Pension Arrangements and Retirement Choices in Europe: A Comparison of the British, Danish and German Systems

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Abstract

We develop a general equilibrium simulation model of a heterogeneous population in whcih both consumption/saving and labour/leisure choices are endogenous. We use it to explore the effects of the different state benefit systems on labour supply of old and older workers in Denmark, Germany and the United Kingdom. We find that, in broad terms, differences in labour force participation can be accounted for by differences in benefit structures. The broad conclusions are not altered when we allow for the effects of poor health at different ages. We find that the UK system is preferred by young people while the German arrangement is chosen by old and older people; the latter are in the majority in our simulated population.

1 Introduction

The aging of populations in industrialised countries and the accompanying trend toward earlier retirement has motivated recent interest in the determinants of retirement behaviour. Analyses of retirement behaviour are commonly based upon econometrically estimated models, which serve to clarify the relations that are exhibited by survey data. Such studies are, however, limited by the data that are available for estimation, and by the complexity of the retirement decision. Most econometric studies consequently report estimates for reduced form models, or for structural models that exclude household savings – neither of which is particularly adequate for inferring the likely behavioural responses of savings and retirement to policy counterfactuals. The current study addresses these issues by using a behaviourally consistent model of savings and labour supply to compare the implications for retirement of alternative transfer systems.

Answers are is sought to the following questions:

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1. How far can the differences in retirement behaviour in Denmark, Germany and the United Kingdom be accounted for by differences in the provision of state benefits for old and older people?

2. Is this likely to be sensitive to the state of health of the population?

3. Which of the three systems would voters be likely to select?

As such, the current study contributes to the debate regarding the influence of pension policy on the timing of retirement[1]. Furthermore, the study defines competing possibilities to existing government policy, and hence provides a useful platform for comparison and evaluation.[2]

The countries that are compared by this study have been selected with some care. Most importantly, Germany, Denmark and the UK span the political typology that is advocated by Esping-Anderson (1990), which distinguishes between the "liberal" systems that are commonly found in Anglo Saxon countries – see results for the UK; the social democratic regimes that are typical of Scandinavian countries – see results for Denmark; and the conservative regimes of continental Europe – see results for Germany.[3] These alternative welfare models involve very different value judgements, and it is consequently of interest to consider their respective implications for retirement behaviour. The practical relevance of the study is reinforced by the associated discussion regarding European integration. Furthermore, analysis presented in Work Package 4 suggests that, of the various European transfer systems that are considered by the AGIR project, the Danish state pension system is likely to impose the smallest fiscal burden on future generations, the German system will impose the greatest burden, and the UK system falls between the two.[4]

The principal innovation of the analysis reported here is the use of a structural model of the labour/leisure and consumption/savings decisions. The advantages of this model for an analysis of retirement behaviour are revealed by a brief review of the associated literature. Most econometric studies that have attempted to estimate behavioural responses to pension policy incentives consider reduced form models. These studies typically focus upon one of three forms of policy variation

[1] The reverse relation, that demographics affect policy, is not considered here (see, for example, Profeta, 2002, for recent empirical evidence).

[2] Smeeding and Gunther (1990).

[3] In addition, reference has been made to the "subsidiarity" model that is common of southern European countries, which places emphasis on support from an individual's extended family. This model is not considered by the current study.

[4] It should be noted, however, that pension systems across the EU are characterised by a strong state component and in only three Member States – Denmark, the Netherlands, and the UK – are private sector elements of the pension systems well developed (*Progress report to the Ecofin Council on the impact of ageing population on public pension systems*, Economic Policy Committee Report, October 2000).

described by survey data: variation observed at a point in time for a single country due to heterogeneity of individual circumstances[5]; variation observed through time for a single country due to a policy experiment[6]; or variation observed at a point in time between the policies of alternative countries[7]. Estimates obtained using country specific data differ substantially between studies.[8] Nevertheless, the general conclusion of this literature is that there exists a significant, though modest, negative relation between public pension policy and the timing of retirement.[9] In contrast, studies that consider cross-country data usually find that public pension policy has a substantial effect on retirement behaviour.[10] This difference can be attributed to the subtlety of the policy variation that is usually described by country specific data, and to delays in the behavioural response to policy change (see Burtless, 2004, pp. 12-13).

A common critique of the reduced form approaches to analysing retirement behaviour is that the reported estimates are affected by collinearity and omitted variable bias. In the case of studies that consider cross-sectional data for a single country, the variation of public pensions is often strongly correlated with other characteristics, such as individual income histories, which may relate to tastes for retirement. Studies of retirement behaviour that consider time-series data for a single country are often complicated by the fact that the policy variation described by data is slight, or exhibits a stable temporal trend. And cross-country studies of retirement behaviour usually suffer from undesirable population heterogeneity, in the form of institutional differences between countries.

More fundamentally, however, analyses of retirement behaviour that use reduced form models are susceptible to the Lucas Critique. As noted by Rust (1995, pp. 3082-3083), "Reduced-form estimation methods can be viewed as uncovering agents' decision rules or, more generally, the stochastic process from which the realisations [described by data] were "drawn", but are generally independent of any particular behavioral theory." Hence, although reduced form regression estimates can provide useful information regarding retirement behaviour *given* existing pension policy, they are usually inappropriate for considering the behavioural response to policy counterfactuals. Results

[5] See, for example, Pellechio (1981), and Gordon and Blinder (1980). Recent research in this vein has focussed upon the influence of a retirement Option Value (OV), following the analysis by Stock and Wise (1990). See, for example, Samwick (1998), Coile and Gruber (2000), Blundell and Emerson (2003), and Chan and Stevens (2004).

[6] See, for example, Burtless (1986), Anderson *et al.* (1986), Krueger and Pischke (1992).

[7] See, for example, Gruber and Wise (1999), Blöndal and Scarpetta (1998), and Burtless (2004).

[8] Krueger and Pischke (1992), for example, note that widely diverging conclusions are reached by various reviews of the literature.

[9] See, for example, review by Krueger and Meyer (2002), and Mitchell and Fields (1981) for a summary of the early literature. Blau (1994) is an interesting example of a reduced form analysis, which suggests that both social security benefits have large effects on labour force transitions, and that changes in benefits over time account for only a small part of observed variation in labour force participation.

[10] See, the volume edited by Gruber and Wise (1999) for a prominent example.

presented by Lumsdaine *et al.* (1992) support this conclusion. Lumsdaine *et al.* (1992) compare the in-sample and out-of-sample predictive power of three models of retirement, using data that describe a policy experiment. The principal conclusion of this study is that: "the option value and dynamic programming models are considerably more successful than the less complex probit model in approximating the rules individuals use to make retirement decisions" Lumsdaine *et al.* (1990, p. 31).

In response to the short-comings of reduced-form models for analysing retirement behaviour, a number of studies have considered structural models of retirement. The most commonly cited of these include Burtless (1986), Burtless and Moffitt (1984), Gustman and Steinmeier (1985, 1986), Berkovec and Stern (1991), and Rust and Phelan (1997).[11] These models are comprised of three elements: a single period utility function, a discount factor, and a transition probability density. Individuals are assumed to select their chosen action at any time t, from their range of possible options to maximise their expected discounted value of utility derived over all future periods. Estimation of the model progresses in three stages. First, the assumed beliefs regarding probable future outcomes – as embodied by the transition probability density – are estimated from survey data, subject to the additional assumption of rational expectations. Second, given the expectations estimated in the first stage, the Dynamic Programming problem is solved numerically by backward induction. And third, a likelihood function is formulated from the numerical solution to the Dynamic Programming problem, which is used to estimate the unknown discount factor and utility function parameters.[12]

The general finding of studies that are based upon econometric estimates of structural models is that public policy has a strong (negative) effect on labour supply. The structural analysis reported by Gustman and Steinmeier (1986), for example, suggests that the US retirement peaks at ages 62 and 65 can be motivated entirely by social security, pensions and mandatory retirement. Rust and Phelan (1997) extend upon the analysis of Gustman and Steinmeier (1986), by adding the incentive effects of Medicare for an analysis of male retirement behaviour in the US.[13] Like Gustman and Steinmeier, the analytical results reported by Rust and Phelan (1997) capture the retirement peaks

[11] See also Bingley and Lanot (2004) for Denmark. The model by Stock and Wise (1990), is also structural, but does not conform to the dynamic programming framework that is the focus here. As noted in Section D of Stock and Wise (1990), the Option Value model assumes that individuals consider the value of future utility in terms of the maximum of the expected value of future alternatives, rather than the expectation of the maximum of future alternatives. This essentially means that an individual fails to take into consideration the fact that they can adapt their choices to new information obtained in the future when evaluating their expectations regarding the utility value of future options. Stern (1997) shows that this simplification can exhibit poor properties. Nevertheless, Lumsdaine *et al.* (1992) suggest that the simplification has a minor effect on the predictive power of the Option Value model.

[12] See Rust and Phelan (1997) for a detailed discussion.

[13] The analysis by Rust and Phelan (1997) focuses upon the subpopulation that do not have a private or occupational pension.

described by survey data. In the case of the peak at age 65, however, the results presented by Rust and Phelan depart from those reported by Gustman and Steinmeier, by suggesting that medical insurance plays an important role.

The analytical complexity of a structural model is usually purchased at the expense of the detail that is used to describe population heterogeneity. Perhaps the most important simplifying assumption that is commonly made is that households consume all of their income immediately, which omits consideration of the consumption/savings decision. The principal justification that is cited for this omission is the lack of accurate wealth data that are available for estimation. Furthermore, an appeal can be made to statistical and theoretical evidence that downplays the role of wealth in the retirement decision (see, for example, Samwick, 1998, and Deaton, 1991). Nevertheless, such qualifications may fail to allay concerns regarding the results obtained. Omitting wealth from the analysis focuses attention upon the foregone opportunities that are associated with selecting a particular date for retirement. This is one aspect that affects the consumption that an individual can afford during their retirement. Wealth is clearly another aspect that has a bearing on the future consumption that an individual can afford.

The potential importance of wealth in determining the timing of retirement is reflected by a recent study by Blundell and Emerson (2003). Blundell and Emerson estimate a reduced form probit model that describes retirement in terms of an individual's wealth, their age, and their option value (following Lumsdaine *et al.*, 1990). Importantly, Blundell and Emmerson (2003, p. 12) report that:

> In each specification, the coefficients on these wealth are always strongly significant and suggest that the restrictions underlying the standard option value model need to be relaxed to allow saving and borrowing against future pension wealth.

These results suggest the intuitive conclusion that an early accumulation of wealth tends to encourage early retirement. Notably, the coefficient on the OV variable estimated by Blundell and Emmerson (2003) ceased to be significant (at any reasonable confidence interval) following the addition of wealth to the probit regression.

Rust (1987) was one of the first studies to suggest a method for estimating structural models of retirement that incorporate the consumption/savings decision. Nevertheless, practical applications have been frustrated by the implied computational burden. For example, one of the most recent attempts to estimate a structural model of the consumption/saving decision is by Gourinchas and Parker (2002), who use an optimal consumption model to account for the life-cycle spending pattern described by the United States' Consumer Expenditure Survey. Although Gourinchas and Parker choose the parameters of the utility function to minimise an econometric criterion, they do not fit their model to the whole cross-section of data. Rather, they optimise for mean consumption as a function of age, and do not account for differences of behaviour between consumers of the same age. Their model does not address the labour/leisure margin and, as far as we are aware, no researcher to date has suggested a method for making this problem computationally tractable, given the limitations of current state-of-the-art personal computing technology.

The model considered here is specified to simulate endogenously the labour/leisure and consumption/savings decisions. Calibration of the model closely follows the existing literature that considers structural models of retirement. Specifically, the required transition probability density is estimated from survey data. The retirement decision is formulated as a dynamic programming problem, which is solved numerically, by imposing the estimated transition probability density. However, unlike the method of likelihood estimation that is commonly adopted in the literature, the discount rate and utility function parameters are manually calibrated to reflect broad observations drawn from survey data regarding consumption, employment status, and wealth. This side-steps the immense computational burden that is associated with econometric estimation.

Section 2 describes the direct tax and benefits systems of the UK, Denmark, and Germany, with a particular emphasis on the transfer schemes that target the elderly. The simulation model used to analyse retirement behaviour is described in Section 3, and the derived analysis is reported in Section 4. A summary of the study's findings and associated implications are drawn together in a concluding section.

2 Three Models of Social Welfare

2.1 An Overview

In 1889, Germany became the first country to offer formal state support to individuals during their retirement. This was motivated by the rise in the political power of the socialist movement, following the establishment of the *kleindeutsch* Reich in 1871. As noted by the first German Reich-Chancellor, Otto von Bismarck, it was believed that "The only means of stopping the Socialist movement in its present state of confusion is to put into effect those Socialist demands which seem justified and which can be realized within the framework of the present order of state and society."[14] The current German welfare system retains the principal characteristics with which it was endowed by

[14]Quoted by Zöllner (1982)

Bismarck – eligibility to benefits is closely linked to associated contributions. As such, the German welfare system involves very little intra-generational redistribution, which is why it is referred to as a "conservative" system.[15]

In contrast, the current UK transfer system is structured to insure individuals against risks of extreme hardship, as advocated by the Beveridge Report.[16] It is consequently characterised by smaller benefits than the German transfer system, and higher progressivity. The inherent differences between the Bismarckian and Beveridgean models of social welfare are reflected by the politically charged commentary of the *Times* newspaper, which reported in 1889 that: "natural as free individual development is to the English in their island home, equally necessary is for Germany a rigid, centralised, all pervading state control...the German is accustomed to official control, official delays and police supervision from the cradle to the grave...whereas...self-help and spontaneous growth are better suited to Englishmen."[17] The emphasis that is placed on the importance of individual independence from government intervention is the basis for describing the Beveridge welfare system as "liberal".

The social democratic model of Denmark takes a somewhat middle-road between the conservative Bismarckian, and the liberal Beveridgean social welfare systems, in the sense that it adopts the larger size of the conservative system, coupled with the progressivity of the liberal system. These two characteristics taken together imply that the Danish welfare system is highly redistributive, providing generous benefits to individuals at the bottom of the income distribution, and imposing high tax burdens on those at the top of the distribution. The keystone of the social democratic model is the political objective of full-employment, which Denmark has failed to achieve since the mid-1970s.

The complexity of the German, Danish, and UK transfer systems is such that an attempt to include all of the relevant details here would be a massive undertaking, which – while of potential

[15] The German pension system provided a subsistence benefit until 1957, after which it was designed as a replacement for wages. The omission of intra-generational redistribution as an objective of the German welfare system is consistent with Esping-Anderson's definition of a conservative regime, which features stratification of society along class lines. Taking into consideration the provisions for child support and home production of the German pension system, it is possible to argue that wealth is redistributed from men to women. Furthermore, a means tested benefit has been introduced as part of the pension reforms undertaken after 1992.

[16] The Beveridge Report of 1942 recommended that the British people should be guaranteed a minimum standard of living in times of sickness, unemployment and retirement, in return for a weekly contribution during employment. The value judgements made in the Beveridge Report can, however, be traced to 1536, when English parishes were first authorised to collect money to support the 'impotent poor'. This embryonic welfare state provided a means of sustenance to the elderly, infirmed, blind, and mad. See Fraser (1972) on the evolution of the welfare state in Britain up to 1945. On the contemporary development of the British welfare state, see *The Changing Welfare State: Social Security Spending*, Department of Social Security Publication (2000).

[17] Cited by Conde-Ruiz and Profeta (2003).

interest – lies outside the scope of the current study. Consequently, the country specific welfare systems were divided into five distinct parts for the simulation analysis that is presented in Section 4. These parts are:

1. the application of tax and benefits policy to employed individuals.
2. the application of tax and benefits policy to individuals not employed between age 20 and 50.
3. the application of tax and benefits policy to individuals not employed between age 51 and 64.
4. the application of tax policy to individuals not employed over age 64.
5. an explicit consideration of state provided pension policies.

As this list indicates, particular care has been taken to simulate the influence of pension policies, which reflects the current focus on retirement behaviour. Summary tax functions were used to simulate the first four of the parts listed above. These functions are described in the following subsection. A detailed description of the pension systems considered for analysis is provided in the three subsequent subsections; one for each country.[18]

2.2 Country Specific Tax Functions

Four functions for each country are used to simulate tax and benefits policy in the UK, Denmark, and Germany: one for all working individuals, one for individuals who are not employed and aged between 20 and 50, one for individuals who are not employed and aged between 51 and 64, and one for individuals over age 64 and not employed. The functions are specified at the household level, and were selected to reflect the most pertinent aspects of the respective transfer systems, after considering various alternatives. Each of the functions used defines a linear tax schedule, where both the intercept, and the marginal tax rate are defined with regard to the numbers of adults and children in the household. A household's age is defined by the age of the reference person, and labour status is defined with regard to all household members. Weighted least squares estimates were obtained for the tax functions using data derived from the ECHP for 2000/01, and these are displayed in Table 1.[19]

[18] With the notable exception of Germany, the pension system that is current for 2003 has been used as the basis for the stylised specifications that are provided below. In response to sustainability concerns, German pension policy has been the subject of reforms that began in 1992 and remain ongoing.

[19] See Appendix A for details regarding the ECHP.

Table 1: Country Specific Tax Functions - Regression Estimates

	UK		DE		DK	
Parameter	Est	Std Err	Est	Std Err	Est	Std Err
			Employed			
C	510.62*	801.54	2891.27	458.21	341.37*	711.60
NA	7776.90	481.37	5276.08	224.47	7236.42	725.90
NC	2638.40	653.27	1359.81	203.72	5484.94	932.39
(NA+NC)^2	-299.43	96.10	-	-	-568.57	146.95
X	0.47559	0.02603	0.38565	0.00820	0.38978	0.01137
NA.X	-0.03221	0.00885	-	-	-	-
R-square	0.88914		0.86265		0.89045	
std error	7001.51		5640.75		4830.84	
			Not Employed - age 20-50			
C	5824.84	1175.63	7303.13	925.59	1060.77*	1780.13
NA	2346.85	812.13	1799.76	740.07	9338.85	1367.85
NC	1726.32	301.77	2039.18	613.00	5407.31	991.49
X	0.34482	0.01463	0.35456	0.02296	0.12222	0.03038
R-square	0.69807		0.81476		0.65272	
std error	5957.37		4745.7		6584.99	
			Not Employed - age 51-64			
C	1702.07*	1759.24	2964.14*	1588.85	7624.71	2061.17
NA	6181.22	1186.00	5855.46	926.70	6051.93	1284.53
D60	-	-	1457.79*	1298.61	-	-
D61	-	-	2096.20*	1985.72	-	-
D62	-	-	5033.60	1925.20	-	-
D63	6555.53	2609.23	4417.53	1695.61	-	-
D64	5838.84	1708.94	8087.44	2221.16	-	-
X	0.53963	0.13877	0.52620	0.08938	0.19804	0.04179
X.D64	-	-	-	-	0.52695	0.25080
R-square	0.63396		0.33669		0.48918	
std error	9502.58		10241.5		5683.73	
			Not Employed - age 65 and over			
C	2889.95	905.44	1421.56	642.03	2709.18	1356.44
X	0.77356	0.05893	0.91162	0.03451	0.77948	0.08744
R-square	0.85312		0.90251		0.88143	
std error	4216.03		3483.31		4396.76	

* denotes insignificant estimate at 95% confidence interval

All currency values defined in terms of Purchasing Power Standards - see ECHP for details

C denotes the regression constant

NA denotes the number of adults in the household

NC denotes the number of children in the household

X denotes household pre-tax income

DXX denotes a dummy variable, taking the value 1 at age XX

All currencies are specified in terms of Purchasing Power Standards (PPS), obtained by dividing the national currency by the relevant Purchasing Power Parity (PPP). The PPPs used were calculated by Eurostat, and are provided with the ECHP.

The coefficient estimates reported in Table 1 reflect the general properties of the respective transfer systems. In the case of Denmark, the estimates obtained for the working lifetime (under age 65) suggest that relatively high benefits are off-set by high effective tax rates on income. The UK transfer system by contrast, is characterised by relatively low benefits for households that are not employed during the working lifetime, and withdrawal rates that are lower than those for the Danish system. Furthermore, the estimated marginal tax rates imposed on employed households are lowest for the UK transfer system, which is consistent with the liberal model. Estimates for the German transfer system suggest that it provides benefits that are slightly higher than the UK transfer system to households of working age that do not work, and imposes withdrawal rates that are similar to the UK. The estimates obtained for the impact of taxes during retirement (ages 65 and over) also reflect aspects of the respective countries' pension systems – Danish and UK pensions are taxed as income, while pensions are exempt for Germany.

It should be noted, however, that the parameter values reported in Table 1 were subject to some variation as part of the calibration procedure for the analysis that is presented in Section 4. In the case of the German tax functions, parameters on the dummy variables for age 60 and 61, $D60$ and $D61$, were each multiplied by a factor of 1.5, and the parameters for $D62$ and $D63$ were set equal to 4700.00. These adjustments cannot be rejected at the 95 per cent confidence interval, and are discussed at greater length in the following subsection. Furthermore, analysis based upon the parameter estimates reported in Table 1 for the Danish transfer system suggested very low labour participation rates. This is consistent with the particularly generous transfer benefits implied by the Danish estimates, and the relatively high tax rates. To mitigate the difficulties associated with this issue, the intercept terms of the tax and benefit functions for individuals not employed, and between age 20 and 65 were multiplied by a factor of 0.75. Unlike the adjustments made to the German tax parameters, the adjustment made to the Danish parameters is rejected by an F-test at any reasonable confidence interval. Nevertheless, the adjustment can be rationalised by assuming that it reflects the impact of measures taken by the Danish government to discourage benefit receipt, or an associated social stigma. Denmark has created an environment where benefits appear generous, but are not available indefinitely. The write-down assumed here reflects this aspect, which makes the benefit system "not as good as it looks". The UK tax and benefit functions are not similarly altered.

2.3 German Pension System[20]

Approximately 90 per cent of the German population is covered by "Public Retirement Insurance" (*Gesetzliche Rentenversicherung*, GRV).[21] This scheme offers generous replacement rates to retirees, particularly when considered from an international context, and as a consequence very few German retirees rely upon occupational or personal pensions to a significant extent.

Members of GRV are required to contribute 19.5 per cent of their first €5,100 per month (the *Beitragsbemessungsgrenze*, or upper earnings threshold, which is approximately twice the average income) to the scheme. These payments are used to fund current retirees through a Pay-As-You-Go (PAYGO) framework.[22] Contributions entitle members to claim a (fully-annuitised) pension commencing between the ages of 60 and 65. Under the eligibility conditions that are considered here, an individual may claim GRV benefits:[23]

- from age 60, after 15 years of service, and unemployment for three years, subject to an income test.
- from age 60, after 35 years of service, and loss of at least 50 per cent income capacity, subject to an income test.
- from age 60 for women, after 15 years of service, 10 of which need to be provided from age 40.
- from age 63, after 35 years of service, subject to an income test.
- from age 65, after 5 years of service.

The period up to age 65 is modelled by the functions described in Subsection 2.2, where four parameters were adjusted as part of the model calibrations: the dummy variable at age 60, $D60$, was adjusted to 2186.69 (1.5 times the estimated coefficient displayed in Table 1, but less than 1 times the associated standard error), $D61$ was adjusted to 3144.30 (also 1.5 times the estimated coefficient), and $D62$ and $D63$ were both adjusted to 4700.00. These adjustments warrant further comment.

[20] Much of the discussion presented here is based upon Börsch-Supan and Wilke (2003).

[21] GRV is mandatory for public and private employees, and is optional for the self-employed. Civil servants (approximately 7 per cent of the population) are covered by a special scheme that is more generous than GRV, and the remaining 3 per cent of the population is comprised of the self-employed who opt for private pensions.

[22] Interestingly, German public pension expenditures account for a huge sum - 11.8 per cent of GDP, or €200 billion in 2001 - and reserves held under the GRV are only sufficient to last approximately 14 days.

[23] These eligibility requirements approximately correspond to 1972 Legislation, which applied until cost cutting reforms undertaken in 1992.

The coefficient estimates obtained for the dummy variables $D60$ and $D61$ are associated with a high degree of error. This is of little surprise, given that some individuals who are identified by the ECHP as not employed at age 60 or 61 are in receipt of GRV benefits as per the above eligibility tests, while others are not. The adjustment made to the associated parameter estimates reflects the fact that those who retire at age 60 or 61 and obtain GRV receive more substantial government support than those who are not eligible to receive GRV (and whose inclusion in the ECHP data depresses the estimates obtained for the regression coefficients on $D60$ and $D61$). With regard to $D62$ and $D63$, the associated dummy variables were adjusted to take the same value to avoid misleading variation regarding the influence on retirement behaviour. There is no particularly good reason why $D63 > D62$, and the parameter estimates are not significantly different from one another at the 95 per cent confidence interval. Hence they are both adjusted to take the intermediate value of 4700.00.

Following age 65, pensions are modelled explicitly based upon the regulations of the GRV. The pension annuity payable upon retirement to individual i at time t by the GRV, P_{it}, is described by:[24]

$$P_{it} = RP_i.AF_i.PV_t \tag{1}$$

where RP_i denotes the "Remuneration Points" held by individual i upon retirement, AF_i their relevant "Adjustment Factor", and PV_t the "Pension Value" at time t.

- REMUNERATION POINTS - The RPs accrued by individual i depends upon their contribution assessment basis in each year of their working lifetime t, $CAB_{i\tau}$, and the average contribution assessment basis of the population, $\overline{CAB}_\tau$:

$$RP_i = \sum_{\tau=t_0}^{T} \frac{CAB_{i\tau}}{\overline{CAB}_\tau} \tag{2}$$

  where t_0 defines the first year of individual i's working lifetime, and T defines the last year of their working lifetime. An individual with 45 years of average earnings consequently will have accrued 45 RPs.

- ADJUSTMENT FACTOR - The AF_i is considered to vary in relation to the age that retirement is first taken.[25] AF_i takes a value of 1 if an individual applies for a pension at the relevant age threshold stated above, decreases by 0.003 for each month taken prior to the designated age, and increases by 0.005 for each month taken after the designated age.

[24] See and Börsch-Supan and Wilke (2003), pg. 13.

[25] In practice it also varies to account for benefits provided under alternative schemes, including widows' and orphans' pensions.

- PENSION VALUE - PV is the crucial link between current wages and pensions. It is considered to be specified to ensure that an individual with 45 RPs will obtain a pension with a 70 per cent replacement rate of average earnings:

$$PV_t = \frac{0.7 * \text{average wage}}{45} \tag{3}$$

For the simulations $\overline{CAB}_\tau$ is specified to ensure that anyone with average earnings receives 1 RP. Furthermore, AF_i is assumed to equal 1 for all i. This implies that the pension annuity considered for the simulations is defined by:

$$P_{it} = \sum_{\tau=t_0}^{T} \frac{\min\left(y_{it}, y_{\max}\right) 0.7}{45} \tag{4}$$

where y_{it} denotes the income of individual i in year t, and $y_{\max}$ is the upper earnings threshold defined above.

Unemployment insurance has also been used as an early retirement vehicle. The benefit is paid to an unemployed individual if they previously had one full year of employment, and replaces 63 per cent of their last net pay for a period of up to 3 years.

2.4 Danish Pension System[26]

The current Danish Pension system is comprised of three tiers; the state administered Public Pension (*Folkepension*), the Labour Market Supplementary Pension Scheme (*Arbejdsmarkedets tillægspension*), and Occupational and Personal Pension schemes. All pensions are treated as labour income for the purposes of taxation.

- **Public Pension:** The Public Pension is a universal benefit based upon citizenship and residency requirements, and is paid from age 65.[27] It is financed from general taxation revenues of the current work-force via a PAYGO framework, and benefits are defined with regard to the individual. The Public Pension is comprised of two rates:

  - The basic rate, or *grundbeløb*, was equal to DKK 54,204 in 2003. This is subject to a taper rate of 30 per cent on wages earned by the pensioner in excess of the basic rate threshold, equal to DKK 230,300 for a single and DKK 159,000 for a couple.

[26] Much of the material presented here is based upon Abrahamson and Wehner (2003).

[27] To be eligible, an individual must have been in residence in Denmark for at least three years, and for non-nationals 10 years including the 5 years immediately prior to the pension. The simulations assume that all citizenship and residence requirements are always satisfied.

– The Pension Supplement, or *pensionstillæg*, was equal to DKK 54,564 for a single pensioner, and reduced by 30 per cent of any income earned in excess of DKK 102,000 in 2003. For single earner couples, the Pension Supplement was worth DKK 25,464, and reduced by 30 per cent for any income earned in excess of DKK 102,000. For dual income couples, the Pension Supplement was worth DKK 25,464, and subject to a 15 per cent taper on any income earned in excess of DKK 102,000. If a spouse does not receive a pension, then 50 per cent of their income is not taken into consideration when calculating the Pension Supplement.

- **Labour Market Supplementary Pension Scheme (ATP):** The ATP is a state administered defined-contribution pension scheme that is partly funded, and partly PAYGO. Membership of the ATP is compulsory for all employees aged between 16 and 66 working nine hours or more per week.[28] ATP contributions do not depend on income, but vary with the extent of the member's association with the labour market. The normal ATP contribution (the "A" contribution) was DKK 2,684 in 2003, and is paid by most wage earners, and by contribution-paying recipients of social benefits.[29] ATP contributions are credited to a notional account, which pays a lifetime annuity from age 65. The annuity paid is equal to DKK 100 for every DKK 396 credited to an individual's notional account. Furthermore, the benefit can be deferred for a period of up to 3 years, in return for which the annuity will increase by 0.6 per cent for each month of deferral.[30] This scheme is supplemented by the *Saerlige Pensionsopsparing*, SP, which is a Defined Contribution pension that was introduced in 1999. Membership of SP is mandatory, and requires all employed individuals to pay a contribution of 1 per cent of gross income, which entitles them to a 10 year annuity at age 65.[31]

- **Occupational and Personal Pensions:** Occupational pensions in Denmark are defined by individual agreements between social partners. Membership is linked to employment, and is compulsory. As such, Occupational pensions are essentially designed as a form of collective insurance. Working members pay contributions as a percentage of their salary (between 8% and 16%), and generally receive a fully-funded defined-contribution benefit upon retirement. Individuals can also elect to create their own pension funds, referred to as personal pensions,

[28] It is also compulsory for people who receive daily allowances in case of sickness, birth, adoption or unemployment. Civil servants are administered under an alternative system. The simulation model does not take into consideration ATP contributions during periods when an individual chooses not to be employed.

[29] The simulations assume that all individuals who are employed accrue DKK 2,684 of ATP contributions during a given year.

[30] Deferrals are not taken into consideration by the simulation model.

[31] The simulation model applies the same annuity to SP as to ATP, which extends to the full lifetime.

which are subject to similar rules and tax conditions as occupational pensions. Private and Occupational pensions are simulated as a form of discretionary saving.[32]

The Danish welfare system also includes an early retirement program (*Efterlön*) for individuals between the ages of 60 and 64 who have no part-time job or social pension, and who are eligible for unemployment benefits.[33] As in the case of Germany, the Danish early retirement programme is modelled as part of the tax and benefits function defined in Subsection 2.2 for 50 to 64 year olds who are not employed.

2.5 United Kingdom Pension System[34]

The current UK pension system is comprised of three tiers. The first tier consists of the Basic State Pension, BSP; the second tier of all government run contributory pension benefits (the State Earnings Related Pension Scheme, SERPS, and the Second State Pension, S2P); and the third tier of all private pension schemes. Furthermore, Incapacity Benefit is a commonly used vehicle to fund early retirement.

- **Incapacity Benefit:** With regard to its use as a vehicle to fund early retirement, Incapacity Benefit is payable to individuals who have paid National Insurance Contributions, and have been incapable of work because of sickness or disability for at least 4 days in a row. Existing legal judgements have assigned a broad interpretation to what defines an individual as 'incapable of work'. The benefit pays £54.40 per week for the first year, and £72.15 per week for each succeeding year. Early retirement typically occurs in the UK from age 50[35], and the benefits for not working during this period are consequently modelled separately by the tax functions reported in Subsection 2.2. Note, however, that two parameters of the UK tax function for not employed households between 50 and 64 years of age were adjusted as part of the model calibrations: the estimates displayed in Table 1 for $D63$ and $D64$ were both reduced by two times the associated standard deviations to take into consideration the practical difficulties associated with obtaining the Incapacity Benefit.

[32] Bingley and Lanot (2004) report econometric estimates which suggest that Danish occupational pensions have a small effect on retirement behaviour, relative to the state pension system (although the effect reported for women is statistically significant).

[33] In principle, an individual must also be a member of an *a-kassa* for at least 25 of the preceding 30 years, although there exist some exceptions.

[34] See *A Guide to State Pensions*, Department for Work and Pensions, NP46, ISBN 1-84388-094-6, October 2003.

[35] See, for example, Blundell *et al.* (2002) for empirical evidence.

- **Basic State Pension:** The full BSP, equal to £77.45 per week for a single person and £123.80 for a couple (in 2003), is paid to individuals who have been accredited with qualifying years for approximately 90 per cent of their working lives (between age 16 and State Pensionable Age, SPA, 60 for women and 65 for men). A qualifying year is defined as one in which an individual has earned an annual income that exceeds the Lower Earnings Limit, equal to £4,004, and also includes years of unemployment, or incapacitation. This implies that most households qualify for the full BSP. For simplicity, the BSP is consequently modelled as a universal benefit. BSP is funded by PAYGO contributions of current employees. Specifically, annual income earned between £4,628 (the Employees' Earnings Threshold, EET, as at 2003), and £30,940 (the Upper Earnings Limit, UEL, as at 2003) is subject to National Insurance Contributions (NICs) of 8.95 per cent to fund the BSP.[36]

- **Second State Pension:** Until recent reforms, the benefit payable under the second tier of the UK pension system was entirely related to an individual's average earnings over their working lifetime. Membership to the second tier state pension is compulsory for all employees (but not the self-employed), unless the employee has contracted out into a private pension scheme. The second tier system was administered under the SERPS until April 2002, when it became the S2P. Upon reaching SPA, the wages earned by an individual during each year of their working life are rescaled by average wage growth, and the average determined. The average wages earned between £4,004 and £11,200 (in 2003) are multiplied by 0.46, wages between £11,201 and £25,600 are multiplied by 0.115, and wages between £25,601 and £30,940 are multiplied by 0.23.[37] The aggregate of these values determine the individual's annual S2P benefit. Unlike SERPS, individuals with incomes below the lower earnings threshold (£11,200 per year in 2003) earn S2P entitlements as if their income was at the lower earnings threshold. The S2P is PAYGO, funded through contributions of current workers at a rate of 1.6 per cent on income earned between the UEL and the EET[38]. The simulation model is specified to reflect S2P and not SERPS.

Underlying the BSP and the S2P is the Pension Credit (PC), which guarantees anyone aged 60 or over an income of at least £102.10 per week or £155.80 per week for a couple (including the BSP). The PC applies a taper rate of 40% on gross private income in excess of the full BSP. The

[36] The total NIC charged is 11%, 2.05% of which is used to fund the National Health Service (NHS). Employers are also required to pay NICs above the EET, at a rate of 12.8% (of which, 10.9% is used to fund the BSP).

[37] For example, if an individual earned the equivalent of £ 40,000 in one year, then they would be credited with £ 6,194.02 = 0.46*(11,200-4,004) + 0.115*(25,600-11,201) + 0.23*(30,940-25,601).

[38] the "contracting-out" rebate on NICs.

PC is also subject to an assets test. The first £6,000 of assets are ignored, but thereafter an income is imputed to any savings above this threshold at a rate of 10% a year. The Pension Credit is modelled as part of the tax function described in Subsection 2.2.

- **Private and Occupational Pensions:** The third tier of the UK pension system is comprised of private pension schemes, of which there are two types: occupational pensions and personal pensions. Contributions into these schemes are made out of pre-tax income, so that contributions are effectively subsidised (at the basic tax rate) by the Government. An occupational pension can usually be classified as either a 'defined benefit' scheme (where the benefits are earnings related), or as a 'defined contribution' scheme (where the benefits are related to the value of the accumulated contributions). Personal pensions are always run on a defined contribution basis. Occupational pensions play an important role in the UK pension system – forming one half of the so-called public-private partnership, they account for approximately 50 per cent of total pension entitlements.[39] Private and Occupational pensions are simulated as a form of discretionary saving.

3 The Simulation Model

A partial equilibrium dynamic microsimulation model is used to explore the influence of retirement policy on household savings and retirement decisions. A summary of the model is provided here – for full details see Sefton and van de Ven (2004). The calibrated parameters assumed for the simulation model are described in Appendix B.

The decision unit in the model is the household. Each household is aged by annual increments, from 20 to 90 based upon the age of the household's reference person.[40] In every year, the household decides whether to work full-time or not at all (households are treated as having an aggregate labour supply)[41], and how much to consume given its economic situation, under the constraint that its net worth must remain positive. A broad definition is assumed for the economic situation of a household, which includes the household's age, its size, the wealth that it has managed to accumulate, the interest rate, the level of means tested income support available, and the wage that it can command for its labour. This wage rate evolves stochastically.

[39] See, for example, Blake and Orszag (1997, table 12).

[40] See The *Family Expenditure Survey 2000-2001 User Guide*, Vol. 1 for the definition of a household reference person.

[41] An alternative version of the model allows households to work part-time. This option is omitted here to focus attention upon the issue of retirement.

The household is forced to retire by state pensionable age, if it has not already chosen to do so. In retirement the household pays for its consumption out of its savings, or out of income derived via pensions and investments.

Simulated households are described by 7 characteristics:

1. the number and age of household members.
2. time of death.
3. the human capital of the household.
4. the labour supply of the household.
5. household consumption.
6. household wealth.
7. household (mandatory) Defined Benefit (DB) pension entitlement.

Demographic Size and Composition: The size of each household varies with time to reflect the coupling of individuals, and the birth and aging of children who eventually leave home. Household size is, however, modelled in a pre-determined fashion, and consequently behavioural effects are not considered in this dimension. For models of endogenous fertility, see Nerlove *et al.* (1984), and Barro and Becker (1989).

Household Mortality: Each household is selected to die, based upon an exogenously defined survival function. Importantly, households do not know *a priori* when they will die, they only know the simulated survival function. This means that the model is able to capture the precautionary savings that households are likely to accrue in practice to offset the effects of uncertain life expectancy. The model does not, however, include any endogeneity of the survival probabilities that might be expected to exist with, for example, household wealth.

Human Capital: A household's labour income is equal to their human capital multiplied by their labour supply. The human capital of a household is simulated as a stochastic process using a regression toward the mean model that adjusts for a learning-by-doing effect. As in the case of mortality, households are assumed to know the process by which human capital evolves, but are unable to predict future income perfectly due to its stochastic nature.

Labour Force Status, Consumption, and Wealth: Household decisions regarding labour supply, consumption and saving are endogenous to the model. As this is a fundamentally important aspect of the simulation model, a detailed description of the methods involved is provided in the following subsection.

3.1 Labour Force Status, Consumption, and Wealth

Households choose their labour supply and consumption in every period. These choices are made as if they are maximising their expected utility subject to a budget constraint. The expected lifetime utility is described by the additively separable function:

$$U = E\left(\sum_{i=t}^{70} u\left(\frac{c_t}{m_t}, l_t\right)\delta^{i-t}\phi_{i-t,t}\right) \tag{5}$$

where $c_t \in R^+$ is household consumption, $m_t \in R^+$ is the household's adult equivalent size, and $l_t \in [0,1]$ is household leisure at time t.[42] The parameter δ is the discount factor (which is assumed to be time independent). From the state pensionable age, $t_P = 65$, the household is forced to retire – that is $l_t = 1$ for all $t \geq t_P$.

A Constant Elasticity of Substitution (CES) utility function is assumed, which is defined by:

$$u(C_t, l_t) = \frac{1}{\left(1-\frac{1}{\gamma}\right)}\left(C_t^{\left(1-\frac{1}{\rho}\right)} + \alpha^{\frac{1}{\rho}} l_t^{\left(1-\frac{1}{\rho}\right)}\right)^{\frac{1-1/\gamma}{1-1/\rho}} \tag{6}$$

where γ is the inter-temporal elasticity of substitution and ρ is the elasticity of substitution between $C_t = c_t/m_t$ and l_t. The higher the value of ρ, the higher the proportional change between consumption and leisure for a given proportional change in prices. Similarly, the larger the value of γ, the higher the proportional substitution between consumption today and consumption tomorrow for a given change in interest rates. Wealth in any period, W_{it}, is constrained to be non-negative, and is given by:

$$W_{it+1} = W_{it} - c_{it} + y_t^{DI}(W_{it}, y_{it}, m_{it}) \tag{7}$$

where $y_t^{DI}(W_{it}, y_{it}, m_{it})$ is the disposable post-tax and benefit income obtained by a household of age t given wealth W_{it}, pre-tax income y_{it}, and equivalence size m_{it}. Pre-tax income is obtained from real returns to investment, RW_{it}, from labour during the working lifetime, $h_{it}(1-l_{it})$, and from Defined Benefit pension rights during retirement, S_{it}:

$$y_{it} = RW_{it} + h_{it}(1-l_{it}) + (S_{it} | t \geq t_P) \tag{8}$$

[42]See, for example, Balcer and Sadka (1986), and Muellbauer and van de Ven (2003) on the use of this form of adjustment for household size in the utility function.

4 Analysis of Retirement Behaviour

Simulated data for the UK are compared with associated survey data, before reporting the impact on retirement behaviour of replacing the UK transfer system with comparable elements of the contemporary systems that are applied in Germany and Denmark.

4.1 Simulated and Survey Data for the UK

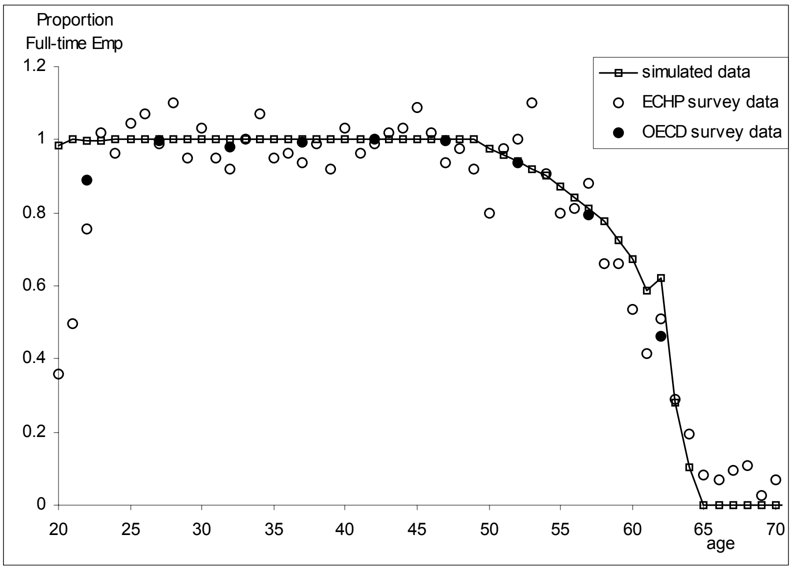
The current analysis focusses upon retirement behaviour with regard to age, wealth and income, subject to tax and benefits policy for 2003. It is consequently useful to compare the simulated data, with data that describe the 2003 population cross-section. Unfortunately, the most recent year for which comprehensive data are currently available is 2000, and hence data for the 2000 population cross-section are considered here.

The data used are drawn principally from the 7th wave of the ECHP (10th wave of the British Household Panel Survey, BHPS). This wave of data is particularly useful in the current context because it provides comprehensive information regarding household wealth in the UK.[43] Where more recent data were available at the time of writing, they have been included for comparison.

It may be argued that cross-sectional data do not describe the actual life experience of any actual cohort, and that this detracts from the practical relevance of the analysis undertaken. The implications of the current focus on cross-sectional data are, however, limited by the Markov process that is assumed for the simulation model. The assumption of a Markov process implies that the calibrated model embodies three important assumptions. First, that individuals make their decisions regarding actions at any time $t+1$, with regard to their observed state in the immediately preceding period t and expectations regarding their future. Second, that discount rates and utility function parameters are constant across cohorts. And third, that expectations regarding the future are formed purely on the basis of current cross-section characteristics. These assumptions warrant further comment.

The first two of the above assumptions are artifices of the framework that is used to simulate behaviour. Specifically, the structure of the model implies that heterogeneity of historical experience is fully characterised by state variables of the model. Furthermore, given the uncertainty that is associated with demographic trends and income growth, the assumption that expectations are based upon the current cross-section does not appear inappropriate. The focus on cross-sectional survey data does, however, imply that care should be exercised when interpreting statistics that aggregate

[43] See van de Ven (2004) for details.



ECHP Survey data	Average employment status reported for UK household heads in 2000/01 wave of ECHP
	Adjusted to full employment for 25 to 45 year olds
OECD Survey data	Activity rates for UK Men and Women in 2002 – 5 year age groups allocated to mid-points
	Activity rates adjusted to ensure full participation for 40-44 year old age group

Figure 1: Labour Participation for the UK – Simulated and Survey Data

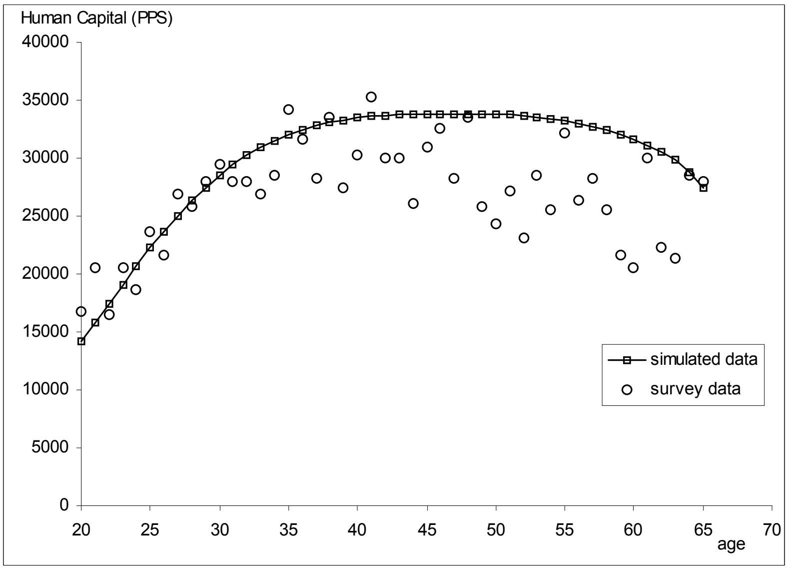
over the simulated lifetime. Although the simulated profiles are behaviourally consistent, they do not describe the experience of any actual cohort. As such, the simulated profiles are better suited to consider broad effects of policy over the lifetime, rather than the fine detail.

Figure 1 displays average labour participation rates by age, derived from simulated data, and described by ECHP and OECD data.[44] Data reported in the figure reveal that simulated early retirement begins at age 50, and progresses so that approximately one third of the population (32.6 per cent) has departed the workforce by age 60, and 28 per cent are identified as working by age 63. This trend of departure from the labour force is broadly consistent with both the ECHP and OECD data displayed in Figure 1.

Figures 2 and 3 suggest that the simulation model reflects the relationship between household income and age described by cross-sectional data fairly closely. The observed disparity between the simulated household take-home pay and the associated survey data over age 64 is attributable to the fact that households are forced to retire by age 65 in the simulation model, but may continue to draw upon labour income at higher ages in practice.[45]

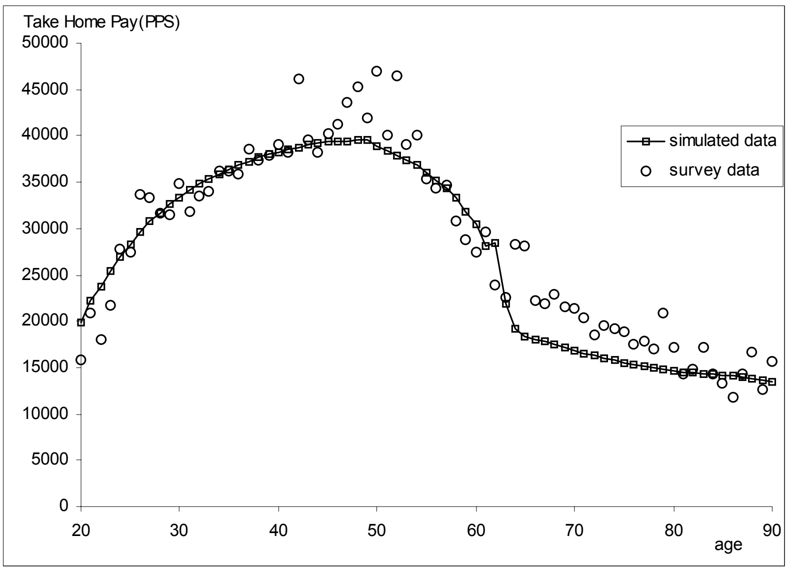
[44] Data from the ECHP and OECD are adjusted to reflect the fact that involuntary unemployment is not included in the simulations presented here.

[45] The associated survey data were obtained from the Family Expenditure Survey (FES) due to the finer detail that that survey provides regarding the definition of household income. See Appendix A for details regarding the



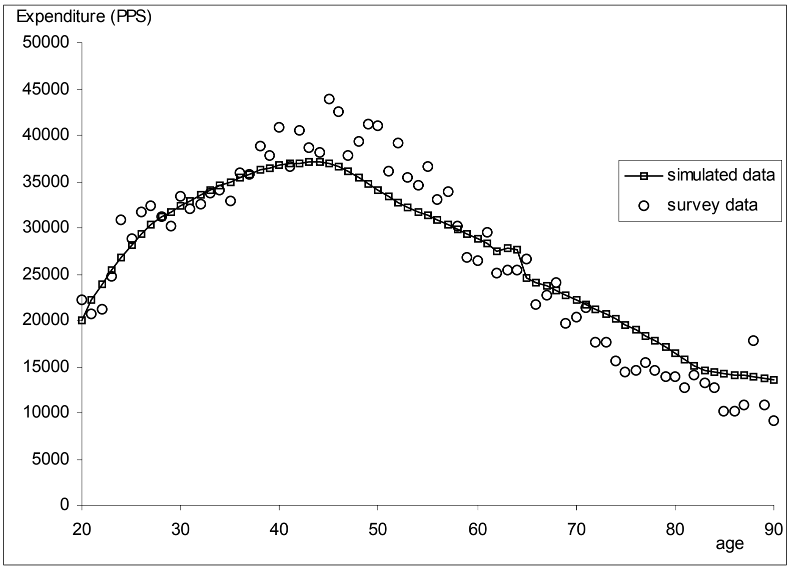
Survey data: Geometric mean of full-time wages reported for UK household heads in 2000/01 wave of ECHP

Figure 2: Human Capital for the UK – Simulated and Survey Data



Notes: Survey data – average post-tax and benefit income reported for UK households in 2000/01 wave of FES

Figure 3: Household Take Home Pay for the UK – Simulated and Survey Data



Notes: Survey data – average household expenditure reported for UK households in 2000/01 FES

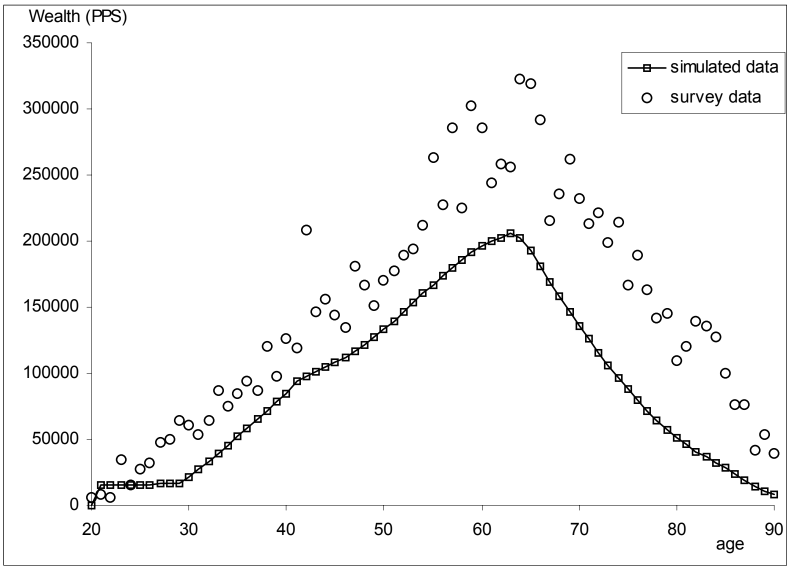
Figure 4: Expenditure for the UK – Simulated and Survey Data

Figure 4 reports simulated household expenditure against expenditure data described by the 2000/01 Family Expenditure Survey (FES). FES survey data were used in response to the fact that the measures of household expenditure recorded by the ECHP (BHPS) are notoriously poor. Figure 4 indicates that the humped shaped profile of household expenditure described by survey data is approximately reflected by the simulation model, although expenditure appears to be under-predicted systematically between ages 38 and 57, and over predicted for ages above 71. This latter observation can be explained by the fact that simulated households die with certainty by age 90.

Household wealth that is generated by the simulation model is defined to include all financial and housing assets, and accrued rights to the S2P, personal and occupational pensions. The methods used to impute these data from the ECHP (BHPS) are described in van de Ven (2004). Figure 5 reports the simulated data against the wealth data derived from the ECHP. This figure suggests that the simulation model captures the humped shaped profile that can be inferred from survey data. In the case of wealth, however, the simulations systematically under-predict observations drawn from survey data for almost all ages, an observation that warrants extended comment.

The wealth comparisons between the simulated and survey data referred to above are, in a sense, inconsistent with the associated income and expenditure comparisons – if the simulated income (inflow of wealth) and expenditure (outflow of wealth) profiles with age match survey data reasonably well throughout the lifetime, then the same should be approximately true for (the stock

FES.



Survey data: Average household wealth reported for UK in 2000/01 wave of ECHP

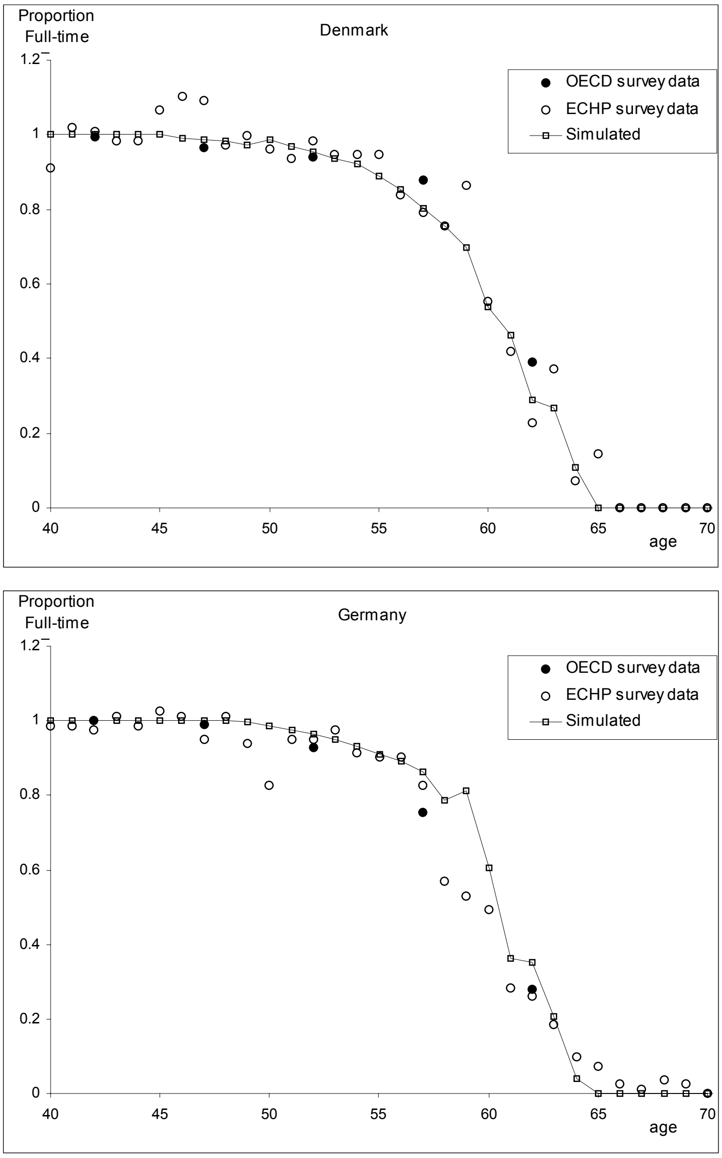
Figure 5: Wealth for the UK – Simulated and Survey Data

of) wealth. It is clear something is missing from the system. Two considerations are of particular note here. First, the survey data against which the simulation model is compared are drawn from a single cross-section, and hence do not describe the experience of any one cohort (as discussed above). And second, the cross-section used for calibration had experienced a particularly high real rate of return as a result of the stock market boom of the 1980s and 1990s Given that this high rate of return is unlikely to persist over the longer-run, the simulation model is based upon a more realistic return of 5%.

4.2 Incentive Effects for Retirement Behaviour of Danish and German Fiscal Policies

The preceding subsection reveals that the simulation model generates a close reflection of UK survey data when the UK tax and benefits system as described in Section 2 is applied. We address the first of our questions, how far retirement behaviour in Denmark, Germany and the United Kingdom is affected by the benefit environment by exploring what choices UK households would make if subject to first the Danish and secondly the German transfer system. Given the current focus on retirement behaviour, discussion of this question begins with associated figures that display the impact on labour supply.

Figure 6 displays simulated data regarding labour supply by age for the German and Danish transfer systems, and associated ECHP and OECD survey data. The top and bottom panels of



ECHP Survey data	Average employment status reported for household heads in 2000/01 wave of ECHP, by country
	Adjusted to full employment for 29-48 (DK) and 38-48 (DE) year olds
OECD Survey data	Activity rates for Men and Women in 2002 – 5 year age groups allocated to mid-points, by country
	Activity rates adjusted to ensure full participation for 30-34 (DK) and 40-44 (DE) year old age groups

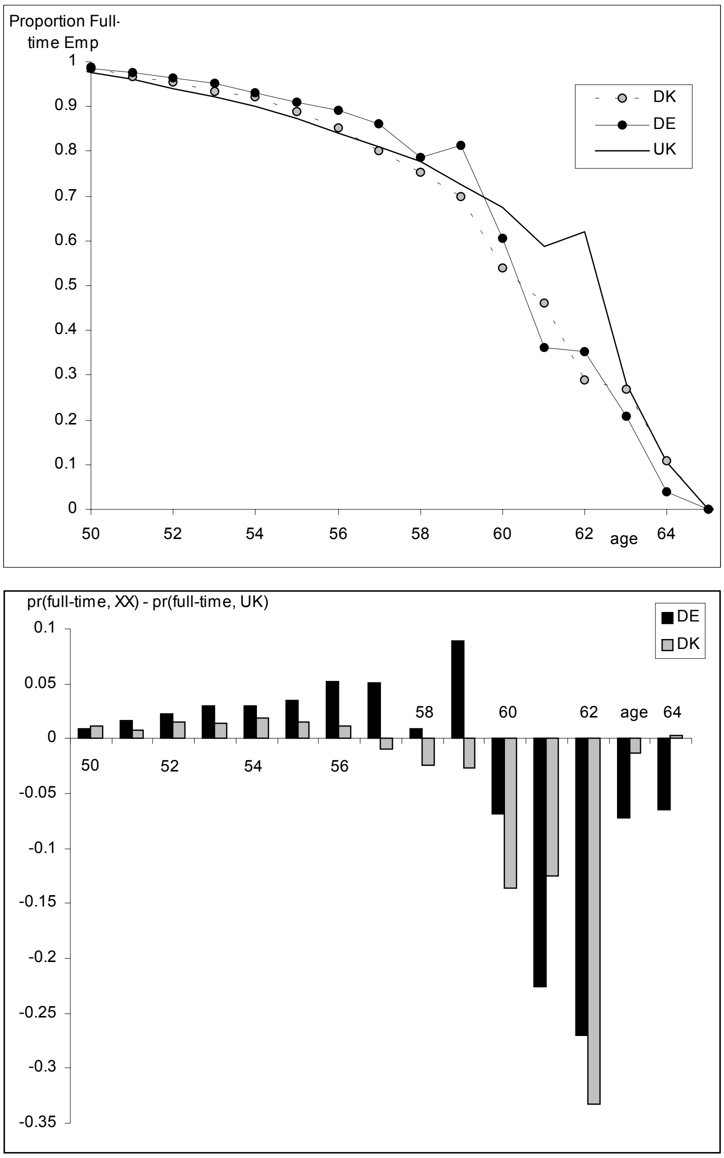
Figure 6: Simulated Labour Supply under the German and Danish Transfer Systems

the figure indicate that, despite its obvious simplicity, the model does a reasonable job of capturing the incidence of early retirement in Germany and Denmark. The reflection of survey data by the simulation model is particularly close for the Danish transfer system, where the simulated timing of retirement does a surprisingly good job of capturing the ECHP data. In the case of simulations based upon the German transfer system, the simulation model predicts a slightly longer working life than exhibited by survey data. This disparity is particularly evident for 58 and 59 year olds, and may reflect a deficiency in the methods used to simulate the impact of the German retirement system.

Figure 7 presents data that are useful for considering the predicted answer of the simulation model to the question: What would be the effect on the timing of retirement if selected elements of the UK transfer system were replaced by comparable elements of the contemporary systems that are applied in Germany and Denmark? The top panel of Figure 7 reports the proportion of the simulated cohort that was identified as full-time employed, by age and simulated transfer system. The bottom panel is obtained from the top panel by subtracting the age specific proportion of the population identified as full-time employed under the UK transfer system, from the associated proportions identified when subject to the German and Danish transfer systems respectively. The bottom panel of the figure consequently highlights the simulated effect on early retirement of exchanging the UK transfer system with elements of the German and Danish transfer systems. Data are presented here for the 50 to 65 year age band to focus upon the issue of early retirement.[46]

Figure 7 indicates that exchanging the UK transfer system with those of Germany and Denmark increased simulated labour supply slightly between ages 50 and 56, and resulted in accelerated early retirement between ages 60 and 64. These observations are approximately consistent with the associated ECHP and OECD survey data that are considered above. In the case of OECD data, for example, the unadjusted activity rate of 45 to 49 year old men and women in 2000 was 85 per cent for the UK, and slightly higher at 88 per cent for Germany and Denmark. Furthermore, the participation rate of 50 to 54 year old men and women was substantially lower for the UK (80 per cent), compared with the same data for Denmark (85 per cent) and Germany (84 per cent). By the 55 to 59 age group, the OECD data indicate that the UK and Germany have similar participation rates (67 per cent), and Denmark has a substantially higher rate of participation (80 per cent). However, the UK has the highest participation rate of the three countries for the 60 to 64 year old age group, taking a value of 39 per cent relative to 35 per cent for Denmark, and 25 per cent for

[46] It should be noted that the limited calibrations undertaken for the tax function of the working lifetime mean that the model fails to capture important labour supply effects at the time of labour-market entry (to age 29 for DK, and age 38 for DE).



Notes: pr(full-time, XX) = proportion of population full-time employed by age, country = XX

Simulated Data

Figure 7: Impact on Timing of Retirement of Alternative Transfer Systems

Germany – the UK has slightly lower labour market participation at the earliest ages of retirement, but is overtaken by Germany and Denmark at the 60-64 age group.

It is useful to consider how the respective transfer systems affect post-tax income, household wealth, and expenditure to gain some insight into the labour market effects discussed above. In this respect, Figure 8 is particularly interesting. The top panel of the figure indicates that pre-tax and benefit income simulated under the three alternative policy regimes is very similar, which is a fundamental aspect of the analytical framework adopted. The bottom panel of Figure 8 suggests that, compared with the German and Danish transfer systems (which have a very similar impact on pre-tax income), the UK transfer system imposes a lower average tax burden on working households, and provides a smaller pension during retirement. These two effects of transfer policy act to encourage continued labour force participation in old age in the UK as observed. Comparing take-home pay simulated under the German transfer system with take-home pay simulated under the Danish system suggests that, although the two transfer systems embody quite different value judgements, they have a similar impact on average post-tax income, and Figure 6 suggests that they also have a similar effect on the timing of retirement.

An additional implication of the income data displayed in Figure 8 is that the UK transfer system places a greater emphasis on self provision for retirement than either the German or Danish transfer systems. The impact that this has upon simulated behaviour is displayed in Figure 9. Figure 9 indicates that households save more under the UK transfer system, than under either the German or Danish transfer system (between which savings are very similar). This reflects the substantial role played by private and occupation pensions in the UK relative to both Germany and Denmark.

In summary, the simulated behavioural responses to tax and benefit policy imply that exchanging the UK transfer system with the German or Danish transfer systems would have a weak trend toward earlier retirement. The most important effect of the policy experiments considered here is on household savings, which adjust to compensate for the alternative generosity of the respective pension policies considered. This result serves to underscore the potential importance of including savings and household wealth in an analysis of retirement behaviour.

The smoothing effect of household savings is underscored by measures of average annual expenditure calculated under the three policy regimes, displayed in Figure 10. This figure indicates that the simulated profiles of household expenditure are very similar for all three policy regimes, where the most important difference is attributable to the simulated wealth constraint. The simulation procedure adopted implies that households face a less binding wealth constraint following retirement under the UK transfer system, due to the lower proportion of their savings that are

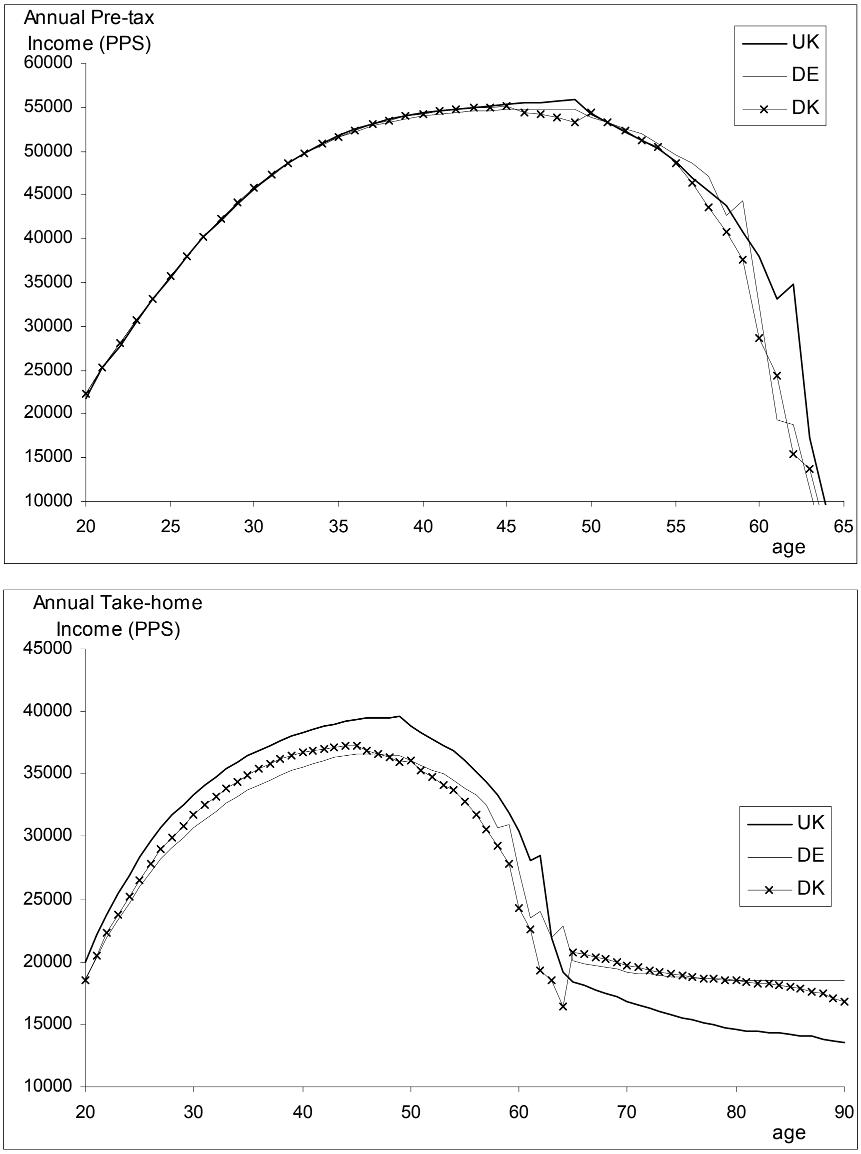


Figure 8: Household Take-home Pay by Age and Transfer System – Population Averages

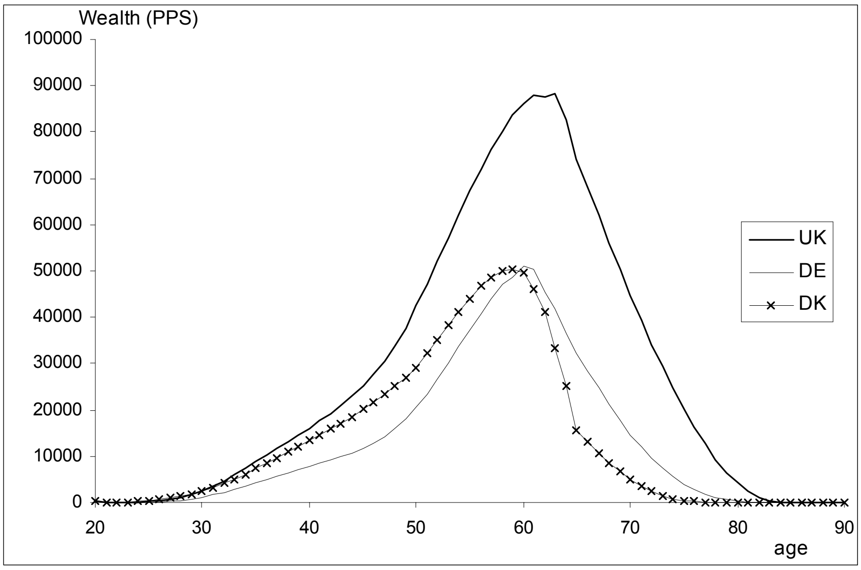


Figure 9: Household Wealth by Age and Transfer System – Population Average

annuitised. Consequently, households choose to shift some of their consumption from retirement to their working lifetime under the UK transfer system, relative to the German and Danish transfer systems. This last observation has potentially important welfare implications.

Specifically, Figure 10 reveals that the larger pension benefits of the German and Danish transfer systems, in a sense, force households to save more than they would otherwise choose to, pushing expenditure into a later part of the simulated lifetime. The justification for this government intervention is directly related to the fundamental justification of public pension provision. If, for example, a government is bound by political pressure to ensure that every one of its citizens is able to afford some minimum threshold expenditure, then there exists an implicit minimum income guarantee. To off-set the saving disincentives that are associated with a minimum income guarantee[47], the government may elect to force individuals to make sufficient provision for their own retirement – via a public pension system – to prevent them from falling below the assumed threshold. The higher average benefits provided by the German and Danish pension systems suggest that the 'political thresholds' of those countries are higher than the threshold is in the UK.

[47]Benefits associated with a minimum income guarantee are assumed to be subject to a 100 per cent taper rate on any private income earned.

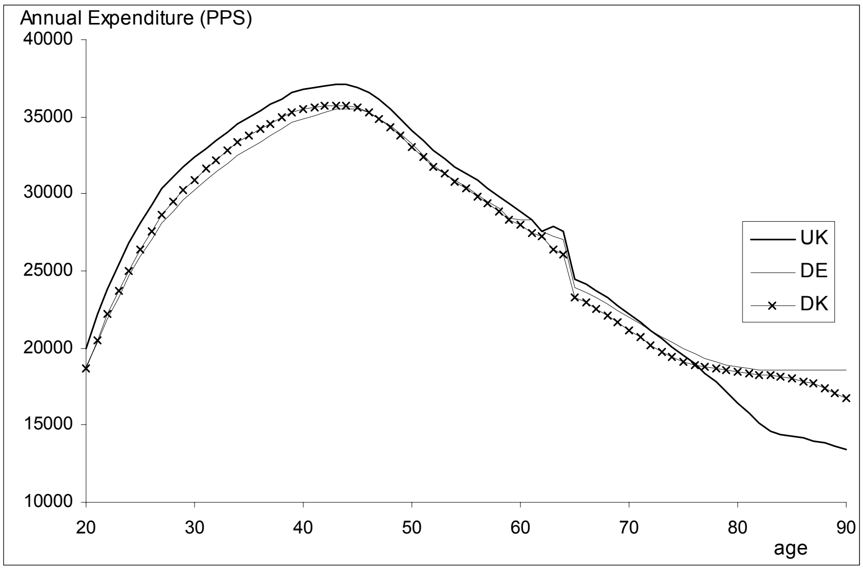


Figure 10: Household Expenditure by Age and Transfer System – Population Average

4.3 Implications of Alternative Health Profiles

Our second question concerned whether deterioration in health was likely to have an impact on these conclusions. The impact of health on the policy analysis undertaken here is best accommodated by appropriate recallibration of the equivalence scales that are imposed. However, estimates for the necessary adjustments are scarce, due to limitations of existing survey data. The most recent paper that presents estimates for the equivalence scales of health related characteristics in the UK is by Jones and O'Donnell (1995). They use data taken from the 1986–87 Family Expenditure Survey to estimate the impact of disability on household costs. Jones and O'Donnell (1995) present a range of equivalence scale estimates, the most compelling of which (for current purposes) suggests that physical disability increases household costs by 45 per cent.[48] The equivalence scale considered here is adjusted by Jones and O'Donnell's point estimate for health costs, as described by:

$$a_{i,t} = a_{i,t}^{*}\left(1 + \left(a_H - 1\right) pr_t\right) \tag{9}$$

where $a_{i,t}^{*}$ denotes the McClement's scale that is considered by the analysis presented in the preceding subsection, $a_H = 1.45$ is the health related scale estimated by Jones and O'Donnell (1995), and pr_t is the proportion of the UK population reported with limiting longstanding illness[49]. These data are displayed in Figure 11.

[48] Based upon Engle curve estimates for consumption of "transport".

[49] The proportion of the population with limiting longstanding illness is the average of the figures reported by age in the 1992, 1996 and 2000 General Household Surveys.

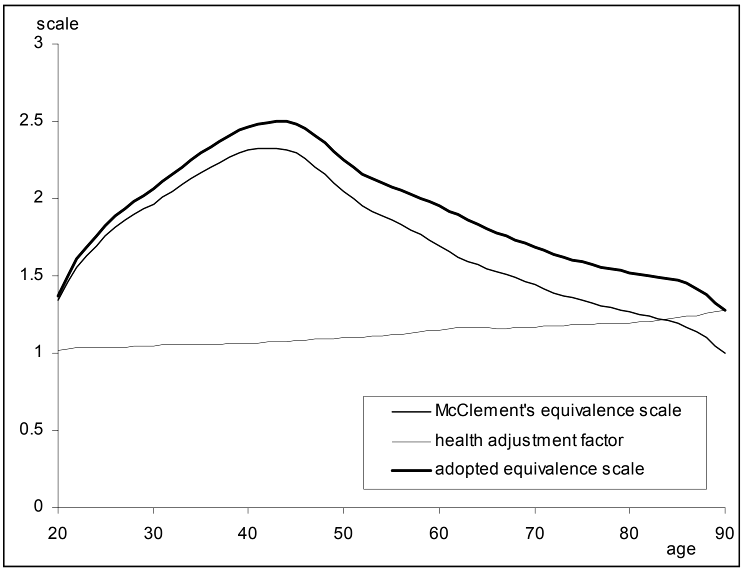


Figure 11: Equivalence Scales Adjusted for Estimated Household Health Costs

We focus here upon the impact of the simulated timing of retirement. Figure 12 displays three simulated series of employment data for the UK transfer system: one that repeats data reported in the preceding subsection (Equivalence Scales Omitting Health Effects); one that was simulated with the health adjusted equivalence scales reported in Figure 11 but leaves all other model parameters as they were in the preceding subsection (Equivalence Scales with Health Effects); and one that was simulated using the health adjusted equivalence scales and adjusting an associated utility function parameter to reflect survey data, as is discussed below.

The series reported in Figure 12 reveals that including the effects of age dependent health care in the analysis, *ceteris paribus*, induces simulated households to work longer. This is consistent with the higher costs that households face during retirement to fund a given level of utility. To match the employment profile described by survey data, it was consequently necessary to increase preferences for leisure. This was achieved by increasing the utility parameter α, described by equation (6), from 0.00121 to 0.00130.

Comparing the two panels of Figure 13 with those of Figure 7 reveals that similar profiles of labour exit were simulated with and without taking into consideration the costs of health care. Both figures suggest that employment participation between ages 50 and 59 is highest when the population is subject to the German transfer system, and lowest when subject to the UK transfer system. Both figures suggest that between ages 60 and 64 employment participation is highest when the population is subject to the UK transfer system. These results, as stated previously,

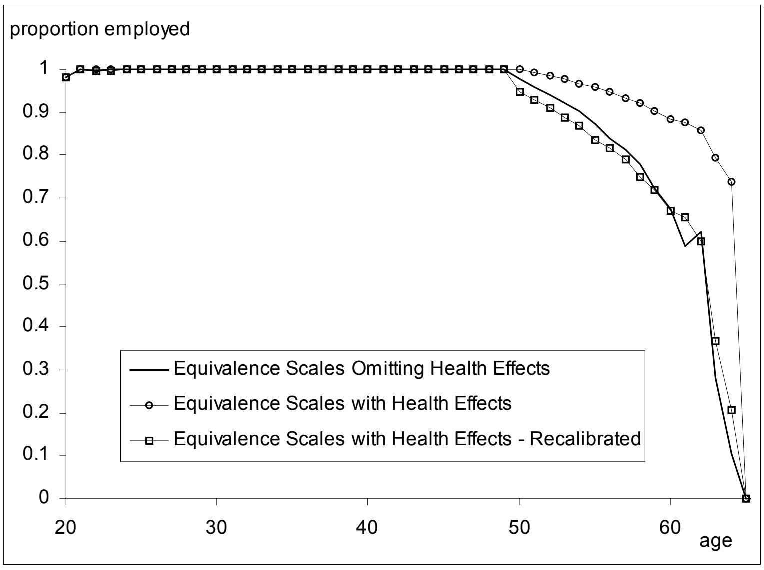


Figure 12: Simulated Employment by Age – UK Transfer System

are consistent with employment statistics reported by the OECD for the respective countries, and suggest that the findings are not particularly sensitive to the value judgements made with regard to the equivalence scales assumed.

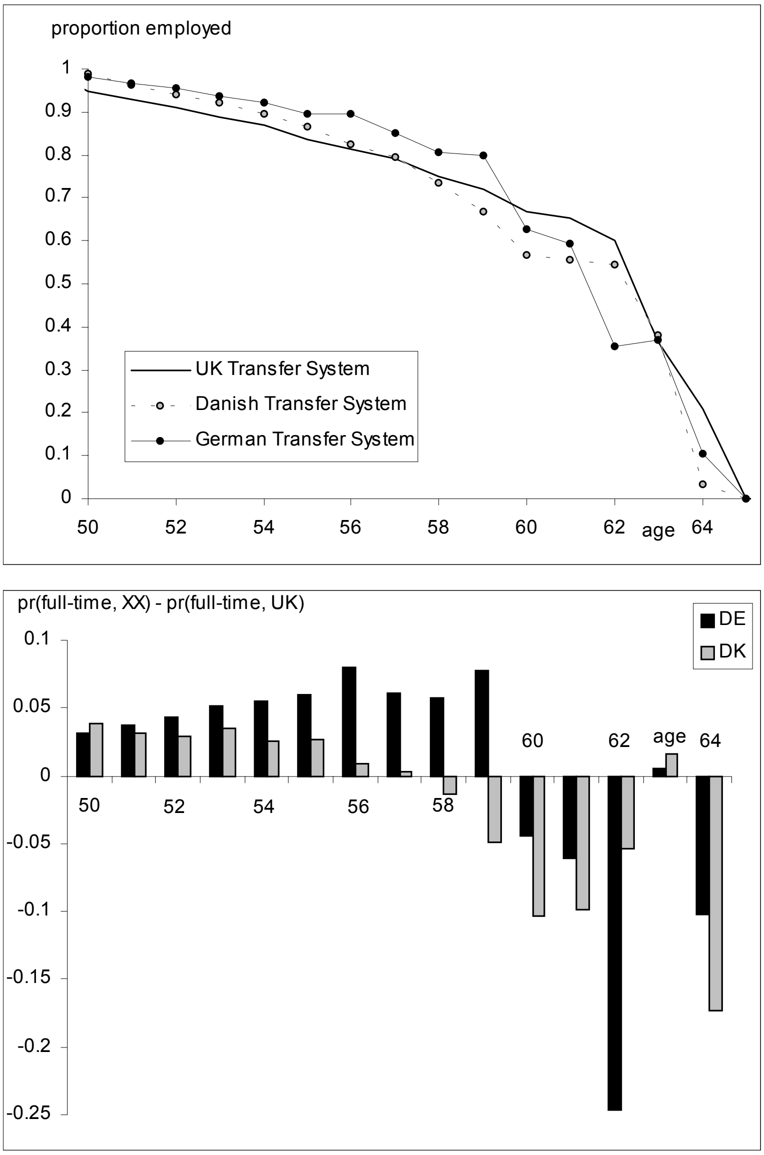
It is noteworthy that poor health, in all cases, leads to increased employment participation. This may seem superficially counter-intuitive, but actually the reason is obvious. The prospect of poor health raises the effective cost of living of people in older age. As a consequence old workers need to save more for their retirements in order to support a given standard of living. Thus average participation of old and older workers in the labour force is increased[50].

5 Macro-economic Implications and Voter Preferences

In this section we explore the effects of the different schemes on people's welfare at different points in their lives. The latter figures, unlike comparisons of disposable income, take account of discounted welfare over the whole of the remaining life-span and allow for the fact that people respond to the tax/benefit environment by varying both labour supply and savings decisions. The implications of the latter cannot be properly reflected in models subject to the Lucas critique.

Table 2 summarises the impact of the different benefit systems on labour force participation, with the figures measured relative to the prime age participation rate in the United Kingdom.

[50] We have made these calculations using only UK data on health because there is considerable uncertainty about the international comparability of these data. Thus even if everything else is equal, the impact of reported poor health in Germany or Denmark on the cost of living is likely to be quite different.



Notes: pr(full-time, XX) = proportion of population full-time employed by age, country = XX

Simulated Data

Figure 13: Impact on Timing of Retirement of Alternative Transfer Systems – Includes the Impact of Health Costs

Table 2: Labour Force Participation Rates with the Three Benefit Systems

Age Group	Transfer System		
	UK	DK	DE
Good Health			
45-49	1.00	0.99	1.00
50-54	0.94	0.95	0.96
55-59	0.81	0.80	0.85
60-64	0.45	0.33	0.31
Health Adjusted			
45-49	1.00	0.98	1.00
50-54	0.91	0.94	0.95
55-59	0.78	0.78	0.85
60-64	0.50	0.42	0.41

It is plain that the participation rates among old workers are substantially reduced in Denmark and Germany. The table also shows the impact on participation of poor health, using country-specific health data and the equivalence scales of Section 4.3. These show higher labour-force participation than does the standard model because poor health effectively raises the cost of achieving a particular standard of living and thus also the marginal utility associated with any particular level of consumption. In both cases it is clear, as Figures 1 and 6 already show, that differences in labour force participation can largely be explained by differences in benefit structure.

Both the differences in the underlying costs of the schemes and the differences in the participation rates they induce affect the budgetary implications of the schemes. Table 3 shows the net budgetary contribution made by people in quinquennial age groups and also the total life-time contribution. The figures are calculated for each age group and weighted by the size of the age group in a steady state population with death rates as implied in official life tables. The total contributions are shown both discounted back to the beginning of working life and without discounting. These figures are all positive, reflecting the fact that only a part of taxation is used to pay for benefits; the surplus goes to pay for the other services governments provide. The similar net positions in the UK and Denmark mask the fact that in Denmark both contributions and benefits are higher. The health adjusted figures show higher net surpluses because, as the participation figures implied, the prospect of poor health in old age stimulates labour force participation among those of working age.

Finally we explore the welfare implications of the different schemes. Our model allows us to identify who gains and who loses with each of the systems in place. Thus we can explore the preferences of the median voter in each age group and also in the economy as a whole. Table 4 shows the preferences of the median voter. The figures are calculated for each age of life separately.

Table 3: Budgetary Effects of the Three Benefit Systems

Age Group	Transfer System		
	UK	DK	DE
Good Health			
20-24	364.85	526.76	550.54
25-29	842.13	1004.89	1067.58
30-34	1227.21	1370.52	1463.44
35-39	1400.49	1527.88	1621.08
40-44	1416.14	1561.71	1613.15
45-49	1410.26	1531.39	1591.34
50-54	1236.35	1498.69	1473.95
55-59	913.60	1072.68	1173.86
60-64	72.18	-198.43	-519.61
65-69	-1043.49	-1410.91	-1312.27
70-74	-879.71	-1161.53	-1118.70
75+	-1259.19	-1614.86	-1624.93
All Ages Total	5694.96	5702.96	5973.60
All Ages Discounted	3255.97	3704.92	3880.01
Health Adjusted			
20-24	361.64	526.71	547.39
25-29	843.07	1004.80	1067.04
30-34	1234.12	1372.83	1464.89
35-39	1415.27	1535.02	1625.51
40-44	1439.09	1574.88	1620.99
45-49	1441.04	1539.62	1601.70
50-54	1157.74	1474.89	1451.69
55-59	862.02	1018.65	1173.33
60-64	194.74	28.52	-228.73
65-69	-1033.95	-1408.36	-1322.63
70-74	-872.79	-1161.25	-1128.18
75+	-1253.34	-1616.91	-1639.84
All Ages Total	5782.81	5883.55	6227.32
All Ages Discounted	3271.74	3732.54	3914.79

Thus within a five-year age band there are five median voters and we show the proportions in which they allocate their votes. The overall votes are calculated by weighting the median vote in each age by the size of the cohort. Thus they show what the overall outcome would be if the voters were presented with the choice between the systems.

We can see that the Danish system attracts few votes. Voters prefer the UK system when they are young and the German system when they are old. The reason for this is quite straightforward. Young voters favour the low tax rates in the UK while old voters favour the generous benefits offered by the German system. The switch over point occurs at 45 in the case where voters have good health. Nevertheless, if we look at the welfare of a voter starting its working life at the age of twenty, welfare is higher with the UK than with the German system and a benevolent social planner would therefore adopt the UK rather than the German system. The difference between the two choices arises because children under twenty including those not yet born are affected by the choice of regime. *A fortiori* they should be expected to prefer the UK system. Their preferences do not, however, enter into the median voter analysis. These calculations are performed for a stable population. As the post-war population bulge passes the age of forty-five, the German system is likely to become harder and harder to reform and the UK may experience increased pressure to move towards something similar to the German structure.

Table 4: Median Voter Preferences

Age Group	Transfer System		
	UK	DK	DE
Good Health			
20-24	100	0	0
25-29	100	0	0
30-34	100	0	0
35-39	100	0	0
40-44	100	0	0
45-49	0	0	100
50-54	0	0	100
55-59	0	0	100
60-64	0	0	100
65-69	0	0	100
70-74	0	0	100
75+	0	0	100
All Ages	44	0	54
Welfare 20yo	411	406	403
Health Adjusted			
20-24	100	0	0
25-29	100	0	0
30-34	100	0	0
35-39	100	0	0
40-44	100	0	0
45-49	10	0	90
50-54	0	0	100
55-59	0	0	100
60-64	0	0	100
65-69	0	0	100
70-74	0	0	100
75+	0	0	100
All Ages	46	0	54
Welfare 20yo	374	370	368

6 Conclusions

We find that in broad terms differences in labour force participation by people in the years leading up to retirement can be accounted for by differences in the benefit systems in place in Denmark, Germany and the United Kingdom. However, taking benefits in Denmark at their face value and without exploring the other aspects of the benefit system we find that incentives to work are week for people of all ages. We make the assumption that benefits availble to people of working age in Denmark are worth only 75% of their true value; in fact the high labour supply is probably achieved by a combination of a strong work ethic and a policy of limiting the duration of some benefits and encouraging people to work in other ways.

The assumption that people's welfare is affected by their state of health has the effect of raising the cost of living in old age- at least on a probabilistic basis. This in turn raises labour force participation among people close to retirement because the expenses associated with achieving any particular living standard after retirement are increased. However in broad terms conclusions about the relative effects of the different welfare schemes are not affected.

We find that the tax/transfer system is cheapest in the UK (seen in terms of net payment to the government discounted to the start of working life) and most expensive in Germany. However this, of course, reflects the fact that it is not possible to distinguish betweend ifferent forms of taxation. The higher tax burden means that young voters prefer the UK system to the German system. However voters over forty-five typically prefer the German system and the degree of longeivty is such that, even for a steady-state population, such voters will be in the majority. This draws attention to obvious political problems which countries with generous pension systems may find difficult to address.

7 References

Anderson, K.H., Burkhauser, R.V. & Quinn, J.F. (1986), "Do retirement dreams come true? The effect of unanticipated events on retirement plans", *Industrial and Labor Relations Review*, 39, pp. 518-526.

Abrahamson, P. & Wehner, C. (2003), *Pension Reforms in Denmark.* Department of Sociology, University of Copenhagen.

Barro, R.J. & Becker, G.S. (1989), "Fertility choice in a model of economic growth", *Econometrica*, 57, pp. 481-501.

Balcer, Y. & Sadka, E. (1986), “Equivalence scales, horizontal equity and optimal taxation under utilitarianism”, *Journal of Public Economics*, 29, pp. 79-97.

Berkovec, J. & Stern, S. (1991), “Job exit behavior of older men”, *Econometrica*, 59, pp. 189-210.

Bingley, P. & Lanot, G. (2004), “Employer pay policies, public transfers and the retirement decisions of men and women in Denmark”, *European Economic Review*, 48, pp. 181-200.

Blake, D. & Orszag, J.M. (1997), *Portability and Preservation of Pension Rights in the UK.* Report of the director-general’s inquiry into pensions, 3. London: Office of Fair Trading.

Blau, D.M. (1994), “Labor force dynamics of older men”, *Econometrica*, 62, pp. 117-156.

Blöndal, S. & Scarpetta, S. (1998), “The retirement decision in OECD countries”, *OECD Economics Working Paper*, ECO/WKP(98)15.

Blundell, R. & Emmerson, C. (2003), “Fiscal effects of reforming the UK state pension system”, *Institute for Fiscal Studies Working Paper*, WP03/13.

Blundell, R., Meghir, C. & Smith, S. (2002), “Pension incentives and the pattern of early retirement”, *Economic Journal*, 112, pp. C153-C170.

Börsch-Supan, A.H. & Wilke, C.B. (2003), “The German public pension system: How it was, how it will be”, *NBER Working Paper.*

Burtless, G. (2004), Pension Reform and Labor Force Exit: Cross-National Evidence. Draft prepared for the *International Forum of the Collaboration Projects* meeting. Tokyo: Japan.

Burtless, G. (1986), “Social security, unanticipated benefit increases, and the timing of retirement”, *Review of Economic Studies*, 53, pp. 781-805.

Burtless, G. & Moffitt, R. (1984), The effect of social security benefits on the labor supply of the aged. In *Retirement and Economic Behaviour.* Edited by H. Aaron & G. Burtless. Washington: Brookings Institute.

Chan, S. & Stevens, A.H. (2004), “Do changes in pension incentives affect retirement? A longitudinal study of subjective retirement expectations”, *Journal of Public Economics*, 88, pp. 1307-1333.

Coile, C. & Gruber, J. (2000), “Social security and retirement”, *NBER Working Paper*, 7830.

Conde-Ruiz, J.I. & Profeta, P. (2003), "What social security: Beveridgean or Bismarckian?", *Università Bocconi.*

Deaton, A. (1991), "Saving and liquidity constraints", *Econometrica*, 59, pp. 1221-1248.

Esping-Anderson, G. (1990), *The Three Worlds of Welfare Capitalism.* Princeton: Princeton University Press.

Fraser, D. (1972), *Evolution of the British Welfare State.* London: Macmillan.

Gordon, R.H. & Blinder, A.S. (1980), "Market wages, reservation wages, and retirement decisions", *Journal of Public Economics*, 14, pp. 277-308.

Gourinchas, P-O. and J.A. Parker. (2002). "Consumption over the Life Cycle", *Econometrica.* 70. pp 47-89.

Gruber, J. & Wise, D.A. (1999), *Social Security and Retirement Around the World.* Editted Volume. Chicago: Chicago University Press.

Gustman, A.L. & Steinmeier, T.L. (1985), "The 1983 social security reforms and labor supply adjustments of older individuals in the long run", *Journal of Labor Economics*, 3, pp. 237-253.

Gustman, A.L. & Steinmeier, T.L. (1986), "A structural retirement model", *Econometrica*, 54, pp. 555-584.

Jones, A. & O'Donnell, O. (1995), "Equivalence scales and the costs of disability", *Journal of Public Economics*, 56, pp. 273-289.

Krueger, A.B. & Meyer, B.D. (2002), "Labor supply effects of social insurance", *NBER Working Paper*, 9014.

Krueger, A.B. & Pischke, J.S. (1992), "The effect of social security on labor supply: A cohort analysis of the notch generation", *Journal of Labor Economics*, 10, pp. 412-437.

Lumsdaine, R.L., Stock, J.H. & Wise, D.A. (1992), Three Models of Retirement: Computational Complexity versus Predictive Validity. In *Topics in the Economics of Aging.* Edited by D.A. Wise. Chicago: University of Chicago Press.

Lumsdaine, R.L., Stock, J.H. & Wise, D.A. (1990), "Three models of retirement: Computational complexity versus predictive validity", *NBER Working Paper*, 3558.

Mitchell, O.S. & Fields, G.S. (1981), "The effects of pensions and earnings on retirement: A review essay", *NBER Working Paper*, 772.

Muellbauer, J. & van de Ven, J. (2003), "Estimating equivalence scales for tax and benefits systems", *NIESR Working Paper*, 229.

Nerlove, M., Razin, A. & Sadka, E. (1984), "Income distribution policies with endogenous fertility", *Journal of Public Economics*, 24, pp. 221-230.

Pellechio, A. (1981), "Social security and the decision to retire", *NBER Working Paper*, 734.

Profeta, P. (2002), "Aging and retirement: Evidence across countries", *International Tax and Public Finance*, 9, pp. 651-672.

Rust, J. (1995), Structural estimation of Markov decision processes. In *Handbook of Econometrics Vol. IV*. Edited by R.F. Engle & D.L. McFadden. Amsterdam: Elsevier.

Rust, J. (1987), "A dynamic programming model of retirement behaviour", *NBER Working Paper*, 2470.

Rust, J. & Phelan, C. (1997), "How social security and medicare affect retirement behavior in a world of incomplete markets", *Econometrica*, 65, pp. 781-831.

Samwick, A.A. (1998), "New evidence on pensions, social security, and the timing of retirement", *Journal of Public Economics*, 70, pp. 207-236.

Sefton, J. & van de Ven, J. (2004), "Simulating household savings and labour supply: an application of dynamic programming", *National Institute Economic Review*, 188, pp. 56-72.

Smeeding, T.M. & Gunther, S. (1990), The LIS DataBase. In *Poverty, Inequality and Income Distribution in Comparative Perspective*. Edited by T.M. Smeeding, M. O'Higgins & L. Rainwater. London: Harvester Wheatsheaf.

Stern, S. (1997), "Approximate solutions to stochastic dynamic programs", *Econometric Theory*, 13, pp. 392-405.

Stock, J.H. & Wise, D.A. (1990), "Pensions, the option value of work, and retirement", *Econometrica*, 58, pp. 1151-1180.

Taylor, M.F. (2001), *British Household Panel Survey User Manual Volume A: Introduction, Technical Report and Appendices.* Colchester: University of Essex.

van de Ven, J. (2004), "The distribution of perceived household wealth in the UK ", Unpublished Manuscript.

Zöllner, D. (1982), Germany. In *The Evolution of Social Insurance 1881-1981.* Edited by P.A. Köhler, H.F. Zacher, & M. Partington. London: St. Martin's Press.

A Survey Data

A.1 European Community Household Panel

The European Community Household Panel Survey (ECHP) is "the most closely co-ordinated component of the European system of social surveys" that are collected by Eurostat (the statistical office of the European Communities). The ECHP provides detailed panel data for households that are drawn from 15 European Community counties, spanning the period between 1994 and 2000 (the most recent year for which data have been made available). The data are collected at annual intervals, and so build up an historical record of 60,500 nationally representative households.[51]

The ECHP data that are considered in this paper, have been sourced by Eurostat from the British Household Panel Survey (BHPS) for the UK, from the Sozio-oekonomische Panel (SOEP) for Germany, and from a National Data Collection Unit commissioned by Eurostat for Denmark.

The BHPS is a panel survey of households that were originally selected to provide a nationally representative sample of the UK population.[52] The first wave of the survey was undertaken in 1990, and includes information for 13,840 individuals drawn from 5,511 households. Subsequent waves have been undertaken annually, to provide a survey history for individuals who were approached in the original wave (and their subsequent households). The most recent wave released by the Office for National Statistics (ONS) supplies data for the year 2000/01 (the tenth consecutive wave), and is of particular interest because it includes a suite of questions that are designed specifically to describe household wealth. When combined with the time-series aspect of the survey, these questions provide a valuable source of wealth data for the UK.[53]

The German Socio-oekonomische Panel (SOEP) is a representative longitudinal study of private households in Germany. The survey commenced in 1984, and records data collected at annual intervals for an initial sample of private households. The survey was extended in 1990 to include the territory of the former German Democratic Republic (GDR).

The variables used to undertake the analysis presented in this paper were extracted from the ECHP using SPSS programs. The authors may be contacted for further details.

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[51] See Eurostat (2003) for further details regarding the ECHP.

[52] Due to the repeated survey methods employed, the most recent wave of the BHPS no longer provides a representative sample of the UK population. See Taylor (2001) for further details regarding the BHPS.

[53] There are currently three main sources of wealth data for the UK; the General Household Survey (primarily for housing wealth), the Family Resources Survey, and the British Household Panel Survey (BHPS). An alternative source that will provide detailed information for the English population over the age of 50 is the English Longitudinal Study of Ageing, the first wave of which has yet to be released. Following a review of these alternative data sets, the BHPS was identified as the most comprehensive source of wealth data currently available for the UK.

A.2 Family Expenditure Survey

The FES is a cross-sectional survey that provides a detailed description of household expenditure, income and demographic characteristics. The model calibrations are based upon expenditure data derived from the 2000/01 FES, which records information for a nationally representative sample of 6,115 households that were randomly selected from the Small Users file of the Post Office's list of addresses.[54] Expenditure data are obtained for the FES from a diary that is kept by each responding adult during a two week period. Data on some expenditures are based on individual recall or the most recent bill.

B Parameters Used for Simulations

Human Capital

The model used to generate human capital, as discussed at length by Sefton and van de Ven (2004), is defined by:

$$h_{it} = \beta^R h_{it-R} + \sum_{s=1}^{R} \beta^{s-1} \left(\theta w_{it-s} + f\left(t+1-s\right) + \varepsilon_{it+1-s} \right) \tag{10}$$

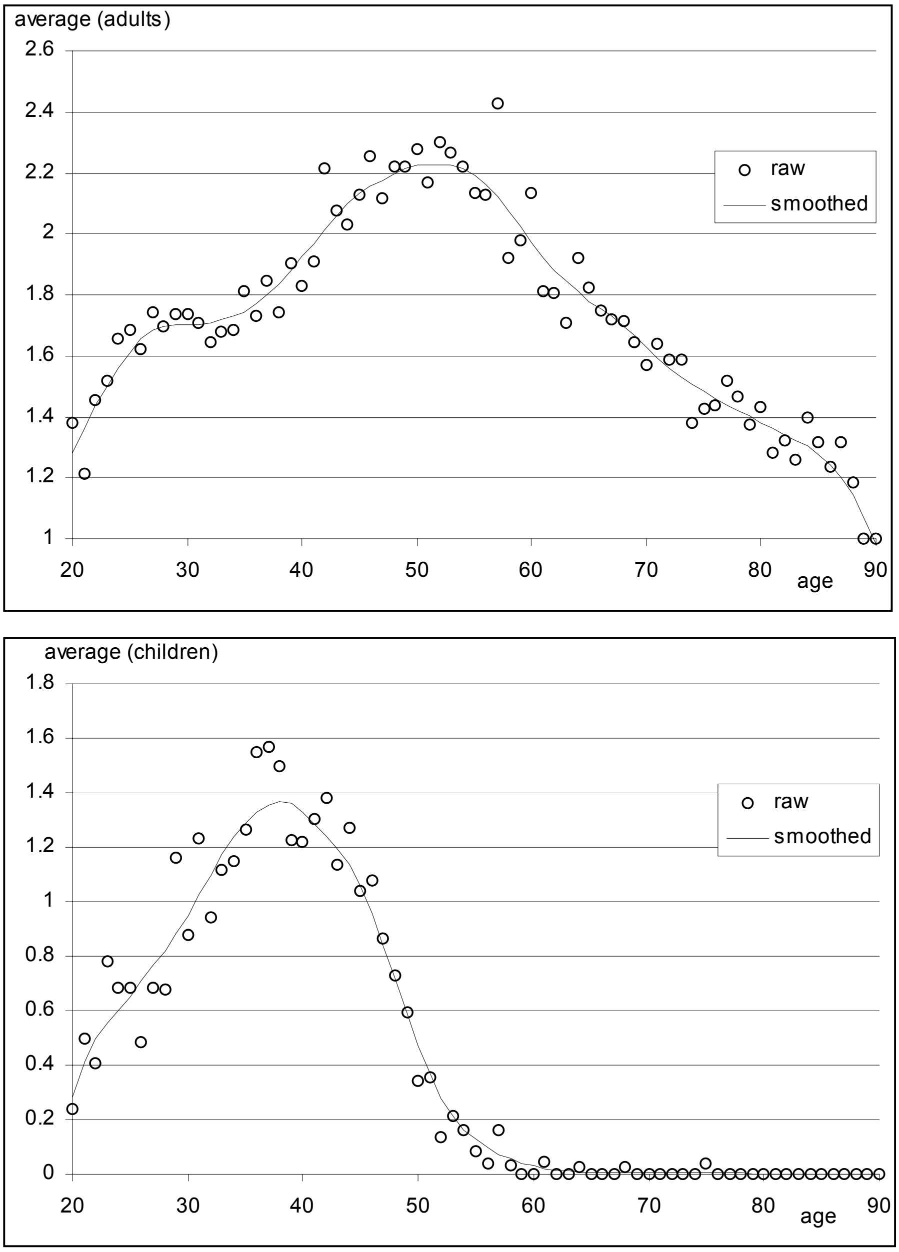
where h_{it} is (log) full-time annual wage the household i at age t, w_{it} is a dummy variable that takes a value of one if the reference person of household i is full-time employed at age t and zero otherwise, and $f\left(.\right)$ is a cubic polynomial of age.

Equation (10) was estimated using a sample selection model of individual full-time employment wages.[55] This model takes into consideration the fact that wages are only observed for individuals who are working, and that there is likely to be a relationship between the probability of working and the wage rate.

The sample selection model involves estimating two equations, a probit to identify individuals who are employed, and a (log) wage equation. The probit equation used predicts the probability of an individual's employment status with regard to various demographic, health, and economic variables. Estimates for a probit model that was arrived at after trialling various alternatives are reported in Table 5. Two sets of regression estimates for equation (10) are reported in Table 6, one in which $R = 3$, and another in which $R = 6$. Both of these regressions use observations drawn

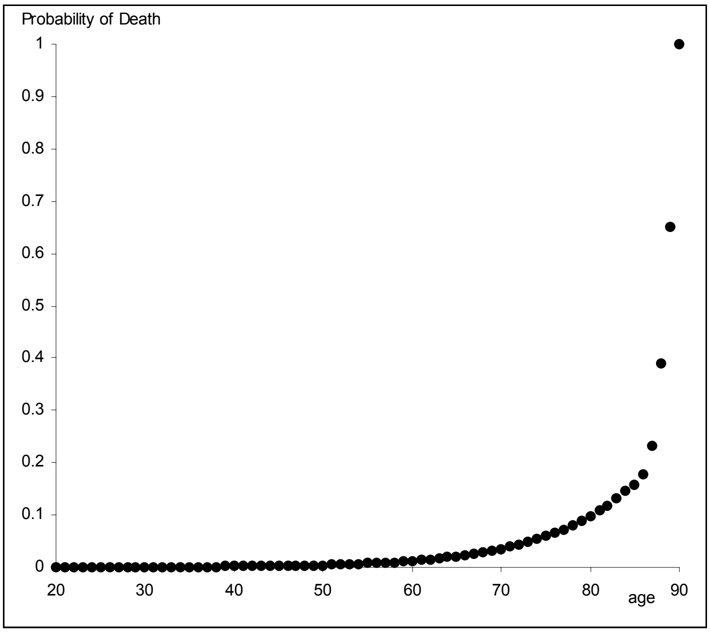
[54] For further information, see *Family Expenditure Survey 2000-2001 User Guide*. London: Office for National Statistics.

[55] The regression was undertaken using the "Sampsel" procedure in TSP, full details of which can be obtained from the "TSP 4.4 User's Guide" (see http://elsa.berkeley.edu/wp/tsp_user/tspugpdf.htm).



Source: Author's calculations.

Figure 14: Household Size by Age of Reference Person



Notes: World Health Organisation Life Tables for the UK, 2000

Probabilities after age 85 subject to manual adjustement to ensure death by age 90

Figure 15: Mortality Probabilities by Age

from the ECHP for 2000/01 to describe h_{it} for household reference people. Table 6 also includes "restricted estimates", which are used for the simulation analysis. The relationship between the various regression models for which estimates are reported in Table 6 is discussed at length by Sefton and van de Ven (2004).[56] The relationship between the income profile implied by the restricted estimates reported in Table 6, and the ECHP survey data is displayed in Figure 16.

Table 5: Probit Regression of Full-Time Employment

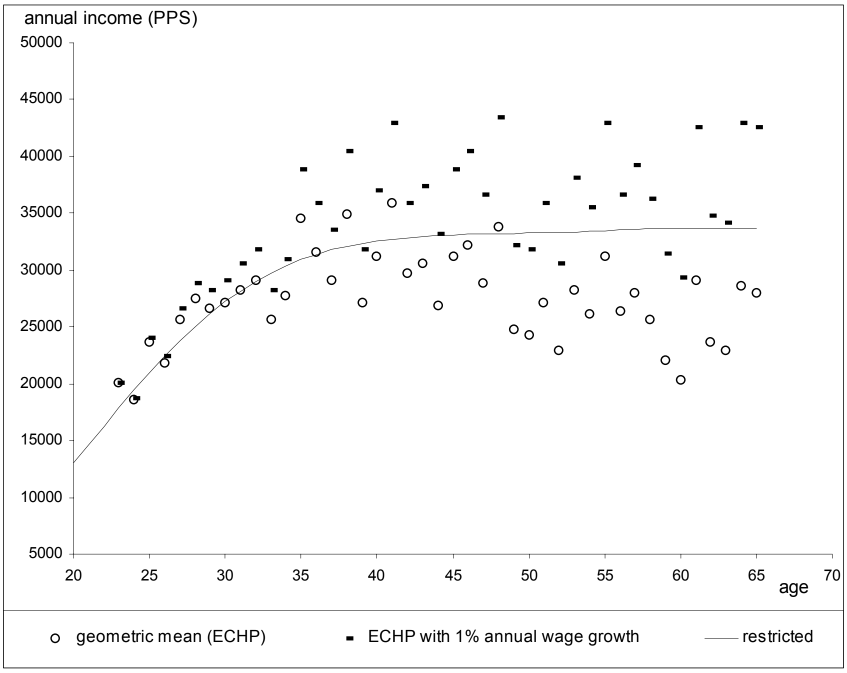
Parameter	Estimate	Std. Error
C	-12.17570	(3.47E+00)
AGE	0.99082	(3.48E-01)
AGE2	-0.03158	(1.26E-02)
AGE3	4.60E-04	(1.95E-04)
AGE4	-2.69E-06	(1.10E-06)
NC	-0.33892	(3.24E-02)
MALE	1.01702	(5.81E-02)
COUPLE	0.03831	(6.83E-02)
CAR	0.48719	(8.45E-02)
ROOMST	0.03914	(1.87E-02)
H45TTM3	-1.43907	(2.28E-01)
H12TTM3	0.23211	(5.72E-02)
correct predictions	0.78782	

[56] All currencies are specified in terms of Purchasing Power Standards (PPS), obtained by dividing the national currency by the relevant Purchasing Power Parity (PPP). The PPPs used were calculated by Eurostat, and are provided with the ECHP.

Table 6: Econometric Estimates of Human Capital Equation

	R=3		R=6		restricted ests.	
	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error
beta	0.829272	8.36E-03	0.881672	6.49E-03	0.975000	NA
theta	0.080523	3.40E-02	0.108149	2.21E-02	0.056670	2.08E-02
c	1.548770	1.80E-01	1.062290	1.19E-01	0.631478	9.72E-02
age	1.96E-02	1.33E-02	5.16E-03	9.04E-03	-2.44E-02	7.49E-03
age^2	-5.41E-04	3.26E-04	-2.26E-04	2.24E-04	4.64E-04	1.88E-04
age^3	4.42E-06	2.59E-06	2.30E-06	1.80E-06	-2.91E-06	1.53E-06
inverse mills	-0.143250	2.99E-02	-0.157948	3.75E-02	-0.028813	4.21E-02
R-squared	0.509533		0.383955		0.362528	
stnd error	0.333069		0.37255		0.424956	
adj stnd error	0.154155		0.106433		0.148882	

The geometric mean assumed for human capital at age 20 is 13,091.88 (PPS) and standard deviation is 0.40, both of which are derived from ECHP data. The standard deviation of the temporal variation term ε_{it}, is assumed to equal 0.1489, which was calculated from the econometric estimate for the standard deviation of the restricted regression reported in Table 6.



.Source: ECHP and author's calculations

Figure 16: Estimates of Human Capital by Age