a fairly sharp reduction in the debt to income ratio, but much smaller than if the economy had

had time to adjust to the new steady state; the transience of the phenomenon would limit its aggregate effects, even if individual cohorts were forced to adjust their consumption patterns more sharply. To the extent that the simulated scenario does not replicate observed behaviour, this raises the question of how far this is a shortcoming of the scenario or the model, or whether the rise in indebtedness has some 'disequilibrium' characteristic.

This discussion points to further research issues. There is a need for more detailed empirical examination and richer theoretical models of borrowing behaviour that address aggregate and cross-section behaviour in the light of the motives and constraints identified in this paper. In particular, the connection between owner-occupation and debt should be further explored.

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