

The incentive effects of means tested UK retirement benefits – has the Pension Credit gone too far?*

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Abstract

Means testing plays an important role in state provided retirement benefits in the UK. Although it is well known that the behavioural incentives associated with means testing are theoretically ambiguous, little work has been conducted to infer the behavioural effects of contemporary means tested retirement benefits. This study uses a carefully calibrated structural model to explore labour supply, savings, and welfare effects for UK households of a revenue neutral shift from a state pension system based on a 40% withdrawal rate – reflecting the current policy environment – to a 70% withdrawal-rate – which is mid-way between the current policy environment, and the 100% rate that was applied prior to October 2003. The analysis suggests that the policy counterfactual would have little effect on savings or retirement from a macro perspective, but would have some important distributional implications. Furthermore, the welfare analysis suggests that it would be preferable, from a lifetime perspective, to increase the withdrawal rate on means tested retirement benefits above the 40% rate that is currently applied.

1 Introduction

In response to concerns regarding fiscal sustainability, countries throughout the developed world have enacted reforms to their respective public pension systems. One method of enhancing fiscal sustainability is to target state provided retirement benefits through the use of pension withdrawal-rates on private income. In the UK, means testing of public pensions has been a central focus of public debate during recent years, with the government reducing the withdrawal rate on pension benefits from 100 to 40 percent in 2003, and on-going calls by some that means testing should be done away with altogether.¹ In this paper I argue, on the basis of observations drawn from a dynamic programming model, that pension withdrawal rates were reduced too far in 2003, rather than not far enough. The analysis reported here suggests that expected lifetime welfare would be improved if the withdrawal rate on means tested pensions in the UK had been reduced by 30, rather than 60 percent.

Unlike most other countries, means testing has been a prominent feature of the UK pensions system since retirement benefits were first introduced in 1908. In the contemporary context, means tested retirement benefits were expanded following the election of the Labour government in 1997. At that

*Special thanks to James Sefton for close collaboration in the technical specification of the model used to undertake the analysis presented here, and to Martin Weale for providing the estimated profiles against which the model was calibrated. I remain solely responsible for any errors, and for the views that are expressed herein. Preliminary and incomplete. Please do not quote without prior permission.

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¹See Curry & Steventon (2006), and *Pensions: Plain and Simple*, published by the National Association of Pension Funds, October, 2002.

time, means tested retirement benefits were re-branded as the Minimum Income Guarantee (MIG), and their generosity was increased. Importantly, however, the MIG did not alter the withdrawal rates applied to means tested benefits, which remained at 100 percent. Between 1997 and 2003, means tested pensions continued to grow relative to other retirement benefits, until the fixed benefit (the excess of the Pension Guarantee to the Basic State Pension), was equal to 5.6% of average gross full-time employment income (£24.65 per week) for a single person, and 7.3% of average employment income (£32.00 per week) for a couple. In October 2003, a reform was enacted which reduced the withdrawal rate from 100 to 40 percent, but left the value of the maximum eligible retirement benefit unchanged. Analysis by Brewer & Emmerson (2003) suggests that a third of all families containing an individual over age 65 in the UK would have been eligible for means tested benefits prior to this reform, and that over half were eligible after it.

But is there any reason to expect that a 40 percent withdrawal rate should be preferred to a 100 percent withdrawal rate? And what if the withdrawal rate was reduced by half as much as it was in 2003? It is well recognised that the effects of changing benefits withdrawal rates on aggregate savings and labour supply behaviour, and the associated fiscal burden of the tax and benefits system, are ambiguous.² This is because changing withdrawal rates have different incentive effects depending upon where an agent is located in the distribution. In the case of low income households who are subject to means testing at the margin, a reduction in withdrawal rates tends to improve their incentives to save (and to work) via the associated substitution effect, and reduce their incentives to save via the accompanying income effect. Hence, behavioural responses of low income households to a reduction in the withdrawal rate applied to means tested benefits are ambiguous. In contrast, middle income households who save just enough to reduce their means tested benefits to zero when subject to a given withdrawal rate will experience reduced incentives to save due to both income and substitution effects following a reduction in the withdrawal rate. Identifying the implications for population savings and the timing of retirement of a reduction withdrawal rates applied to means tested retirement benefits must consequently be done via observations drawn from either natural experiments, or suitably specified simulations. The analysis reported here is based upon the second of these two alternatives.

The focus of this study has important policy implications, at a time when the public debate regarding pensions policy in the UK is nearing a critical juncture. In 2002 the Pensions Commission was appointed by the UK government to advise on appropriate pensions policy reform. A key mile-stone of the contemporary pensions debate was the publication of the Pensions Commission's final report in 2005.

²See, for example, Hubbard et al. (1995) and Meade (1993) who explain the related issues in the context of a simple two period model. Disney & Smith (2002) make a similar point with respect to earnings tested pensions. See also, Feldstein (1987) for an early empirical analysis of the incentive effects of means tested pensions, in which pension benefits are motivated with reference to myopic population subgroups.

One of the recommendations made by the Pensions Commission is the adoption of a means tested retirement benefit, with rates and thresholds frozen (in real terms) around values that are currently applicable under the Pension Credit. In view of the consensus that is beginning to build around the recommendations made by the Pensions Commission, this implies that a 40 percent withdrawal rate is likely to continue to apply to personal income in retirement under the UK pensions system, up to the point where means-tested retirement benefits are exhausted.

Given the theoretical uncertainty that is associated with behavioural responses to means testing withdrawal rates, and the apparent arbitrariness of the 40 percent withdrawal rate that is currently applied to UK pension benefits, it is of note that few studies have focused upon the incentive effects of means tested retirement benefits. This is, in part, because means testing does not feature as a principal component in every country's pensions system. In the case of the US, as in most other countries, greater use is made of *earnings tests*, as opposed to *means tests*. The distinction is important, and motivates the assumed framework of analysis. Whereas earnings tests tax returns to labour – and have been adopted to encourage exit from the labour market; means tests also tax returns to savings³ – and are designed to limit eligibility to those who lack the capacity to provide for their own needs. Consideration of the effects of means tested policy consequently requires a focus on forward-looking behavioural responses, and associated distributional implications. This is distinct from the literature that considers behavioural responses to pension earnings tests, which focuses upon aggregate labour supply responses of individuals who are eligible for immediate benefits receipt.⁴

The analysis reported here is based upon a carefully calibrated structural model of household behaviour, in which decisions regarding consumption/savings and labour/leisure are considered to be made to maximise expected lifetime utility. In making their decisions households are assumed to take into account the budget constraints to which they are subject, and the processes that describe the intertemporal evolution of their circumstances. Importantly, these decisions are made in context of uncertainty regarding both labour income and time of death. The advantage of this approach is that it makes explicit assumptions about individual expectations and preferences that are considered important in determining retirement behaviour, but are unobserved.

The analytical approach that is adopted here is now common with regard to the study of behaviour around retirement – see, for example, Gustman & Steinmeier (1986), Rust & Phelan (1997), and French (2005). In the case of French (2005), the parameters of the model were estimated by Method of Simulated

³Although the policy reform that is considered here is described as applying to private income, the associated pension schemes that apply in practice also included wealth tests.

⁴For recent examples from this literature, see, for example, Friedberg (2000), Gustman & Steinmeier (2004) and French (2005) for the US, and Disney & Smith (2002) for the UK. The US pensions system does include a means tested benefit, called Supplemental Security Income (SSI). In their analysis of this benefit, Neumark & Powers (1998) note that 1.55 million people, or just over 5 percent of the US population over age 64, were in receipt of SSI in 1984. In contrast, the benefits with which the current are concerned affect a substantial proportion of the UK population.

Moments (MSM), to match mean assets, average hours of work, mean participation and median assets described by survey data to the corresponding moments of the same variables in a simulated sample. Higher order moments were not considered “because of problems with measurement error” French (2005), p. 401. A different strategy is adopted here for selecting the model parameters, as the paper focuses upon the distributional consequences of means testing, rather than in population aggregates. Specifically, in-sample variation in the real wage, the timing of retirement and consumption changes around retirement are used to identify unobservable preference parameters via a grid-search procedure.

Elsewhere (Sefton et al. (2006)), an earlier version of the model that is considered here was used to compare three policy scenarios: one that reflected the UK pensions system prior to October 2003 and applied a 100 percent withdrawal rate to means tested pensions, another which reflects the current policy environment and is based upon a withdrawal rate of 40 percent, and a third policy counterfactual which did away with means testing all together. The head-line finding of that study was that expected lifetime utility is higher under the 40 percent withdrawal rate than either of the two alternatives that were considered. Here I explore whether, in reducing the withdrawal rate from 100 to 40 percent, the government may have gone too far, by considering the mid-point of 70 percent. In the current context, I find evidence that a higher withdrawal rate than is currently applied would be beneficial from the perspective of expected lifetime utility.

The intuition behind the behavioural responses and welfare effects with which the current study is concerned is explained in Section 2 using a simple two period model. The fully articulated model considered for analysis is described in Section 3, followed by a description of the model’s calibration in Section 4. Sections describing the articulated model largely restate details that are provided in Sefton et al. (2006), and the reader that is familiar with that study may omit these without excessive handicap. In doing so, however, it should be noted that the model used to undertake the current analysis has been augmented to allow for the accumulation of unsecured debt, and the decision to work part-time. Analytical results derived from the articulated model are presented and discussed in Section 5, and Section 6 concludes.

2 A Two Period Analysis of Means Tested Retirement Benefits

The first period of the two period model corresponds to the working life of a household, and the second period to retirement. Let w_1 denote the total (disposable) resources available to a household at the beginning of period 1 (full-time labour income plus any physical capital endowment). Wealth at the beginning of retirement, w_2 , is then first period savings plus the return to investment:

$$w_2 = (1 + r)(w_1 - e_1) \geq 0$$

where r denotes the real (after tax) rate of return to saving, and e_1 is total household expenditure in period one.

In retirement, all households are assumed to receive the universal basic pension, p . In addition there is a means tested pension benefit, p_c , which is withdrawn at the (constant) marginal rate t_m with regard to wealth, w_2 . Consumption in the second period is consequently equal to:

$$c_2 = p + w_2 + \max(p_c - t_m w_2, 0)$$

Assume that intertemporal preferences are time separable, and that intratemporal preferences are smooth and concave in both consumption and leisure in period one, and in consumption in period two. Furthermore, assume that intratemporal preferences between consumption and leisure in period one are homothetic and that both choice variables are selected from a continuous, closed and bounded set. Then the intertemporal utility maximisation problem can be solved by two-stage budgeting, where consumption and leisure in the first period are linear functions of total expenditure (for internal solutions).

Quite a lot can be learned about the behavioural and welfare effects of means tested retirement benefits using this simple analytical framework. To provide more detail, suppose that the two period utility function, specified in terms of total expenditure in periods 1 and 2, is defined by:

$$u = \frac{1}{1 - \frac{1}{\gamma}} \left(e_1^{1-1/\gamma} + \delta e_2^{1-1/\gamma} \right) \quad (1)$$

where δ is the individual specific discount rate and γ the intertemporal elasticity of total expenditure. Given this specification, Figure 1 reports the effects on incentives and welfare of an increase in the pensions withdrawal rate from 40 to 70 percent (with which the current study is concerned).

Panel A of Figure 1 distinguishes between four population subgroups, based upon the resources held in period one. This panel indicates that reducing the withdrawal rate on means tested retirement benefits has no affect on the welfare of agents at the extremes of the wealth distribution. At the bottom of the distribution, agents are unaffected by the considered policy change because the pension benefits are sufficiently generous (relative to their available resources during the working lifetime) to induce them to make no private provision for retirement, even when the withdrawal rate is low. In contrast, at the top of the distribution are agents who save enough to make them ineligible for means tested benefits under either of the withdrawal rates considered. In between these two extremes, the welfare cost increases with first period wealth to a maximum before falling back away. This profile arises due to the alternative behavioural responses of two population subgroups, with the distinguishing threshold between the two defined where the welfare cost of the pension reform is highest.

To understand the determinants of the welfare profile reported in Panel A, note that the income effect of a rise in the withdrawal rate on means tested pensions tends to increase first period savings,

and this is off-set by the associated price effect. Given the analytical specification described above, it can be shown that a marginal increase in the withdrawal rate on means tested pensions will increase savings at a sufficiently high w_1 relative to $(p + p_c)$, and decrease savings otherwise.⁵ This is because the income effect increases with the amount that an agent chooses to save when subject to the lower pensions withdrawal rate.

Suppose that means tested pensions are specified such that the price effect associated with an increase in the pension withdrawal rate dominates for any agent with an internal solution to the utility maximisation problem that implies receipt of means tested benefits. Then a utility maximising agent will only increase their savings in response to an increase in the pension withdrawal rate if they are made better off following the policy change by moving off of means tested benefits entirely. The agent that is indifferent between receiving and not receiving means tested benefits when subject to the higher withdrawal rate defines the transition between those who increase and those who decrease their savings in response to the policy change.

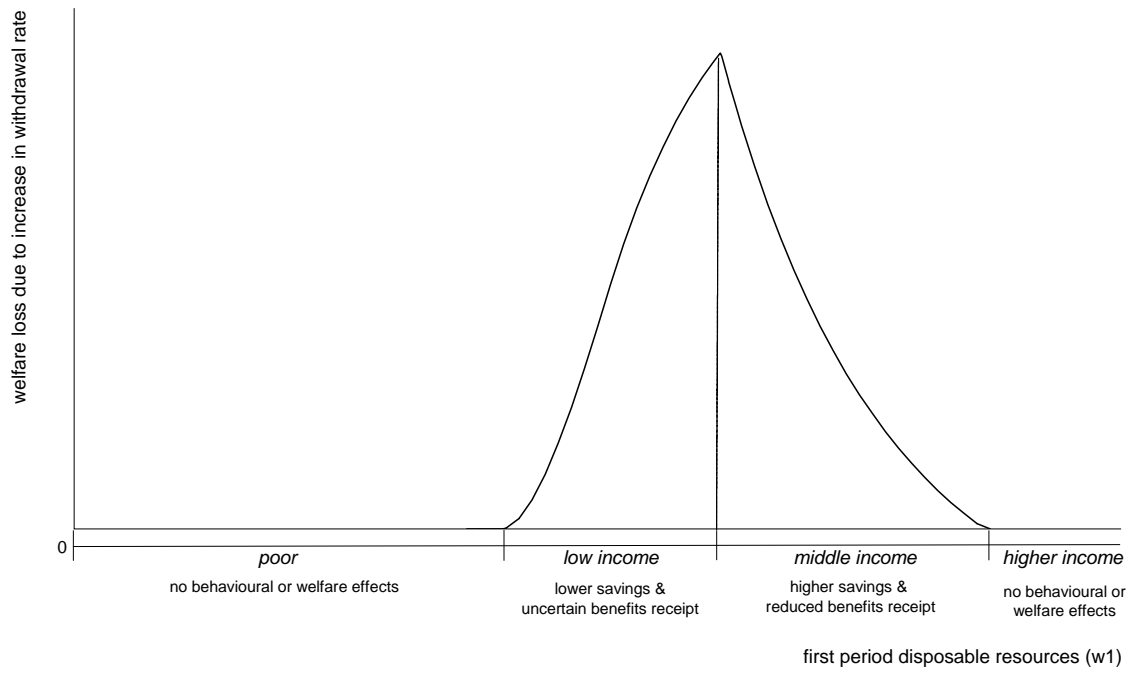
It can also be shown that – when the price effect dominates as described above – the welfare cost associated with a marginal increase in the pension withdrawal rate is increasing in first period wealth for any agent with an internal solution that implies receipt of means tested benefits.⁶ This is reflected in Panel A of Figure 1 by the upward sloping section of the graph denoted for *low income* agents. In contrast, the additional utility derived from the provision of the means tested retirement benefit falls as w_1 rises, because savings are increasing in w_1 . This explains the downward sloping section of the graph displayed in Panel A for *middle income* agents.

Panel B of Figure 1 reports budget lines and optimised indifference curves for low ($w_1 = w^-$) and middle ($w_1 = w^+$) income agents to clarify their respective behavioural responses. The line $ACDE$ in the figure is the low income agent’s budget line under a withdrawal rate of 40 percent, $t_m = 0.4$. The line $ABDE$ is the low income agent’s budget line under the higher withdrawal rate, $t_m = 0.7$. When $t_m = 0.4$, the low income agent maximises their welfare at C , in which case they will choose to save some of their initial resources despite the application of a means test. In contrast, when $t_m = 0.7$, Figure 1 indicates that the low income household will maximise their welfare at point A , where they will consume all of their initial resources in the first period, and the maximum pension benefit in the second.

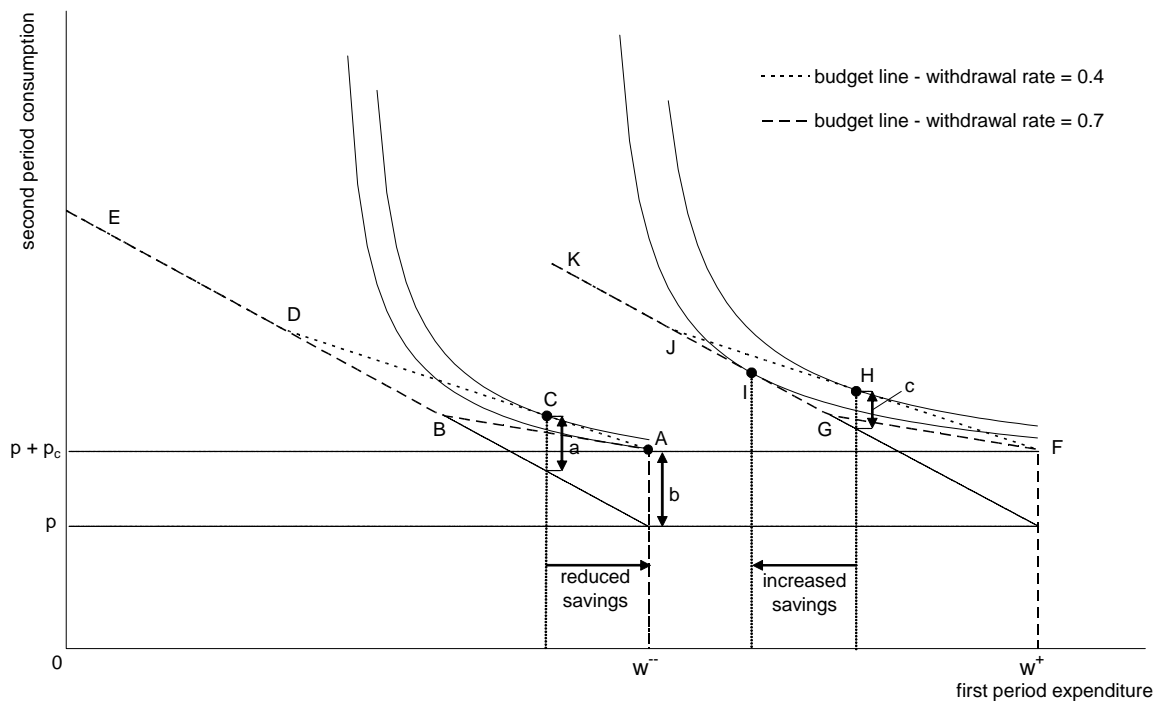
The assumptions made regarding preferences imply that the reduced savings of low income agents in the first period will translate into a proportionate increase in both consumption of goods and leisure during the working lifetime. Thus Figure 1 suggests that a low income agent will choose to save less

⁵ Although trivial to derive, the analytical specifications are messy, and are consequently reported in Appendix A.

⁶ See Appendix A for analytical details.



Panel A: Welfare effects by disposable resources during the working lifetime



Panel B: Responses of low and middle income agents

Notes: Author's calculations based upon similar specification of preferences as described in Section 3 for the fully articulated model
The Author may be contacted for full details

Figure 1: Behavioural and Welfare Effects to an Increase in the Withdrawal Rate on Means Tested Retirement Benefits from 40 to 70 percent

and retire earlier in response to the considered increase in the pensions withdrawal rate. Furthermore, Figure 1 indicates that the aggregate retirement benefit received by low income agents in retirement may be higher when the withdrawal rate is increased ($b > a$). This possibility arises, despite the reduced generosity of the retirement benefits system, due to the offsetting effect that low income agents' savings have on the means tested benefits payable.

With regard to the middle income agent, $FHJK$ is the budget line under $t_m = 0.4$, and $FGIJK$ is the budget line under $t_m = 0.7$. These are to the right of the budget lines of the low income agent due to the larger first period endowment received by the middle income agent ($w^+ > w^-$). Under $t_m = 0.4$, the middle income agent maximises their welfare at H . If the withdrawal rate is increased to $t_m = 0.7$, however, the middle income agent will achieve its maximum welfare at point I . In this case the middle income agent will choose to save and work more when the withdrawal rate on means tested retirement benefits increases. Furthermore, the benefits receipt of middle income agents under the higher withdrawal rate is unambiguously reduced, as they choose to move off means tested benefits altogether ($c > 0$).

While this two period model provides important intuition behind the behavioural responses that can be expected for a rise in the withdrawal rate applied to means tested retirement benefits, it does not permit conclusions to be drawn regarding aggregate effects for a population, as this will depend crucially upon how the population is distributed along the first period wealth distribution. Furthermore, it does not take into account the influence on behaviour of uncertainty that is associated with individual resources (and particularly labour incomes) during the working lifetime. These issues are taken up by the articulated model described below.

3 The Model

The model considers lifetime consumption and labour supply decisions of households in annual increments, from age 20 to the maximum potential age of 110. The section begins by defining the assumed preference relation, before describing the wealth constraint, and the section concludes with an explanation of the approach adopted to solve the lifetime utility maximisation problem.

3.1 The utility function

Expected lifetime utility of household i at age t is described by the time separable function:

$$U_{i,t} = \frac{1}{(1 - 1/\gamma)} E_t \sum_{j=t}^{110} u \left(\frac{c_{i,j}}{\theta_{i,j}}, l_{i,j} \right)^{1-1/\gamma} \delta^{j-t} \phi_{j-t,t} \quad (2)$$

where $\gamma > 0$ is the intertemporal elasticity of substitution (of total expenditure), E_t is the expectations operator, $c_{i,t} \in R^+$ is composite nondurable consumption, $l_{i,t} \in \{l_{FT}, l_{PT}, 1\}$ is the proportion of

household time spent in leisure, and $\theta_{i,t} \in R^+$ is adult equivalent size based upon the McClements' scale. The labour supply decision is between three discrete alternatives, in response to the view that this provides a closer reflection of reality than one in which labour supply is a continuous choice variable for given wage rates. From age 65 (the State Pensionable Age, SPA, of men in the UK), the household is forced to retire if it has not already done so, in which case $l_{i,t} = 1$ for all $t \geq t_{SPA} = 65$. The McClements' scale depends upon the numbers of adults, $n_{i,t}^a$, and children, $n_{i,t}^c$ in a household, and its inclusion in the preference relation reflects the fact that household size has been found to have an important influence on the timing of consumption. To simplify the analysis, household size is assumed to evolve according to a deterministic age profile. $\phi_{j-t,t}$ is the probability of living to age j , given survival to age t , and δ is the discount factor, which is assumed to be the same for all households and time independent.

A Constant Elasticity of Substitution function was selected for within period utility,

$$u\left(\frac{c_{i,j}}{\theta_{i,j}}, l_{i,t}\right) = \left(\left(\frac{c_{i,j}}{\theta_{i,j}}\right)^{(1-1/\varepsilon)} + \alpha^{1/\varepsilon} l_{i,t}^{(1-1/\varepsilon)} \right)^{\frac{1}{1-1/\varepsilon}} \quad (3)$$

where $\varepsilon > 0$ is the (period specific) elasticity of substitution between equivalised consumption $c_{i,t}/\theta_{i,t}$ and $l_{i,t}$. The constant $\alpha > 0$ is referred to as the utility price of leisure. This specification of preferences is standard in the associated literature.

The partial differential of equation (2) with respect to consumption, $c_{i,t}$, and leisure, $l_{i,t}$, is given by:

$$U_{cl,t} = \left(\frac{1}{\varepsilon} - \frac{1}{\gamma} \right) \frac{u_{c,t} u_{l,t}}{u_t^{1+1/\gamma}} \delta^{j-t} \phi_{j-t,t} \quad (4)$$

where the standard notation is used to denote partial derivatives. As within period utility and the marginal utilities of consumption and leisure are all positive, consumption and leisure are direct substitutes ($U_{cl} < 0$) when $\varepsilon > \gamma$, direct complements ($U_{cl} > 0$) when $\varepsilon < \gamma$, and additively separable when $\varepsilon = \gamma$.

3.2 The wealth constraint

Equation (2) is considered to be maximised, subject to an age specific credit constraint imposed on net worth, $w_{i,t} \geq D_t$. Total net worth is defined by:

$$w_{i,t} = \begin{cases} w_{i,t-1} + \tau(l_{i,t-1}, r_{i,t-1} w_{i,t-1} + x_{i,t-1}, n_{i,t-1}^a, n_{i,t-1}^c, t-1) - c_{i,t-1} & \text{if } t \leq t_{SPA} \\ (1-\eta) [w_{i,t-1} + \tau(l_{i,t-1}, r_{i,t-1} w_{i,t-1} + x_{i,t-1}, n_{i,t-1}^a, n_{i,t-1}^c, t-1) - c_{i,t-1}] & \text{if } t = t_{SPA} \end{cases} \quad (5)$$

where $r_{i,t-1}$ is the real interest rate, $\tau(\cdot)$ is the tax and benefit function, and $x_{i,t}$ is private non-property income. The interest rate is assumed to differ, depending upon whether $w_{i,t}$ indicates a net debt; $r_{i,t} = r^D$ if $w_{i,t} < 0$ or r^I if $w_{i,t} \geq 0$.

During the working lifetime, $t < t_{SPA}$, $x_{i,t}$ defines household labour income, equal to $\varphi(l_{i,t}) h_{i,t}$, where $\varphi(l_{i,t})$ is the proportion of the full-time employment wage earned. This household wage is

considered to evolve following a stochastic process. At age $t = t_{SPA}$, a proportion, η , of household wealth is annuitised at an actuarially fair rate χ . During retirement, $x_{i,t}$ is equal to the annuity income generated by private pensions⁷. Private non-property income during the simulated lifetime is consequently described by:

$$x_{i,t} = \begin{cases} \varphi(l_{i,t}) h_{i,t} & \text{if } t < t_{SPA} \\ \eta\chi [w_{i,t-1} + \tau(l_{i,t-1}, r_{i,t}w_{i,t-1} + x_{i,t-1}, n_{i,t-1}^a, n_{i,t-1}^c, t-1) - c_{i,t-1}] & \text{if } t = t_{SPA} \\ x_{i,t-1} \frac{(0.5+0.5(n_{i,t-1}^a))}{(0.5+0.5(n_{i,t-1}^a-1))} & \text{if } t > t_{SPA} \end{cases}$$

3.3 The tax function

The function τ is a stylised representation of the UK tax and benefit system, described as a function of the household's pre-tax income, that is its property income $r_i w_{i,t}$ plus non-property income $x_{i,t}$, its size $n_{i,t}^a$ and $n_{i,t}^c$, and its age, t . The age dependency assumed for the tax function divides the lifetime into three periods: the working lifetime $t < t_{IB} = 55$, early retirement $t_{IB} \leq t < t_{SPA} = 65$, and retirement $t_{SPA} \leq t$. During the working lifetime, the tax function is specified to reflect profiles reported in the April 2003 edition of the *Tax Benefit Model Tables* (TBMT) issued by the Department for Work and Pensions.⁸ The profiles considered take into consideration the impact of income taxes, National Insurance Contributions, the Child Benefit, the Working Tax Credit and the Child Tax Credit. Although this list omits a great deal of the detail of the UK tax and benefits system, it does include the principal schemes that affected healthy families with children during 2003.⁹

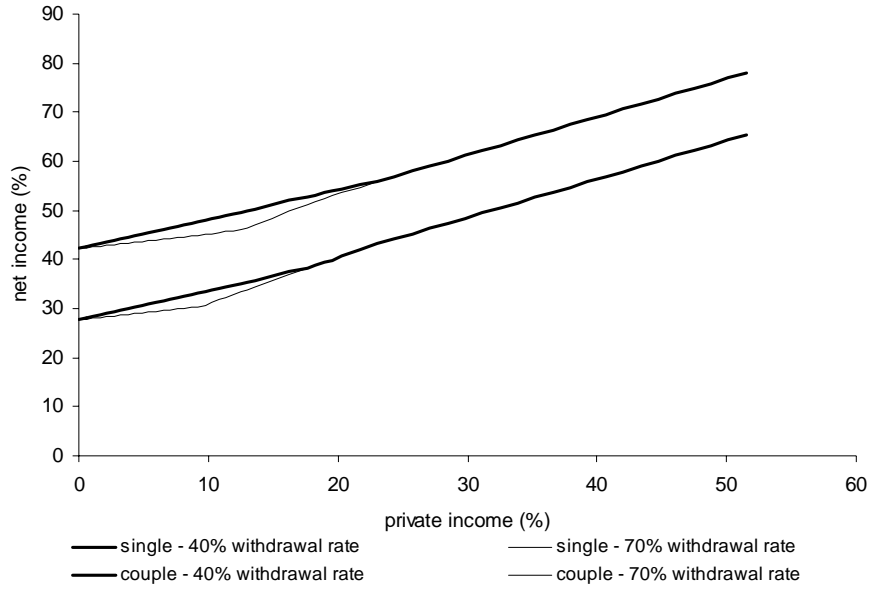
The simulated tax function for ages $t_{IB} \leq t < t_{spa}$ depends upon private income, employment status, age, and demographic composition. Simulated households that choose to supply labour for any t , $t_{IB} \leq t < t_{spa}$, are treated in the same way as during the working lifetime (described above). The tax treatment applied to a simulated household that chooses not to supply labour and is aged $t_{IB} \leq t < t_{MIG} = 60$, is specified to reflect the Incapacity Benefit and income taxes as they stood in 2003/4; between ages $t_{MIG} \leq t < t_{spa}$ the tax function is specified to reflect the Pension Guarantee (identical for the alternative policy counterfactuals considered here) and income taxes.

The specification of the tax function during retirement, $\tau(\cdot)$, $t \geq t_{spa}$, is of particular interest for the current study. The analysis is based upon two pension benefits, one that is means-tested and another

⁷The annuity purchased at age t_{spa} is assumed to reduce to 65% when the number of adults in a simulated household decreases to 1 in response to the mortality of a spouse. This adjustment to retirement income was necessary to capture the decline in expenditure with age observed in survey data.

⁸See <http://www.dwp.gov.uk/asd/tbmt.asp>.

⁹The focus on a single labour supply term for households raises complications for the tax function that is considered for couples. The UK tax system is based upon individual incomes – a couple cannot split their income to minimise their aggregate tax burden. The simulation of household income, as opposed to individual specific income, implies that some allowance could be made to take into account the tax effect of dual income households. Data from the 2002/03 FRS indicate that, on average, 80 percent of labour income earned by couples is attributable to the principal bread winner between ages 20 and 64 (the proportion is slightly lower at 76 percent between 20 and 30, and slightly higher after age 60 at 85 percent). Given this observation, it is assumed that all income is earned by the principal bread winner, and acknowledge that this will slightly overstate the true tax burden faced by dual income households.



Source: Stylised characterisation of the simulated pension policy counterfactuals

The authors may be contacted for further details

Notes: All monetary figures expressed as percentages of median full-time employment income, equal to £369 per week in 2003

Figure 2: Simulated Tax Functions – Retired Households

that is not. All simulated households receive the non means-tested benefit, equal to £77.45 per week for a single pensioner and £123.80 per week for a pensioner couple. These rates are based upon the Basic State Pension as it was applied in the UK during 2003/04. On top of this, all households are considered to be eligible for a means-tested benefit worth £24.65 per week for a single pensioner and £32.00 per week for a couple. These amounts are based upon the difference between the Basic State Pension and the Pension Guarantee that were applied in the UK during 2003. For comparison, the median earnings of all full-time employees in the UK in the winter of 2003/04 was £369 per week.¹⁰ The analysis reported in Section 5 is based upon populations generated under alternative assumptions regarding the withdrawal rate applied to the means-tested pension benefit. The associated tax functions are displayed in Figure 2.

3.4 Income dynamics

In the first period of the simulated lifetime, age 20, each household is allocated a wage, $h_{i,20}$, via a random draw from a log-normal distribution, $\log(h_{i,20}) \sim N(\mu_{20}, \sigma_{20}^2)$. Thereafter, wages are generated using the stochastic process described by the equation:

$$\log h_{i,t} = \beta \log h_{i,t-1} + \kappa \frac{(1 - l_{i,t-1})}{(1 - l_W)} + f(t-1) + \omega_{i,t} \quad (6)$$

¹⁰Reported in Table 34 of the *Labour Force Survey (LFS) Historical Quarterly Supplement*, published by the Office for National Statistics.

where $f(t)$ is an age-dependent wage growth term, β accounts for time persistence in earnings, $\omega_{i,t} \sim N(0, \sigma_\omega^2)$ is a household specific disturbance term, and κ is the return to another year of experience. This model is closely related to alternatives that have been developed in the literature (see Sefton & van de Ven (2004) for discussion), and has the practical advantage that it depends only upon variables from the immediately preceding period $(t-1, h_{i,t-1}, l_{i,t-1})$, which simplifies the endogenous simulation of household savings and labour supply. Furthermore, although the concept of an experience term in a wage regression is not new¹¹, its inclusion is an innovation for the related literature (e.g. Low (2005) and French (2005)). Most related studies omit an experience term because it complicates the utility maximisation problem by invalidating two-stage budgeting. We have, however, found that its inclusion enables us to better capture labour supply at younger ages (see Sefton et al. (2006) for further details).

3.5 Model solution procedure

The assumption of stochastic income implies that an analytical solution to the utility maximisation problem does not exist. The procedure that is adopted consequently uses backward induction to solve the required inter-temporal Bellman equation. Starting in the last possible period of the household's life, T ($= 110$ in the simulations), it is straight-forward to solve for the optimising consumption decisions, given wealth w_T and annuity h_T (where h_t is redefined to denote annuity income for all $t \geq t_{SPA}$, and the household wage otherwise).¹² Given this level of consumption we can denote the maximum achievable utility, the value function, by $V_T(w_T, h_T)$. This function is calculated at all nodes of a two dimensional grid in wealth and retirement annuity.

At time $T-1$ the problem reduces to solving the Bellman equation:

$$V_{T-1}(w_{T-1}, h_{T-1}) = \max_{c_{T-1}, l_{T-1}} (u(c_{T-1}/\theta_{T-1}, l_{T-1}) + \delta\phi_{1,T-1}E_{T-1}(V_T(w_T, h_T))) \quad (7)$$

This optimisation problem is solved for each node of the $T-1$ value function grid, a process that is repeated to obtain successive solutions by backward induction. Post mandatory retirement (periods $65 \leq t \leq T$), this implies searching over feasible consumption choices only. Prior to mandatory retirement (periods $20 \leq t < 65$), it is necessary to search over the feasible consumption choices for each of the three discrete choices of labour supply considered for analysis, and then select the particular consumption/leisure pair that achieves the maximum utility. Furthermore, during the working lifetime, future wages are uncertain, and subject to a log-normal distribution. In this case, expectations of next

¹¹With regard to statistical evidence of the effect of experience on income, Mincer & Ofek (1982) report that in the short run, every year out of the labour market can result in a 3.3%-7% fall in wages relative to those who remain employed. This study also finds, however, that the restoration of human capital tends to be faster than the original accumulation, so that the impact of early labour breaks reduce to 1.3%-1.8% in the long run. Eckstein & Wolpin (1989) do not make a distinction between the long run and short run impact of actual experience, but find that the first year out of the labour market reduces wages by around 2.5%, with subsequent years having a marginally diminishing effect. See also, Waldfogel (1998) and Myck & Paull (2004) for the role of experience in explaining the gender wage gap.

¹²The version of the model considered here does not include an explicit bequest motive (though accidental bequests are generated). Hence, in period T , households choose to consume all remaining resources.

period's value function are evaluated using a gaussian quadrature procedure with 5 abscissae points. A linear interpolation procedure is used to evaluate the value function at points between nodes throughout the simulated lifetime.¹³

For the analysis reported in Section 5, the real non-negative domain of both private income and wealth were divided using log scales, each comprised of 161 points from ages 20 to 64, and 251 points during each of the periods from age 65. Hence, the entire model involves calculating solutions to expected lifetime utility maximisation problems at 6,397,381 points for the simulated lifetime.¹⁴

Having solved for the household utility maximising behavioural responses as described above, the life-courses of individual households are simulated by running households forward through the grids. For example, given a household's initial wealth and wage (w_{20}, h_{20}) we read off from the age 20 grid the household's optimal choice of consumption and leisure (c_{20}, l_{20}) . Then given a random draw from the distribution $\omega_{i,t} \sim N(0, \sigma_\omega^2)$ we use equations (5) and (6) to calculate the household's wealth and wage in the next period (w_{21}, h_{21}) , a process that is repeated for $t = 21, 22, \dots, T$. A cohort is built up by repeating this procedure for a sample of households. Our analysis is based on the data generated for this synthetic population. We now discuss some technical issues that arise in the optimisation procedure.

The value function in this problem is neither smooth, nor concave (though it is increasing and continuous). This is because the labour supply decision is discrete and the budget set is non-convex (due to means testing of welfare benefits). Our solution procedure is explicitly designed to identify local optima that arise as the result of the boundary conditions that are imposed on the problem, internal solutions that involve equating marginal intertemporal utilities, and internal solutions that arise due to non-smoothness of the value function. Furthermore, non-concavities of the value function imply that the optimisation problem (7) can have local maxima, a problem that can be addressed in a number of alternative ways. French (2005), for example, adopts a brute-force method by searching across the grid that defines all possible choice combinations of the assumed control variables. This is very time consuming, which complicates calibration and associated analysis. We therefore chose to solve the Euler equations (for consumption), and guard against the selection of a local optimum. This was relatively straightforward for our decision problem, as we were searching over only one continuous variable (consumption). The procedure that we adopt is described as follows.

For a given discrete labour supply choice, we searched for a solution to the Euler equation over all feasible (bounded) consumption choices using the Bus & Dekker (1975) bisection algorithm. Having found one solution, we searched above and below for an alternative solution.¹⁵ If we found one, we

¹³With regard to computation time, there is a trade-off between the grid resolution and the order of the interpolation procedure. As the value function is not globally smooth or concave, greater accuracy was achieved by adopting a fine grid, and a linear interpolation routine.

¹⁴ $251 \times 251 \times 46 + 161 \times 161 \times 3 \times 45$

¹⁵This involved projecting a limited grid about an identified solution, and evaluating the first order condition for the

searched recursively for any further solutions above and below. This was repeated until all solutions were found. From these solutions we selected only those that were feasible.¹⁶ Of all feasible solutions, the one that maximised the value function was selected. This procedure was repeated for all possible discrete labour choices, and the maximum over the labour choices was selected. It is worth noting that only at a very small proportion of the nodes was more than one solution ever found (because the non-concavities of the value function associated with our problem were slight).

4 Model Calibration

The parameters of the model described above were adjusted to match the characteristics by age of a simulated population to those described by household micro-data. Calibration was undertaken using the following grid-search procedure. First, we normalised by the price of consumption so that wages and interest rates were specified in real terms. The real interest rate was fixed at 4% per annum for non-negative wealth balances and 12.4% per annum for net debt, and wealth at age 20 was set to 0.¹⁷ A full-time employed household is considered to allocate 30% of the time available to its adult members to work, $l_W = 0.7$. A part-time employed household, in contrast is considered to allocate 12.4% of its time to work, and to receive 28.0% of the full time wage. These differences between part-time and full-time employment are specified to reflect averages reported in survey data by the Office for National Statistics.¹⁸ With regard to the simulations, the punitive nature of part-time relative to full-time employment implies that part-time employment does not feature very prominently in the analysis.

The credit limit, D_t , that is considered for analysis is specified to provide maximum flexibility, while at the same time ensuring that households have no debt from age 65, and omitting the possibility of numerical errors in the solution procedure. A numerical error will result if a household is required to consume less than or equal to zero in any period to satisfy the imposed budget constraint. This, combined with the assumption that all households must have paid off their debts by retirement (age 65), resulted in the adoption of an age specific credit limit that is defined in terms of the minimum disposable income stream that is permissible under the analysis.

In defining the assumed credit limit, we took the lowest potential disposable annual income at any age (as described by the considered tax and benefits system), deducted a £5 disregard, and calculated the

Euler maximisation problem at each point on the revised grid. If the first order condition was found to have the opposite sign to its value at the associated limit (lower bound, for grid points below the identified solution, and upper bound otherwise) at any point on the revised grid, then the bisection algorithm was reapplied to solve the associated Euler conditions for the local maximum.

¹⁶This was a check that marginal change in the value function with respect to wealth was locally increasing. Non-smoothness in the value function implies jumps in marginal rates. The interpolation routines will tend to smooth these jumps, possibly introducing an infeasible solution to the Euler equation.

¹⁷The interest rate assumed for debt is based upon the end of month weighted average interest rates on personal loans of banks and building Societies reported by the Bank of England (variable IUMPLTL), averaged between January 2000 and August 2005, and discounted by 2% for inflation.

¹⁸Data derived from the *Labour Force Survey (LFS) Historical Quarterly Supplement*, Table 38.

cumulative discounted value to age 65 implied by the assumed interest charge on debt. The resultant age specific credit limits are reported in Table 1, and the statistics reported there indicate that the assumed credit limit is just over £20,000 for much of the working life, rising slightly from age 20 to 55, before falling away rapidly to retirement. With reference to recent surveys of household indebtedness in the UK, no more than 2% of households interviewed on behalf of the Bank of England or the Citizens' Advice Bureaux, and 7% of households interviewed for KPMG, held unsecured debts totalling £20,000 or more.¹⁹

Having defined the model parameters described above, we then selected a starting value for each of the remaining parameters, against which a solution to the lifetime optimisation problem was obtained following the methods described in Section 3.5. Monte-Carlo methods were used to generate the life-history for a cohort of households, based upon the behavioural responses described by the model solution, and the stochastic processes assumed for the intertemporal development of agent specific state variables. Calibration proceeded by comparing the characteristics by age of the simulated cohort with age profiles that were estimated from survey data.

4.1 The data²⁰

In order to calibrate our model we required age profiles of:

1. The proportion of households employed
2. The mean of household non-property disposable income
3. The variance of household non-property disposable income
4. The mean of household consumption
5. The variance of household consumption
6. Household size as measured by the McClements' scale.

These profiles were estimated using the method described by Deaton (1997) from Family Expenditure Survey (FES) Data covering the period 1971Q1-2001Q1. There appeared to be a discontinuity in the consumption data after 2001Q1 when the FES was replaced by the Expenditure and Food Survey (EFS). Since the purpose of Deaton's method is to estimate a supposedly stable underlying age profile from which cohort and time effects have been removed, and since the discontinuity in the data appeared to disturb the cohort effects, we thought it best to exclude the more recent data provided by the EFS.

¹⁹See the Bank of England (Tudela & Young (2003)), a study commissioned by the CAB (2003), a study by KPMG (2003), and a study by Kempson (2002).

²⁰I should especially like to thank Martin Weale for estimating the data series against which the model was calibrated.

We studied the geometric rather than the arithmetic mean of consumption for the reasons given by Attanasio & Weber (1993) and Deaton (1997) – i.e. that the life-cycle model of consumption explains the profile of the geometric mean. Given this, and the fact that we relate income to consumption, it seemed sensible to look also at the geometric mean of income, and to measure the dispersion of the data by the variances of log income and consumption. We also estimated a profile for the geometric mean of household size based on McClements’ scale. Since the single composite wealth variable adopted for the simulation model includes savings that are not reflected by the survey data (such as wealth held in occupational pensions), we have omitted property income from the calibrations.

We filtered the data before estimating the age, cohort and time effects. When looking at income and consumption we included only those households for which

$$z = \log(\text{Consumption}) - \log(\text{Income}); z \in (-0.8, +0.8)$$

We also excluded those households with heads aged 65 or more with labour income of more than £5 per week in 2003/4 prices and those households with three or more adults. When looking at labour market participation profiles we treated as non-participating those households with labour income below 20% of median household labour income during the quarter in question.

In estimating the age/time/cohort profiles we have, with one major modification, followed Deaton’s approach. We calculated means of the relevant variables by age for the data in each quarter of the FES and used OLS regression with age, time and cohort dummies to explain the data, the age dummies providing the required profiles. As Deaton discusses, restrictions are required on the explanatory variables to enable estimation. He suggests restricting the linear trend through the time effects to zero. Instead, given the substantial evidence that macro-economic time series of log income and log consumption are I(1) processes (see Nelson & Plosser (1982)), we have chosen to restrict the parameters so that the mean of the last four time effects is equated to the mean of the first four time effects, with the implication that the time effects embody an I(1) process with zero stochastic trend, but with deterministic seasonal terms present.²¹ We fitted profiles for the variances as well as the means of consumption and non-property disposable income. We calibrated the model to the figures obtained after multiplying the estimated age profiles of equivalised consumption and disposable income by the age profile estimated for the equivalence scale.

There are a number of complications with the procedure which affect its value as a method for presenting an overall picture of the effects of age on household circumstances. One of the most important of these is associated with the calibration of household income. When calibrating the model against cross-

²¹More precisely, in equation (2.89) on p.124 of Deaton (1997), we impose the restrictions that $\sum_{t=1}^4 \psi_{z,t} = \sum_{t=T-3}^T \psi_{z,t} = 0$ where z indicates the variable of concern (consumption, income, etc) and t indexes calendar quarters; this implies that the time dummies are estimated subject to the restriction that the stochastic growth trend is zero.

sectional data, it is natural to consider data for the year in which the tax policy under consideration was applied, which enables simulations to be matched against distributions of both private and disposable income, and provides a useful validation of the procedures used to model tax and benefits policy. This is not possible when profiles are estimated using Deaton’s method, as the estimated distributions of private and disposable income are not related by any tax and benefits system that applied at a point in time, but rather they depend on an average of the transfer systems that were applied during the period of estimation. Consequently, it was not possible to calibrate *both* gross labour income and disposable income in the current context. As savings and labour supply decisions depend crucially upon income net of tax and benefit payments, the wage generating process was calibrated to match the model against estimated age profiles for disposable household income, subject to the assumed tax system.²²

4.2 Calibration of preference parameters

There are four preference parameters to calibrate, γ , ε , δ , and α . The parameter pair (γ, δ) tend to determine household preferences over feasible intertemporal expenditure paths, and the parameter pair (ε, α) affect preferences over feasible intratemporal consumption/leisure choices.²³ For given values of the elasticity parameters γ and ε , we chose the discount rate, δ , to achieve the ‘closest’ match between the simulated and estimated age profiles for mean household consumption; and we chose the parameter α to match average retirement rates. Effectively this process defines the parameters (δ, α) as a function of (γ, ε) . Additional criteria were therefore required to select the parameters (γ, ε) .

It can be shown (see Sefton et al. (2006)) that increasing ε , decreases the demand for leisure relative to consumption for high income households (equivalent to later retirement in the fully articulated model), but has the opposite influence on low income households. Hence, ε was adjusted to match the cross-sectional timing of retirement. Furthermore, as noted by Heckman (1974), consumption will tend to track labour income under the life-cycle hypothesis if leisure and consumption are direct substitutes in utility. Discussion in Section 3.1 reveals that the value of γ has an important influence on the substitutability between consumption and leisure. A smaller value of γ , *ceteris paribus*, implies greater substitutability between leisure and consumption, and hence more pronounced income tracking. We therefore adjusted γ to fit the distribution of consumption about the mandatory retirement age, when labour changes most substantially. See Sefton et al. (2006) for detailed statistics indicating the sensitivity of the simulations to alternative assumptions regarding γ and ε .

²²A further complication arises if one is concerned about the profile for wealth as well as that for income. The most comprehensive source of microdata for household wealth in the UK is the British Household Panel Survey, which provides relevant data for 1995 and 2000. As this survey provides data for only two years, it cannot be used to obtain age profiles using Deaton’s method. Hence, the model was not calibrated to match wealth data in the current context.

²³This division does not strictly hold because the experience effect on wages invalidates two-stage budgeting. Nevertheless, it does provide a reasonable approximation, particularly toward the age of retirement, when the experience effect on wages has a dampened influence on individual behaviour.

4.3 Calibration of the income process

Three aspects of the wage generating process were subject to detailed calibration: the initial distribution of wages (μ_{20}, σ_{20}^2) were selected to reflect statistics of the distribution for disposable non-property income at age 20; the experience effect (κ) and the intertemporal persistence term (β) were increased to motivate higher labour supply by the young; and age specific dummy variables (one for each year) and the variance of the household specific disturbance term (σ_{ω}^2) were adjusted to match the age profile of the distribution of disposable non-property income to the profiles estimated from survey data.

Finally, the model was calibrated for an assumed proportion of annuitised wealth at retirement, η . This parameter is important in the current context because the proportion of wealth that is not annuitised is considered to be exempt from means testing. Of the various holdings that are included in the composite asset, $w_{i,t_{spa}}$, two principal classes are omitted from the eligibility (income and wealth) tests that were actually applied by UK means-tested pensions policy: owner occupied housing, and the first £6,000 of additional wealth. In the first instance we assume that these exempt assets account for 50% of $w_{i,t_{spa}}$, $\eta = 0.5$.²⁴

4.4 The fit between simulated and estimated age profiles

Following an extensive search, the parameter values that were found to obtain the closest approximations to age profiles estimated from survey data are reported in Table 1. The table is divided into two panels. The top panel reports preference parameters and other exogenously assumed population characteristics, and the bottom panel provides age specific dummy variables.

The calibrated parameter combination implies that consumption and leisure are direct substitutes, and is associated with an average intertemporal elasticity of substitution for consumption of 0.353, which lies within the range of values considered by the literature.²⁵ The parameters assumed for the wage generating process imply strong intertemporal persistence, and a 5% annual wage premium in return for employment. These statistics reflect the difficulties that are commonly experienced in capturing labour participation rates at young ages. The age profiles for household size that were estimated from FRS survey data were exogenously assumed for the model, and are reported in the bottom panel of Table 1. These data reflect the standard hump-shaped age profile for household need that has been found to have an important influence on the profile for consumption. The survival probabilities assumed for the analysis are based upon the probability that at least one member of a couple survives from age 20, and were calculated from statistics reported in the life tables published by the Government Actuary's

²⁴The assumption of less than full annuitisation and uncertainty with respect to the timing of death, give rise to the possibility of accidental bequests in the simulations. These bequests are considered to be returned to the government in the form of 100% inheritance taxes.

²⁵Calculated at population averages for consumption (£386 per week), leisure (0.909), and the equivalence scale (1.837 * 300) between ages 25 and 60, weighting each age equally.

Department for the UK, averaged over the period 1980 (the earliest year for which GAD projections were available) to 2002.²⁶

The relation between simulated data obtained using the calibrated parameter values, and the age profiles estimated from survey data are displayed in Figures 3 to 5. All monetary figures are expressed as percentages of median full-time employment income, equal to £369 per week in 2003.

Figures 3 to 5 indicate that the simulation model based upon the preferred parameter calibration does a good job of capturing the age profiles estimated from survey data. The top panel of Figure 3 reveals that, although the simulation model under-predicts the proportion employed between ages 23 and 42, the age profile of employment tracks the survey data fairly closely, particularly for the period of early retirement (from age 55). Furthermore, the bottom panel of Figure 3 suggests that the simulation model does a reasonable job of capturing the pattern of distribution in retirement, with earlier departure from the labour force observed at the distributional extremes, and later departure for the 3rd and 4th quintiles.

Figure 4 reveals a close relationship between the geometric mean of simulated disposable income and the associated age profile estimated from survey data. However, one of the most conspicuous disparities between the the analytical model and the age profiles estimated from survey data is the degree to which the analytical model understates the inequality of disposable incomes between ages 20 and 40. This disparity is attributable to the assumptions made regarding the tax function, the age profile for household size, and the age profile for geometric mean disposable income. At age 20, for example, the simulations are based upon an average household size of 1.65 adults and 0.95 children, and the distribution of wages has been calibrated to match the geometric mean of disposable income to £174 per week (40% of average full-time employment income). In this context, it is of note that the assumed tax function provides a minimum disposable income of £145 per week to a household based upon the assumed demographics. The small difference between this minimum and the associated geometric mean gives rise to the small measure of inequality obtained for simulated disposable incomes.²⁷ This is a clear example of the complications that can arise when attempting to calibrate the simulation model to age profiles of statistics that have been independently estimated to control for time and cohort effects.

In terms of consumption, Figure 5 reveals that the simulation model based upon the preferred parameter combination obtains a close reflection of the estimated age profiles for both the geometric mean and variance. The figure also reveals that the preferred parameter combination obtains a close

²⁶On 31 January 2006, responsibility for the production of national life tables transferred to the Office for National Statistics (ONS). Current and historic life tables are still available on the GAD website at: http://www.gad.gov.uk/Life_Tables/Life_tables_background.htm.

²⁷The small difference between the minimum income provided by the tax and benefits system and the geometric mean also implies that there is little benefit to working at early ages. The high rates of employment simulated at young ages highlight the influence of the experience effect on labour supply in the current context.

Table 1: Calibrated Model Parameters

General Model Parameters									
intertemporal elasticity (gamma)	0.20				mean log wage at age 20	4.60			
intra-temporal elasticity (epsilon)	0.58				sd log wage at age 20	0.40			
utility price of leisure (alpha)	1.65				wage experience effect (kappa)	0.05			
discount rate (delta)	0.97				wage persistence (beta)	0.99			
interest rate on investments (%)	4.00				sd of log wages from age 21	0.18			
interest rate on debt (%)	12.40				full-time employment leisure	0.70			
wealth at age 20	0.00				part-time employment leisure	0.88			
prop of wealth annuitised at age 65 (eta)	0.50				part-time/full-time wage ratio	0.28			
Age Specific Model Parameters									
age	f(t)	eqv scale	na	nc	credit limit	age	eqv scale	na	survival rate
20	164.228	1.617	1.647	0.950	-	65	1.201	1.454	0.993
21	205.447	1.670	1.713	0.992	20864.27	66	1.193	1.446	0.992
22	254.346	1.724	1.775	1.051	20867.72	67	1.199	1.456	0.990
23	296.595	1.724	1.774	1.016	20871.59	68	1.183	1.428	0.989
24	330.732	1.753	1.813	1.037	20875.94	69	1.173	1.412	0.986
25	353.322	1.775	1.805	1.122	20880.83	70	1.175	1.413	0.984
26	364.472	1.811	1.818	1.210	20886.32	71	1.171	1.408	0.981
27	367.389	1.841	1.822	1.291	20892.50	72	1.150	1.373	0.977
28	366.227	1.877	1.820	1.389	20899.44	73	1.144	1.364	0.972
29	362.738	1.921	1.824	1.500	20907.24	74	1.133	1.343	0.967
30	356.840	1.958	1.822	1.592	20916.00	75	1.134	1.345	0.961
31	349.934	2.011	1.829	1.713	20925.85	76	1.120	1.319	0.954
32	343.018	2.032	1.809	1.780	20936.91	77	1.109	1.296	0.945
33	335.844	2.081	1.829	1.842	20949.35	78	1.106	1.293	0.935
34	329.658	2.114	1.815	1.918	20963.33	79	1.108	1.292	0.924
35	324.849	2.127	1.798	1.929	20979.04	80	1.096	1.268	0.910
36	320.470	2.153	1.791	1.947	20996.69	81	1.088	1.256	0.895
37	316.301	2.176	1.796	1.961	21016.52	82	1.064	1.215	0.877
38	312.127	2.203	1.793	1.992	21038.82	83	1.062	1.211	0.856
39	307.734	2.197	1.789	1.938	21063.87	84	1.074	1.224	0.833
40	303.221	2.179	1.775	1.857	21092.02	85	1.060	1.192	0.808
41	298.456	2.175	1.771	1.813	21123.66	86	1.050	1.161	0.778
42	293.139	2.152	1.765	1.743	21159.21	87	1.040	1.129	0.748
43	286.914	2.085	1.762	1.556	21199.16	88	1.030	1.097	0.714
44	279.363	2.045	1.739	1.462	21244.06	89	1.020	1.066	0.676
45	270.710	2.007	1.740	1.361	21294.52	90	1.000	1.000	0.642
46	261.036	1.930	1.715	1.207	21351.22	91	1.000	1.000	0.603
47	251.144	1.855	1.693	1.059	21414.94	92	1.000	1.000	0.552
48	241.885	1.791	1.693	0.891	21486.55	93	1.000	1.000	0.502
49	233.121	1.708	1.669	0.727	21567.03	94	1.000	1.000	0.452
50	225.072	1.673	1.677	0.626	21657.46	95	1.000	1.000	0.402
51	217.802	1.581	1.645	0.454	21759.09	96	1.000	1.000	0.347
52	210.305	1.547	1.648	0.373	21873.30	97	1.000	1.000	0.300
53	202.611	1.494	1.631	0.268	22001.65	98	1.000	1.000	0.259
54	195.313	1.459	1.633	0.194	22145.88	99	1.000	1.000	0.211
55	187.727	1.424	1.617	0.133	22307.97	100	1.000	1.000	0.166
56	180.226	1.399	1.619	0.064	21639.92	101	1.000	1.000	0.127
57	172.892	1.373	1.610	0.026	20889.18	102	1.000	1.000	0.095
58	164.405	1.354	1.607	0.000	20045.50	103	1.000	1.000	0.077
59	155.068	1.329	1.595	0.000	19097.40	104	1.000	1.000	0.058
60	146.210	1.294	1.559	0.000	18031.94	105	1.000	1.000	0.043
61	137.412	1.275	1.544	0.000	15214.79	106	1.000	1.000	0.031
62	128.978	1.274	1.540	0.000	12048.92	107	1.000	1.000	0.023
63	121.896	1.255	1.519	0.000	8491.17	108	1.000	1.000	0.012
64	114.787	1.239	1.505	0.000	4493.04	109	1.000	1.000	0.004
						110	1.000	1.000	0.000

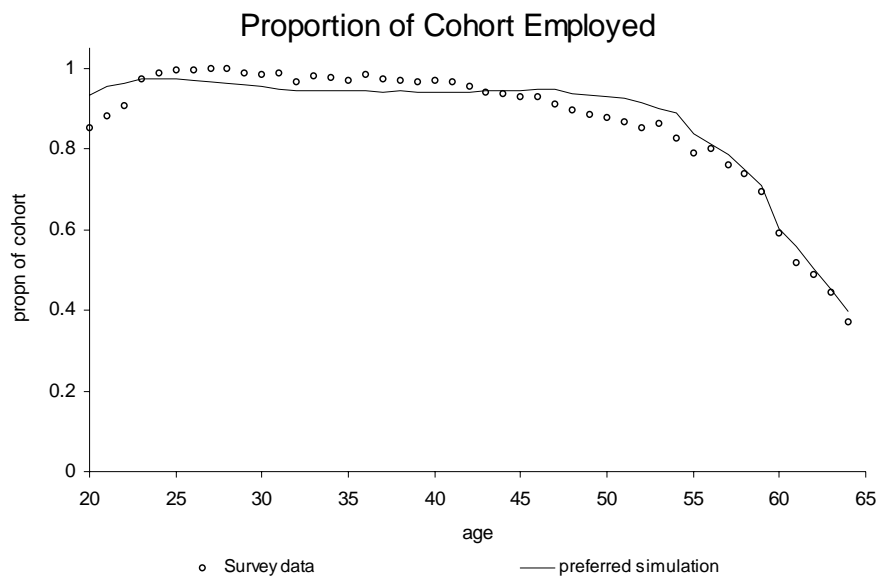
f(t) = age specific dummy variables in wage generating process

eqv scale = McClements' equivalence scale by age

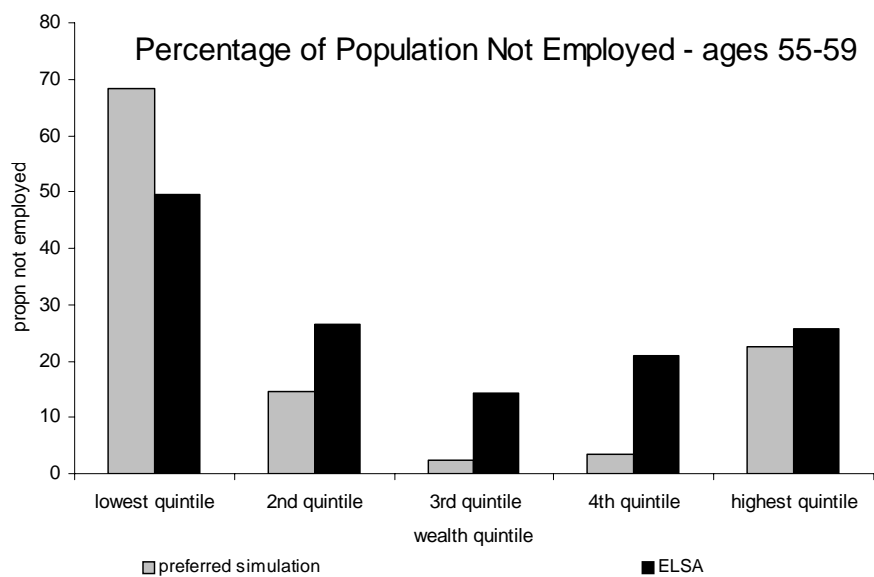
na = number of adults in the household

nc = number of children in the household

credit limit = maximum debt households can draw upon

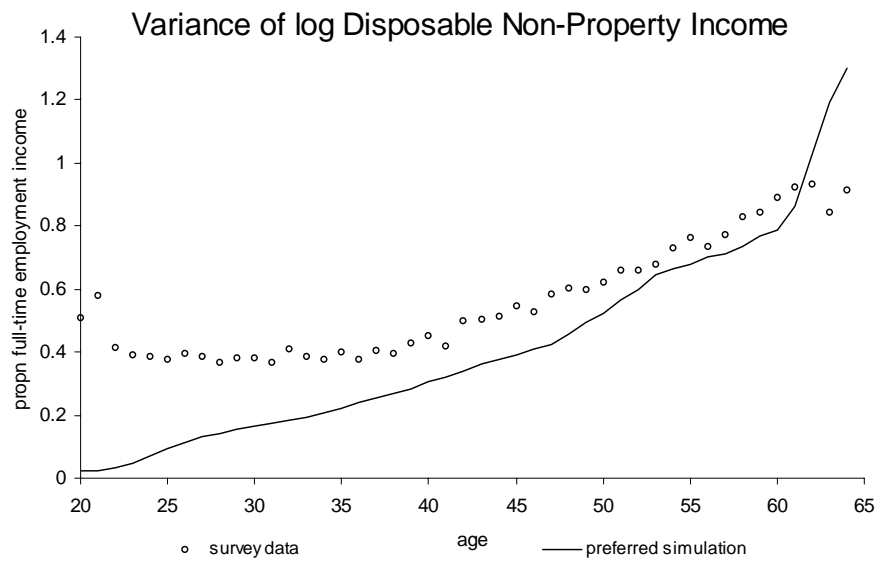
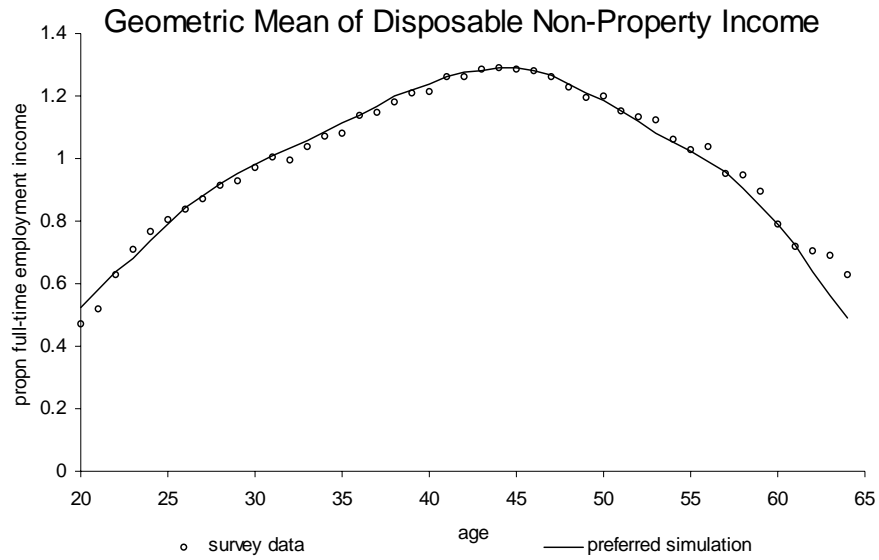


Notes: Survey data – Estimated age profiles, controlled for time and cohort effects
 Survey data arithmetically adjusted to 100% employment at age 27



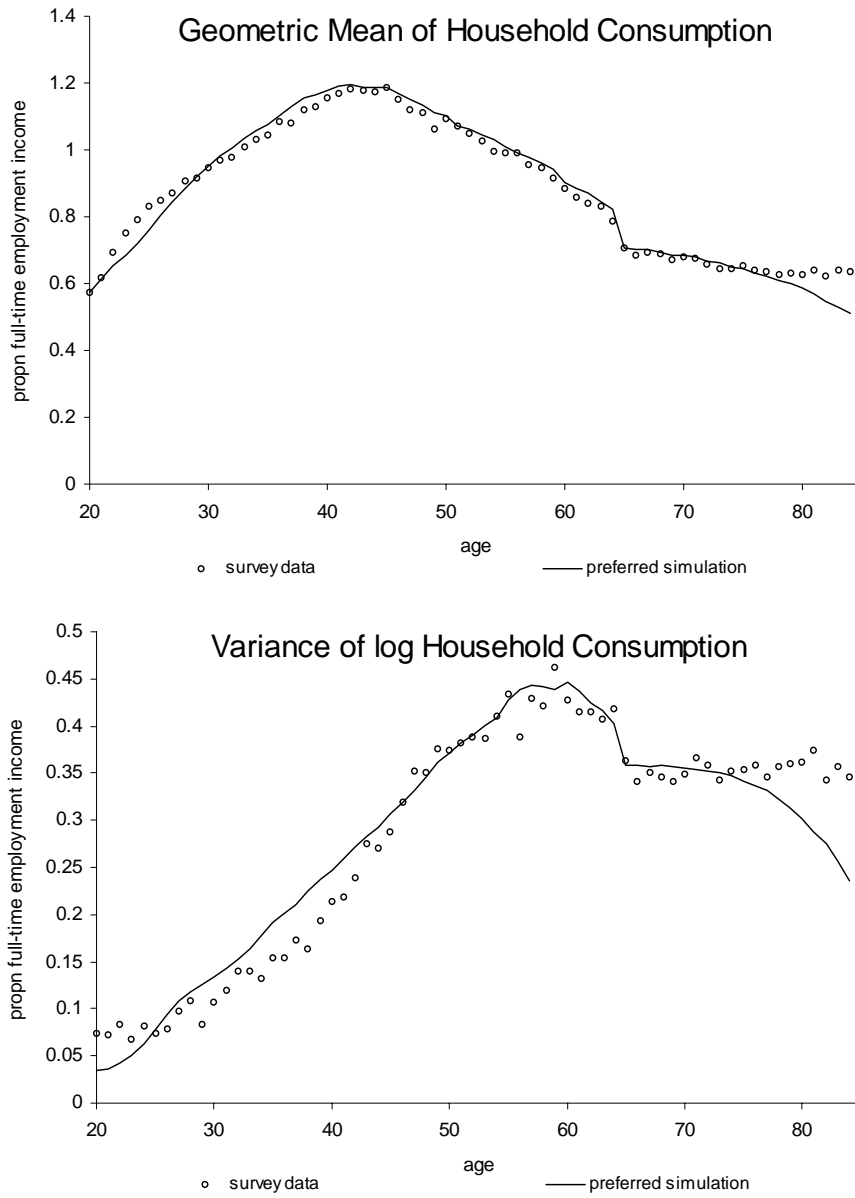
Notes: Simulated quintiles defined with respect to wealth at age 65, ELSA quintiles defined with respect to wealth
 Authors' calculations and Marmot et al. (2003)

Figure 3: Timing of Retirement – simulated versus survey data



Notes: Survey data – Estimated age profiles, controlled for time and cohort effects
 Monetary values reported as proportions of average annual full-time employment income

Figure 4: Disposable Non-Property Income Profiles by Age – simulated versus survey data



Notes: Survey data – Estimated age profiles, controlled for time and cohort effects
 Monetary values reported as proportions of average annual full-time employment income

Figure 5: Consumption Profiles by Age – simulated versus survey data

match for the reduction observed in both the geometric mean and variance of consumption at retirement.

5 Results

This section reports the effects of amending the existing UK pensions system to increase the withdrawal rate on means tested benefits from 40 to 70 percent. The higher of these two withdrawal rates was selected as the mid-point between the current UK pensions system, and the system that existed prior to October 2003. The analysis consequently permits an evaluation of the 2003 reform.

The analysis is based upon descriptive statistics for a cohort of 10,000 households that were simulated by the model described in Section 3. The descriptive statistics are drawn from two simulations, where the only variable between simulations is the considered policy environment.²⁸ A small open economy assumption is made so that interest rates and wage rates are unaffected by the influence that the considered policy change has on population aggregates. Furthermore, marginal tax rates during the working lifetime are adjusted to ensure that the redistributive systems that are compared have the same fiscal burden, evaluated from the perspective of a cohort's lifetime.²⁹

Behavioural responses to policy are identified by comparing the household decisions made under one policy environment with those made under another. Hence the analysis is concerned with the long-term effects of policy change, and not with transitional period effects. Summary statistics that describe the effects of increasing the withdrawal rate on means tested retirement benefits are reported in Table 2.

The first impression made by the statistics reported in Table 2, is that the policy change considered for analysis has a small impact on behaviour and welfare. This is to be expected, given the marginal nature of the policy reform that is considered here. Nevertheless, it is possible to discern a number of interesting distributional patterns. In this respect the statistics reported for the second and third population quintiles stand out, as these include households that are closest to the upper threshold for eligibility to means tested benefits.

The largest statistic reported in the table is the compensating variation from age 65 for the second population quintile. This statistic indicates that the lower 40 percent withdrawal rate on means tested retirement benefits is worth just over one third of median annual full-time employment income on average to households in the second quintile. Households in the second quintile tend to suffer most due to the increase in the pensions withdrawal rate for two reasons. The first is due to the reduced generosity of the pension system when subject to the higher withdrawal rate, which implies that benefits payable to households in the second quintile would fall in the absence of any behavioural responses (the wealth effect). The second is that households in the second wealth quintile earn incomes during their

²⁸Note that each simulated household is subject to the same age specific innovations between alternative policy simulations.

²⁹Marginal tax rates are 0.07% lower when a 70 rather than a 40 percent withdrawal rate is applied.

Table 2: Predicted Long-Term Effects of Increasing the Withdrawal Rate on Means Tested Pensions from 40 to 70 percent

Age Group	Full Population	lowest quintile	2nd quintile	3rd quintile	4th quintile	highest quintile
change in wealth (%*)						
20-49	1.10	0.09	0.43	0.96	1.63	2.39
50-54	5.29	0.19	2.42	6.26	8.70	8.89
55-59	6.87	-0.20	3.70	11.62	10.88	8.33
60-64	7.72	-0.41	5.36	19.12	9.58	4.95
65-79	6.07	-0.13	7.28	18.04	3.69	1.48
80-110	0.31	0.00	0.38	0.98	0.15	0.06
lifetime average	2.56	-0.02	2.10	5.66	2.80	2.27
2001 cross-section	5.08					
change in employment (%**)						
20-49	0.00	-0.02	0.00	0.00	0.01	0.00
50-54	-0.06	-0.17	-0.08	0.04	-0.03	-0.07
55-59	-0.15	-0.31	-0.50	0.25	-0.03	-0.15
60-64	0.18	-0.21	0.21	1.48	-0.49	-0.07
lifetime aggregate	-0.01	-0.09	-0.04	0.20	-0.06	-0.03
2001 cross-section	-0.01					
change in consumption (%*)						
20-49	0.03	0.05	0.05	0.01	-0.01	0.06
50-54	-0.08	0.06	-0.07	-0.47	-0.14	0.24
55-59	-0.07	0.02	-0.14	-0.81	0.34	0.23
60-64	0.05	-0.09	-0.17	-0.14	0.43	0.22
65-79	0.11	-0.02	-0.93	0.98	0.35	0.14
80-110	0.02	0.00	-0.08	0.13	0.03	0.01
lifetime aggregate	0.03	0.01	-0.19	0.13	0.10	0.09
2001 cross-section	0.04					
change in tax burden (%*)						
20-49	-0.15	-0.06	-0.10	-0.14	-0.17	-0.28
50-54	-0.22	-0.08	-0.12	-0.09	-0.23	-0.59
55-59	-0.26	-0.13	-0.23	0.05	-0.14	-0.82
60-64	-0.12	-0.12	0.08	0.97	-0.69	-0.84
65-79	0.36	0.00	1.35	0.38	0.06	0.03
80-110	0.06	0.00	0.19	0.12	0.01	0.00
lifetime aggregate	0.00***	-0.04	0.24	0.11	-0.10	-0.21
2001 cross-section	-0.02					
compensating variations (%*)						
from age 20	-0.12	-0.05	-0.10	-0.12	-0.15	-0.20
from age 65	7.30	0.12	29.19	7.17	0.00	0.00

"Lifetime aggregate" and age specific statistics weighted by survival rates

"2001 cross-section" statistics weighted to reflect census data for UK population quintiles by wealth at age 64 under the MIG

* percentage of median full-time employment income, equal to £19,188 per year in 2003

** percentage of population subgroup

*** statistic is equal to zero by construction

working lives that are insufficient to motivate sufficient saving to place them beyond the upper bound on means tested benefits. Hence they suffer more than most from the distortionary effects of the higher effective tax rates associated with the 70 percent withdrawal rate. Households in the second quintile consequently choose to consume less throughout their simulated lifetimes, and to retire a little earlier under the higher withdrawal rate on means tested retirement benefits. These responses reflect those identified for “low income agents” in Section 2.

The third population quintile suffers the second largest welfare loss from age 65 following an increase in the withdrawal rate on means tested pensions. The behavioural responses of households in the third quintile are, however, quite different to those of the second quintile. In response to the increased withdrawal rate, households in the third quintile tend to work longer and consume less during the working lifetime, to save more for retirement. Indeed they save so much more that their consumption is actually increased in retirement when subject to the less generous of the two pension systems that are considered here. These observations reflect the influence that the more pronounced corner solution under the 70 percent withdrawal rate has on household decisions – the more punitive effective tax rates under the considered reform drive households in the third quintile, on average, to save sufficiently to place them beyond the means tested environment. These responses reflect those identified for “middle income agents” in Section 2. The fact that their incomes during the working lifetime are sufficient to enable them to do this is responsible for the substantially lower welfare loss that they suffer under the reformed pension system, relative to the second quintile.

The policy reform affects the fourth and fifth population quintiles primarily through the lower marginal tax rates that are imposed during the working lifetime under the 70 percent withdrawal rate. As a result, these households tend to consume more throughout their simulated lives. Note, however, that the compensating variations from age 65 calculated for households in the fourth and fifth quintiles are zero, reflecting the fact that these households save sufficiently to make them ineligible for means tested benefits under either of the withdrawal rates considered here (as was the case for “higher income agents” identified in Section 2).³⁰ Households in the lowest population quintile (described as the “poor” in Section 2), by contrast, are not much affected by the withdrawal rate imposed on means tested retirement benefits, as they tend not to save at all.

The compensating variations reported from age 20 are negative for all of the population quintiles, indicating that expected lifetime utility is higher when the withdrawal rate applied to means tested retirement benefits is 70 rather than 40 percent. The disparities between the compensating variations calculated from ages 20 and 65 are attributable to two factors. Firstly, the compensating variations

³⁰Note that the compensating variations from age 65 are necessarily non-negative, since the pension system is strictly less generous when based upon a withdrawal rate of 70 rather than 40 percent.

calculated from age 65 do not take into consideration the different marginal tax rates that are applied by the respective policy counterfactuals during the working lifetime – the less generous pension system associated with the 70 percent withdrawal rate permits a reduction in taxes during the working lifetime to maintain fiscal balance. Secondly, very little of a household’s lifetime uncertainty is revealed at age 20, so that a household does not know whether it will enjoy a particularly fortunate working life, or be subject to adverse circumstances. This uncertainty blurs the distinction between households identified in alternative quintiles, in the style of a ‘veil of ignorance’. The statistics reported in Table 2 consequently imply that lifetime welfare would be higher in the UK if the withdrawal rate on means tested retirement benefits was set at 70 rather than 40 percent.

6 Conclusions

In October 2003, the UK reduced its withdrawal rate on means tested retirement benefits from 100 to 40 percent. Although the behavioural incentives associated with means testing are theoretically ambiguous – and depend largely upon how the population is distributed relative to the means tested environment – little work has been devoted to determining whether, and in what ways, the rates and thresholds now applied by the UK pensions system are appropriate. This problem is addressed by the current study.

Using an articulated and carefully calibrated model, I consider the effects of repealing half of the reduction in the withdrawal rate on means tested pensions that was implemented in the UK in 2003. The analysis reported here suggests that imposing a withdrawal rate of 70 rather than 40 percent would have little effect on population aggregates. This, however, masks important distributional shifts. The increase considered for the withdrawal rate on means tested retirement benefits tends to have a disproportional influence of households in the second and third population quintiles. In the case of households in the second quintile, the counterfactual policy reform reduces consumption throughout the simulated lifetime, and leads to a large welfare cost from age 65. Households in the third quintile, by contrast, tend to work longer and save more during the working lifetime, to consume more in retirement under the higher pension withdrawal rate. Although households in the third quintile are also worse off under the higher withdrawal rate, they suffer a smaller welfare loss than do households in the second quintile.

The welfare losses suffered primarily by households in the second and third wealth quintiles when subject to the higher pensions withdrawal rate are more than offset by the reduced marginal tax rates that are made possible during the working lifetime, and by the uncertainty that is associated with labour income, so that a negative compensating variation from age 20 is observed for all population quintiles. Hence, the analysis suggests that, from a lifetime perspective, it might be preferable to apply a higher withdrawal rate to means tested retirement benefits than is currently the case – the 60 percent

fall in the withdrawal rate implemented in October 2003 might have gone too far.

The analysis presented here, and in our related study (Sefton et al. (2006)) naturally gives rise to the question: *Is there an “optimal” withdrawal rate for means tested pensions in the UK?* Obtaining an answer to this question is the subject of ongoing research.

References

- Attanasio, O. P. & Weber, G. (1993), ‘Consumption growth, the interest rate and aggregation’, *Review of Economic Studies* **60**, 631–649.
- Brewer, M. & Emmerson, C. (2003), Two cheers for the Pension Credit? IFS Briefing Note Number 39.
- Bus, J. C. P. & Dekker, T. (1975), ‘Two efficient algorithms with guaranteed convergence for finding a zero of a function’, *ACM Trans. Math. Software* **1**, 330–345.
- CAB (2003), Financial over-commitment survey. Research Study conducted on behalf of CAB by MORI, July 2003.
- Curry, C. & Steventon, A. (2006), Transition Trade-offs: Options for State Pension Reform. Pensions Policy Institute Discussion Paper.
- Deaton, A. (1997), *The Analysis of Household Surveys*, John Hopkins University Press, Baltimore.
- Disney, R. & Smith, S. (2002), ‘The labour supply effect of the abolition of the earnings rule for older workers in the United Kingdom’, *Economic Journal* **112**, C136–C152.
- Eckstein, Z. & Wolpin, K. I. (1989), ‘Dynamic labour force participation of married women and endogenous work experience’, *Review of Economic Studies* **56**, 375–390.
- Feldstein, M. S. (1987), ‘Should social security benefits be means tested?’, *Journal of Political Economy* **95**, 468–484.
- French, E. (2005), ‘The effects of health, wealth, and wages on labour supply and retirement behaviour’, *Review of Economic Studies* **72**, 395–427.
- Friedberg, L. (2000), ‘The labor supply effects of the social security earnings test’, *Review of Economics and Statistics* **82**, 48–63.
- Gustman, A. L. & Steinmeier, T. L. (1986), ‘A structural retirement model’, *Econometrica* **54**, 555–584.

- Gustman, A. L. & Steinmeier, T. L. (2004), The social security retirement earnings test, retirement and benefit claiming. NBER Working Paper 10905.
- Heckman, J. (1974), 'Life cycle consumption and labor supply: an explanation of the relationship between income and consumption over the life cycle', *American Economic Review* **64**, 188–194.
- Hubbard, R. G., Skinner, J. & Zeldes, S. P. (1995), 'Precautionary saving and social insurance', *Journal of Political Economy* **103**, 360–399.
- Kempson, E. (2002), Overindebtedness in Britain. Report to the Department of Industry and Trade.
- KPMG (2003), Debt crisis – an attempt to make ends meet or a frivolous approach to spending? Press Notice describing survey carried out by YouGov on behalf of KPMG.
- Low, H. (2005), 'Self-insurance in a life-cycle model of labour supply and savings', *Review of Economic Dynamics* **8**, 945–975.
- Marmot, M., Banks, J., Blundell, R., Lessof, C. & Nazroo, J. (2003), Health, wealth and lifestyles of the older population in England. Institute for Fiscal Studies.
- Meade, J. E. (1993), *Liberty, Equality and Efficiency*, New York University Press, New York.
- Mincer, J. & Ofek, H. (1982), 'Depreciation and restoration of human capital', *Journal of Human Resources* **17**, 3–24.
- Myck, M. & Paull, G. (2004), The role of employment experience in explaining the gender wage gap. Institute for Fiscal Studies Working Paper WP04/16.
- Nelson, C. R. & Plosser, C. I. (1982), 'Trends and random walks in macroeconomic time series: some evidence and implications', *Journal of Monetary Economics* **10**, 139–162.
- Neumark, D. & Powers, E. (1998), 'The effect of means-tested income support for the elderly on pre-retirement saving: evidence from the SSI program in the US', *Journal of Public Economics* **68**, 181–206.
- Rust, J. & Phelan, C. (1997), 'How social security and medicare affect retirement behavior in a world of incomplete markets', *Econometrica* **65**, 781–831.
- Sefton, J. & van de Ven, J. (2004), 'Simulating household savings and labour supply: an application of dynamic programming', *National Institute Economic Review* **188**, 56–72.
- Sefton, J., van de Ven, J. & Weale, M. (2006), The effects of means-testing pensions on savings and retirement. NIESR Discussion Paper 265.

Tudela, M. & Young, G. (2003), ‘The distribution of unsecured debt in the United Kingdom: survey evidence’, *Bank of England Quarterly Bulletin* **2003**, 417–427.

Waldfogel, J. (1998), ‘The family gap for young women in the United States and Britain: can maternity leave make a difference?’, *Journal of Labor Economics* **16**, 505–545.

A Analytical Derivations for the Two Period Model

Problem:

$$\max_{e_1, e_2} U(e_1, e_2) = \frac{1}{1 - 1/\gamma} \left(e_1^{1-1/\gamma} + \delta e_2^{1-1/\gamma} \right) \quad (8a)$$

$$\begin{aligned} \text{subject to } e_1, e_2 &\geq 0 \\ e_1 &\leq w_1 \\ e_2 &\leq p + w_2 + \max(0, p_c - t_m w_2), \text{ where } w_2 = (1 + r)(w_1 - e_1) \end{aligned} \quad (8b)$$

and where all variables are as defined in Section 2. Let \hat{e}_i denote the utility maximising total expenditure in period i . Then, interior solutions for households in receipt of means tested retirement benefits are defined by:

$$\hat{e}_1 = \frac{(p + p_c) + (1 + r)(1 - t_m)w_1}{(1 + r)(1 - t_m) + [\delta(1 + r)(1 - t_m)]^\gamma} \quad (9)$$

The effect of the pension withdrawal rate on saving of agents in receipt of means tested benefits

For agents in receipt of means tested benefits, a marginal change of the withdrawal rate affects first period saving, w_2 , as described by:

$$\frac{dw_2}{dt_m} = Aw_1 - B(p + p_c) \quad (10)$$

$$A = \frac{\delta^\gamma (1 + r)^{\gamma-1} (\gamma - 1) (1 - t_m)^{\gamma-2}}{1 + \delta^\gamma [(1 + r)(1 - t_m)]^{\gamma-1}} \left(\frac{\delta^\gamma [(1 + r)(1 - t_m)]^{\gamma-1}}{\left\{ 1 + \delta^\gamma [(1 + r)(1 - t_m)]^{\gamma-1} \right\}^2} - 1 \right) \quad (11)$$

$$B = \frac{(1 + r) + \delta^\gamma (1 + r)^\gamma \gamma (1 - t_m)^{\gamma-1}}{\left\{ (1 + r)(1 - t_m) + [\delta(1 + r)(1 - t_m)]^\gamma \right\}^2} \quad (12)$$

If $\gamma < 1$ (as is usually the case for the intertemporal elasticity), then $A > 0$ and $B > 0$, so that $dw_2/dt_m > 0$ if w_1 is sufficiently larger relative to $(p + p_c)$, and vice versa.

The effect of the pension withdrawal rate on welfare of agents in receipt of means tested benefits

For agents in receipt of means tested benefits and some savings, a marginal increase of the withdrawal rate will necessarily reduce lifetime utility.³¹ The way in which this reduction varies with first period

³¹This is because the revised budget constraint will be strictly dominated by the original budget constraint, and agents in receipt of means tested benefits and some savings will no longer be able to afford their original utility maximising consumption bundle.

wealth is described by:

$$\frac{d^2V}{dt_m dw_1} = -\frac{1}{\gamma} \hat{e}_1^{-\frac{1}{\gamma}-1} \frac{d\hat{e}_1}{dt_m} \quad (13)$$

where $V = U(\hat{e}_1, \hat{e}_2)$ denotes utility at the optimum. Since $\hat{e}_1, \gamma \geq 0$ by assumption, and $d\hat{e}_1/dt_m > 0$ if the price effect dominates (as described in the preceding subsection), then $d^2V/(dt_m dw_1) < 0$. Hence, the fall in utility associated with a marginal increase in the pensions withdrawal rate is larger as w_1 increases.