ISBN 0 7325 1207 7

THE UNIVERSITY OF MELBOURNE

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RESEARCH PAPER NUMBER 26
February 1996

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JC-95-38

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I. INTRODUCTION

Individuals approaching retirement are faced with a dual decision problem concerning both the age at which to retire and the manner in which to allocate accumulated assets. In Australia, the range of choice at retirement is so complex that it is apt to refer to it as a 'superannuation maze'; see Atkinson, Creedy and Knox (1995). The way in which assets are allocated at retirement has implications not only for taxation at the time of retirement but also during retirement. In addition, this allocation may have implications for the administering of the means-tests, relating to income and assets, associated with the age pension. The complexity of the system makes it difficult to disentangle the incentive structure influencing the dual decision.

By considering the implications of a large number of routes through the retirement maze, using alternative evaluation criteria, Atkinson and Creedy (1995) examined a set of optimal choices for a simulated population on the assumption that each individual retires at age 65. The assets modelled consisted of accumulated superannuation contributions (from employers and employees) made over the working life as part of the Superannuation Guarantee Charge (SGC) along with any additional private savings. The population group consisted of a large number of males in a single cohort, assuming that the SGC scheme is fully mature. It was found, for example, that there is very little incentive inherent in the tax and age pension system for individuals to use their assets to purchase annuities. The government's stated objective in introducing the SGC is, however, to encourage the private provision of retirement incomes in order to reduce reliance on the means-tested age pension.

* This research was supported by a grant awarded to Creedy by ASFA, which is greatly appreciated.

The purpose of the present paper is to extend the previous analysis to allow for the retirement age to vary between 55 and 65 years. The analysis does not allow for the transition to part time work, and retirement is treated as being irreversible and total. Although voluntary early retirement may affect longevity, this type of interdependence is also ignored. The standard form of labour supply model in a multi-period context, as described in Creedy (1994, pp 120-122), is of little value in this context given the complexity of the tax and transfer systems. The simulation model is a substantially extended version of the LITES (Lifetime Income, Taxation, Expenditure and Superannuation) model described in Atkinson, Creedy and Knox (1994). It enables, for each of 11 retirement ages, 46 different routes through the 'retirement maze' to be evaluated in terms of lifetime utility; the best combination for each individual of the 506 alternatives of age and routes is then selected. Working an extra year involves giving up leisure in favour of work in return for extra consumption, during that year and following years, as a result of the further accumulation of assets. This may perhaps suggest a simple marginal condition, following Mitchell and Fields (1984), in terms of the equality of marginal utility from an extra year of work and that from an extra year of leisure. However, such a simple 'flow' condition is not operational in this context.[1]

The analysis focuses on two main questions. First, to what extent does the current system in Australia (in its mature form) offer an incentive for individuals to retire early? Second, to what extent is the decision at retirement, that is the optimal route through the 'maze', affected by the retirement age? [2]

Some further comments on the population group are perhaps warranted at this stage. In view of the complexities involved in modelling the labour force participation of women over the life cycle, a model of age-earnings profiles was estimated for Australian males, over all occupations and household types; see Creedy (1992). When calculating the tax paid during the working life and retirement, and when considering the age pension and its associated means tests, the simulated individuals were, however, treated as if they were single and home owners. In a more complete analysis it would obviously be desirable to model household formation and joint decision-taking, where appropriate. It is argued that the present approach is sufficient to demonstrate the complexity of the system in Australia and the nature of the incentive structure created. The extension of the model to allow for joint decisions would involve a considerable increase in complexity and information requirements.

All individuals are assumed to enter the workforce at age 20 and no deaths are assumed to occur before age 65. Results are obtained both under the assumption that all individuals live for the same length of time (until age 79), and on the assumption that there is a process of differential mortality. The latter process is such that, on average, those with higher annual average lifetime earnings live relatively longer, following the specification in Creedy (1982). The simulation of earnings over the working life and the process used to allow for differential mortality are described in Appendix 1.

The retirement options, or routes through the maze, are described in Section II. Simulation results are presented in Section III, with brief conclusions in Section IV. First, however, some features of the current system in Australia are described in the following subsection.

The Current System

In this study, each individual has accumulated assets at the time of retirement which may be classified in three ways. First, there is the sum of superannuation contributions arising from employee contributions, assumed to be 3% of gross earnings throughout the working life. Secondly, there are accumulated employer contributions, known as deducted contributions, assumed to be 9% of gross earnings in each year, plus all other investment income earned by the fund. These contribution rates correspond to those recommended for a 'mature' version of current policy and have bipartisan political support; see Dawkins (1992). These two components are treated in different ways for tax purposes and are known as the undeducted benefit and the taxable benefit respectively. Thirdly, each individual has other accumulated savings; these are assumed to be made at the rate of 5% of disposable income in each year. These assets are disposed of at retirement, and the initial disposal identifies amounts put to various uses thereafter.

The recently proposed 3% government co-contribution is not modelled here, since it is still a matter of controversy.

A brief summary of the superannuation tax system in Australia is provided in Table 1. For further details, see, for example, Carney and Hanks (1994), Bateman and Piggott (1992), and Atkinson, Creedy and Knox (1994, 1995).

TABLE 1. SUMMARY OF CURRENT SYSTEM

Accumulation period:	
Contribution rates	Employer 9% , Employee 3%
Contribution tax	15% on deducted Employer contributions
Employee Contribution rebate	10% of employee contributions, subject to tests on income (maximum rebate $100, maximum salary $32,000) and age related maxima on total contributions. Rebate may not exceed tax liability.
Superannuation Fund Earnings	Nominal rate of tax of 15% (assumed to be an effective rate of 7.5% after allowance for credits).
At Retirement:	
Lump Sum Tax	Undeducted contributions are not subject to lump sum tax.[1] The taxable benefit included in the lump sum is subject to 16.4% tax on amounts in excess of a threshold ($77,796 in 1993-94). Excessive amounts are taxed at 48.4%.[2] Rates include the Medicare levy.
In Retirement:	
Age Pension	Taxable Pension payable subject to income and asset means-tests. Income tax rebate depending on income.
Annuities in payment	Superannuation annuity taxed as income, except UPP exempt.[3] Other annuities taxed as income, except the purchase price allowance which is exempt.[4]
Superannuation pension rebate	15% rebate of the eligible part of the superannuation pension associated with contribution tax.

Notes:

1. 'Undeducted contributions' are the sum of employee contributions which have not been taken as a deduction against income tax. The remainder of the benefit, which includes all interest earnings, including those on the undeducted contributions, is the 'taxable benefit'.
2. Excessive amounts: The excessive proportion of a Lump Sum is that proportion in excess of a maximum 'reasonable benefit' level, $400,000. If less than 50% of the superannuation fund is taken as a lump sum, the maximum reasonable benefit level is $800,000.
3. The UPP (undeducted purchase price) for a superannuation annuity in the current system is that part of the cost of the annuity attributed to undeducted contributions, divided by the expected term of payment.
4. Purchase price allowance is the cost of the annuity divided by the expected term of payment, (14.6 years for males aged 65).
5. AWE stands for average weekly earnings.

II. RETIREMENT DECISIONS

This section describes the range of decisions, regarding the allocation of assets at retirement, that are modelled in the simulations.

The range of routes available

The superannuation assets may initially be used in a combination of two ways. They may be used to purchase a lifetime annuity, or may be taken as a lump sum which is subject to lump sum tax. The other savings, and any superannuation lump sum taken, may be used in one of three ways. The simulation model allows for the after-tax cash amounts to be used to purchase an annuity, to be deposited in an interest-bearing bank account, or to be put to immediate consumption. These three destinations are available in any combination and to various degrees. Any annuities purchased are identified throughout retirement according to the source of the money which is used to purchase them. This distinction governs the income tax rules which apply to them, and also the treatment under the operation of the age pension means tests. Annuities purchased by lump sum proceeds from the superannuation benefit are treated in the same way as annuities purchased from other savings; both are considered to be purchased by after-tax money.

The model allows for two basic methods of retirement income provision, the money purchase method, and the defined benefit method. In the former method, a proportion of the available amount used to purchase an annuity is specified, and in the latter method a level of required income is specified. Defined benefit levels are described as a proportion of the average of the final three years' earnings before retirement.

After the purchase of annuities from pre- or post-tax money, an amount may be placed in an interest bearing bank account; the amount is specified as a proportion of the money available. The account attracts taxable interest payments at a constant rate, and is subject to annual drawings. The amount withdrawn at the end of each year is calculated as the balance of the account divided by the number of years remaining to age 80; thus the account is assumed to be extinguished at age 80. This is an arbitrary assumption, but it is made in the absence of an explicit model of bequest behaviour and the formation of expectations of length of life. This assumption approximates to the conditions governing the draw-down of allocated pensions and provides an appropriate alternative to the other choices available here. As individuals do not know how long they will live, it is possible that they will die leaving some money in the bank account, in which case this provides a bequest. Hence, bequests exist in some cases, but their provision is modelled as a residual rather than as deliberate decision of individuals. Under the assumption of common mortality, when all individuals are assumed to die aged 79, this approach implies that there are no bequests. The final allocation of resources at the time of retirement is to consumption. All money remaining after the above provisions for income and investment is spent immediately.

Given the complexity of the maze of choices, there is in principle an infinitely large number of routes which may be taken at retirement. In this paper a catalogue of 46 routes through the maze has been constructed. The range of routes from which each individual makes the optimal choice are described in Tables 2 and 3 for defined benefit and money purchase cases respectively. The defined benefit is specified in relation to average earnings in the three years immediately before retirement; this average is referred to as the 'final salary'. In Table 2, column 2 indicates the first call on the use of pre-tax superannuation assets. The initials 'LS' signify that the superannuation assets are taken as a lump sum. The initial 'A' signifies that the superannuation assets are used to provide an annuity to the defined level of income described in column four. If the superannuation assets are insufficient to purchase an annuity to the required level, then savings are drawn upon until the level is reached. Any balance of pre-tax money is then taken as a lump sum, and added to other post-tax money. If there is insufficient money to purchase the defined level of income, the individual buys as much as possible, so that all assets are devoted to annuity purchase.

It is assumed that the age pension becomes payable only at age 65, and no provision is made for other social transfer payments. Thus, those retiring earlier than the age pension eligibility age must rely entirely on their own resources to provide income. They may be eligible to receive the low income earners rebate, in addition to a rebate linked to the age pension.

Fringe benefits associated with the age pension or low income levels are not modelled. It would be difficult to make such allowance in a reasonable way, since such benefits reflect to a large extent the consumption pattern, as well as the income level of an individual. However, the inclusion of such an allowance would exaggerate rather than moderate the incentives revealed below, since it would be inclined to increase the relative value of the low annuity income and high consumption options; options which are already preferred by the low income and high mortality groups.

In Table 3, column 2 indicates the percentage of pre-tax superannuation assets used to purchase an annuity. The balance of superannuation assets is taken as a lump sum and later pooled with any balance of the savings accumulation. If the superannuation assets are converted entirely to a lump sum, as in routes 35-46 inclusive, then the post-tax money is added to the savings accumulation and the stated percentage applied to the purchase of an annuity. Thus, for example, route 35 specifies that all superannuation is taken as a lump sum and all the money then available is used to buy an annuity. Route 25 specifies that all benefits are used to purchase annuities, but one annuity arises from pre-tax superannuation assets while the other arises from post-tax savings and therefore involves a different tax and age pension treatment.

The route which has the highest value of lifetime utility, as defined below, is the one chosen by an individual. The model operates a 'sieve' effect, whereby if there is more than one route with the same value, the highest route number is preferred.

TABLE 2.

ROUTES 1 - 24: DEFINED BENEFIT CASES

Route no.	Superannuation pre-tax destination	Savings and post-tax destination	Defined benefit % of Final Salary	% of Balance to Bank	% of Balance to consumption
1	A	A	85	-	100
2	A	A	75	-	100
3	A	A	65	100	0
4	A	A	65	50	50
5	A	A	65	-	100
6	LS	A	65	100	-
7	LS	A	65	50	50
8	LS	A	65	-	100
9	LS	A	60	-	100
10	A	A	50	100	-
11	A	A	50	50	50
12	A	A	50	-	100
13	LS	A	50	100	-
14	LS	A	50	50	50
15	LS	A	50	-	100
16	LS	A	45	-	100
17	A	A	35	100	-
18	A	A	35	50	50
19	A	A	35	-	100
20	LS	A	35	100	-
21	LS	A	35	50	50
22	LS	A	35	-	100
23	A	A	25	-	100
24	A	A	10	-	100

TABLE 3.

ROUTES 25-46: MONEY PURCHASE CASES

Route no.	% of Superannuation to annuity	% of Savings and post-tax to annuity	% of Balance to Bank	% of Balance to consumption
25	100	100	Nil balance	Nil balance
26	100	0	100	0
27	100	0	50	50
28	100	0	0	100
29	50	50	100	0
30	50	50	50	50
31	50	50	0	100
32	50	0	100	0
33	50	0	50	50
34	50	0	0	100
35	LS	100	Nil balance	Nil balance
36	LS	85	100	0
37	LS	70	100	0
38	LS	70	50	50
39	LS	50	100	0
40	LS	50	50	50
41	LS	50	0	100
42	LS	0	100	0
43	LS	0	75	25
44	LS	0	50	50
45	LS	0	25	75
46	LS	0	10	90

Evaluation of retirement choice

The criterion for evaluating the retirement choice is specified in terms of a utility function based on net consumption and leisure in each year. Total leisure available in each year is normalised to unity, so that leisure is specified as a proportion of the available time. During retirement years this proportion is set equal to one in each year, and for working years it is set equal to a fixed value less than one (the sensitivity to this assumed value is examined below). If c_t and h_t respectively denote the amount of consumption and the proportion of time in leisure in year t, utility in that year is defined as $U_t = c_t^{\alpha} h_t^{1-\alpha}$ where $\alpha < 1$; this is the Cobb-Douglas form of function. If there is a bequest, its value is added to consumption in the final year of life. Lifetime utility is then defined as the present value, at entry to the workforce, of the stream U_t.

Individuals are assumed not to save from any disposable income during retirement. The amount of net consumption in any year in retirement is the sum of income from any purchased annuities, plus the age pension received where relevant, plus the amount taken from the bank account, less the amount of income tax paid, allowing for the appropriate income tax rebates due. This amount is not the same, in general, as the net income in the year. Net income includes the interest earned on the bank account, but does not include the capital amount withdrawn from it. The amount of the bequest, if any, is the balance of the bank account at the time of death. Since the bank account is reduced to zero by age 80, any individual who survives this age provides no bequest.

It is necessary to stress that the evaluation of each route for each individual is made ex post. That is, the criterion refers to the consumption stream and bequest actually received by the individual over the whole of the retirement period. Hence the optimal route is the one that 'turned out' to be the best in the end. These results do not therefore directly indicate which routes are optimal ex ante, since it would be necessary to model explicitly the formation of expectations by individuals about the length of life. The two concepts coincide only if individuals know at retirement how long they will live;

Hammermesh (1985) examines the differences between expectations and actual longevity for a sample of individuals in the US.

Annuity rates

Individuals who retire early and purchase an annuity will receive benefits over a longer period than if they retire later. The purchase rate of annuities depends on the age from which they become payable. The current rate in Australia for a whole-life annuity escalating at 5% per year for a male aged 65 is 12.5 (from the Rice-Kachor Rollover/Annuity League Table). That is, the cost of an annuity which pays $1 in the first year on retirement at age 65 is $12.50. Annuity purchase rates have been constructed for other ages consistent with this base value. This was done using the software package ADVANCE (Actuarial and Demographic, Visual And Numerical Curricula Enhancement) developed at the University of Melbourne.

The market for whole-life annuities in Australia is currently quite small, but as the SGC matures it is expected (if the government intention is realised) that this market will increase to include individuals previously absent from the annuity market. Hence the mortality characteristics of those purchasing retirement annuities are expected to change. The following simulations therefore use purchase rates based on differing mortality assumptions. Two sets of rates are used in this study, as follows.

The first set of annuity rates for early retirement, A1, assumes that the underlying mortality experience is that of typical annuitants, and is based on the mortality table a(90) males. Current rates would be expected to reflect the effects of self-selection exercised by purchasers of annuities. On this mortality assumption, a purchase price of 12.5 at age 65 implies an underlying real rate of interest of 1.90 % allowing for escalation at 5%. Assuming that all expense allowances and other costs are implicitly allowed for in this real rate of interest, ADVANCE was used to calculate the corresponding rates for ages 55 to 64, on the basis of the a(90) males mortality table.

The second set of annuity rates, A2, is based on the same real rate of interest implied by current market rates, that is 1.90%, but uses a different assumption of mortality experience, the Australian Life Table 1985-87, males. This mortality table is representative of a wider population than the annuitants mortality table used for the first set of rates, and the mortality rates are in general higher.

Annuitants' mortality is lower than the general population since it represents a group self-selecting on the basis of expectation of survival. If the purchase of retirement annuities becomes much more common than it is at present, then purchase rates would be expected to reflect the higher mortality experience of a wider group of purchasers of annuities. Thus, the second set of purchase rates is intended to be representative of market rates which might obtain when the SGC scheme is mature and the purchase of retirement annuities is much more widespread than it is at present. The two set of rates are shown in Table 4.

TABLE 4.

ANNUITY PURCHASE RATES

Age	A1	A2
55	17.57	16.92
56	17.04	16.40
57	16.52	15.87
58	16.00	15.35
59	15.48	14.83
60	14.97	14.32
61	14.47	13.80
62	13.97	13.30
63	13.48	12.80
64	12.99	12.30
65	12.50	11.81

Notes: Annuity is payable annually in arrear, and escalates at 5% per year. Rates are calculated using a real rate of 1.90%, using the software ADVANCE.

III. SIMULATION RESULTS

The modified LITES model is used to simulate the lifetime experience of each of 3000 individuals. In each case the value of discounted lifetime utility, based on the Cobb-Douglas form, is evaluated for each of the 46 routes through the maze and each retirement age from 55 to 65, and the combination of age and route giving the maximum value of utility is recorded. The simulation is carried out both for the assumption of common mortality, such that all individuals live to age 79, and for differential mortality whereby the relatively richer live, on average, relatively longer (and the expectation of life for the median individual is 79 years). Any affect which early retirement may have on life expectancy is not modelled.

The choice of values of h_t (the proportion of time spent in leisure during each year) and α must be somewhat arbitrary. All that can be done is to choose sensible values as a base case and then to consider the sensitivity of results to variations. The coefficient α is the exponent on consumption. The form of U_t implies that, within each year, utility is constant if a 1% increase in leisure is matched by a reduction in consumption of $\{(1-\alpha)/\alpha\}$ percent. Hence if α is set at 0.5, a 1% increase in h_t accompanied by a 1% reduction in c_t results in no change in utility. If α is increased to 0.6, for example, an increase in h_t of 1% must be matched by a reduction in c_t of 0.667 percent to maintain the same utility, reflecting a higher weight attached to consumption. If α is instead 0.4, a similar change in h_t implies a fall in consumption of 1.5 percent if utility is to be constant. The central value of $\alpha = 0.5$ is taken as the base case, along with the assumption that $h_t = 0.25$ during each of the working years. After retirement a value of $h_t = 1$ is used. Results for alternative values of h and α are given in Appendix 2.

<u>Common mortality</u>

Tables 5 and 6 respectively show the optimal route choices for the A1 and A2 annuity rates, and the base values of $h_t = 0.25$ and $\alpha = 0.5$, on an assumption of common mortality (CM). Each table shows the number of members of the cohort selecting each age and route combination. The proportions of each cohort retiring at each age are illustrated in Figure 1, for the two annuity rate assumptions.

Table 5. RETIREMENT AGE AND CHOICE OF ROUTE
(h = 0.25; α = 0.5; A1; CM)

Route	Age at retirement 55	56	57	58	59	60	61	62	63	64	65
1	11	-	-	-	-	-	-	-	-	-	-
2	25	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	69	51	10	2	-	3	1	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-
8	24	6	1	1	-	-	-	-	-	-	-
9	17	28	28	33	40	23	17	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-
12	166	207	197	105	19	20	20	22	23	8	4
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-
15	26	32	57	79	143	225	207	113	27	2	-
16	2	3	6	13	44	106	129	135	85	25	1
17	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-
19	10	10	6	1	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	1	3	21	38	24	15	2
23	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-
25	63	35	17	7	14	15	12	10	4	3	4
26	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-
28	15	13	3	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-
35	13	-	-	-	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-
41	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-
TOTAL	441	385	325	240	261	395	407	318	163	53	12

Table 6. RETIREMENT AGE AND CHOICE OF ROUTE
(h = 0.25; α = 0.5; A2; CM)

Route	Age at retirement										
	55	56	57	58	59	60	61	62	63	64	65
1	12	-	-	-	-	-	-	-	-	-	-
2	35	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	90	55	39	7	7	11	3	3	-	1	1
6	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-
8	24	10	5	6	-	-	-	-	-	-	-
9	19	25	35	34	56	43	27	13	1	-	-
10	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-
12	171	210	214	119	38	11	15	17	14	3	3
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-
15	19	15	45	60	116	199	224	105	35	6	-
16	5	4	2	5	25	49	79	93	72	15	-
17	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-
19	5	6	8	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	4	12	12	7	2
23	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-
25	107	52	33	23	25	22	36	22	12	14	6
26	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-
28	11	9	5	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-
35	17	-	-	-	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-
41	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-
Total	515	386	386	254	267	335	388	265	146	46	12

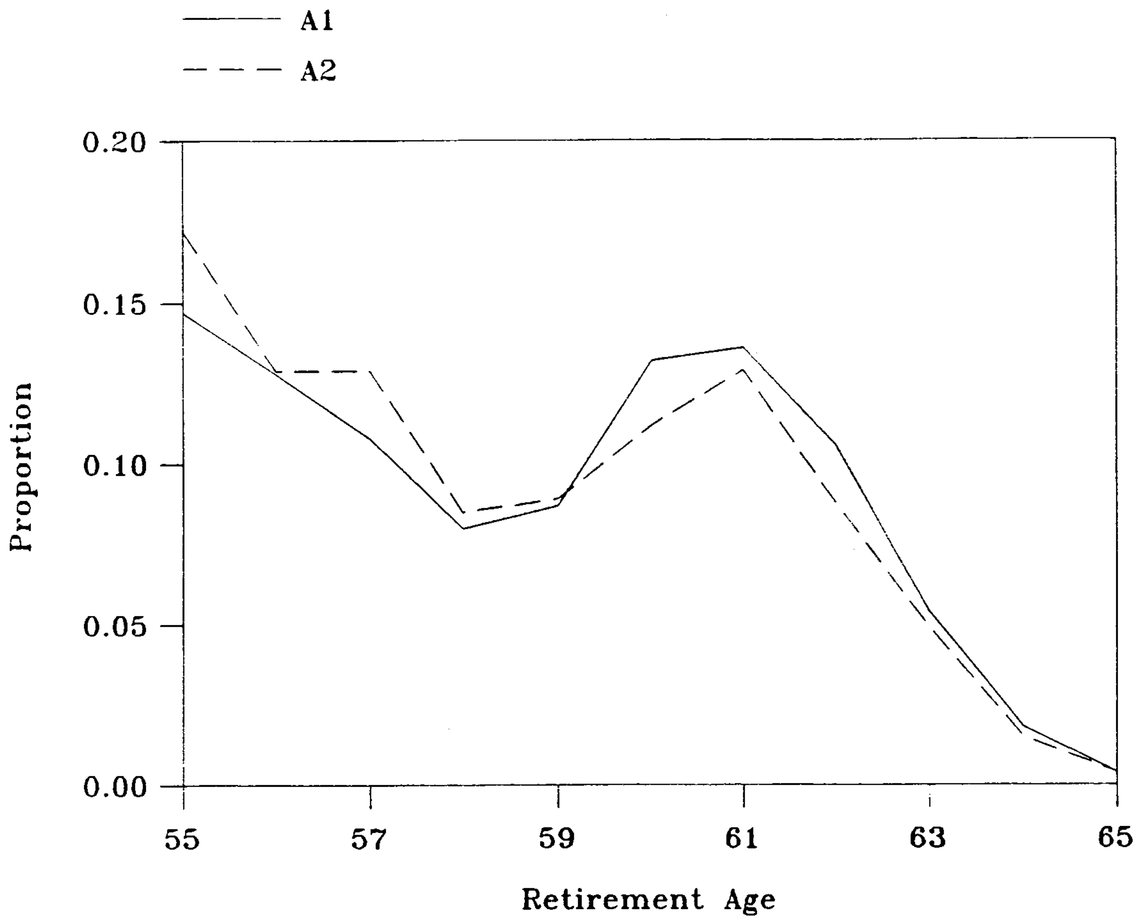

Fig 1. AGE AT RETIREMENT A1 vs A2

The essential features of the two tables are the same. The most preferred retirement age is 55, with a second mode at age 61. The preferred routes all involve using a proportion of the available funds to purchase an annuity and allow for the immediate consumption of any cash balance. Of the routes chosen, all (apart from 25, 28 and 35) are defined benefit routes and all involve the consumption of the balance of funds after the defined level of income has been met. These results, because based on common mortality experience, do not favour any use of the bank account, since the persisting capital value of this as an estate is only relevant when individuals die before age 80. The lower annuity purchase rates A2 involve more individuals taking routes 5, 9 and 25, and fewer taking routes 16 and 22, compared with the rates A1.

The results shown in Tables 5 and 6 reflect the combined action of different effects and there is no single reason which explains the pattern of choices. A more detailed study was made of individuals and their optimal choice and, from the detail, it was found that patterns emerge. Looking at the defined benefit choices, it appears that the major part of the cohort are opting to buy a level of income which maximises their receipt of the means-tested age pension. Thus, in general, those choosing to retire with 50% of final (average three years) salary rather than 35%, for example, are retiring with similar levels of annuity income, but have a lower average salary over the final three years of work. Some routes purchase an annuity of the same proportion of final average salary, (for example the pairs of routes 5 and 8, 12 and 15, 19 and 22) but from different sources (using pre or post-tax money). These pairs of routes differ only in the tax treatment of the annuity income purchased and the way in which the annuity is treated for the purposes of the age pension means-test. Routes 12 and 19 are preferred by those retiring earlier, whereas routes 15 and 22 are preferred by those who retire relatively later. Hence those retiring later find it advantageous to take their superannuation assets as a lump sum (and pay any tax if appropriate) before purchasing an annuity.

Consider the money purchase routes chosen. Route 28 allows for all superannuation benefits to be put to annuity purchase and the balance of assets to be spent immediately. This route is, effectively, preferred by individuals whose optimal percentage salary replacement is not represented in the defined benefit options. Similarly route 35 and route 25, which provide for all assets to be used to purchase annuity income, are distinguished by the fact that route 25 involves all superannuation assets being used to purchase an annuity, and route 35 specifies taking a lump sum and using after-tax money to purchase an annuity. Thus, the optimal routes chosen fall into associated pairs, and each member of the pair is distinguished by the associated tax and means-test operation.

The general trend is that those whose income level is such that the operation of the age pension means-test may have an effect, purchase a level of income which will maximise their benefit. This constitutes the majority of the cohort: this majority arrange affairs such that they just get under the means-test thresholds.

There is a small group whose level of earnings are so low that the workings of the means tests are irrelevant, in that they are never able to purchase an income in excess of the thresholds. For this group, the optimal behaviour is to retire as early as possible, since there is no relative advantage in remaining in low paid employment.

There is another small class of individuals who are always able to purchase income well in excess of the means-test thresholds. These individuals arrange their net income according to the relationship between the annuity purchase rates and their level of income.

A Universal Pension

The above results suggest that a substantial proportion of individuals in the cohort are affected by the age pension means-test, which influences not only the allocation of assets but also the age of retirement. It is therefore useful to examine the effects of abolishing the means-test. Table 7 shows that the optimal choice of the same cohort under conditions which are the same as those for Table 5, except that the age pension is universal and subject to no means-testing. The differences in choice are thus entirely due to the removal of the means-test. Obviously, those few individuals beneath the effects of the means-test do not change their behaviour. The distribution of retirement ages becomes unimodal with the universal age pension. This eliminates the mode at the lowest age, but the single mode is slightly lower than the highest mode when there is means-testing. The two distributions are shown in Figure 2. The arithmetic mean optimal retirement age is the same in each case, at 59 years.

The result is that the removal of means-testing leads more individuals to replace a higher proportion of income and/or to retire later. The majority of the cohort is within the reach of the existing age-pension means-test and, when this is removed, these people are encouraged to purchase higher levels of income and to work longer in order to do so.

Comparison of Tables 5 and 7 also shows that almost all of those choosing to buy annuities with after-tax money rather than directly from superannuation, in Table 5, were doing so because the means-test distinguishes between them rather than because the income tax rules make a distinction. With a universal pension, very few continue to choose routes 8, 15, 19 and 22. Similarly, more choose routes 25 and 28.

One argument made against the introduction of a universal pension is that it involves higher expenditure. However the results presented here show that, in the context of early retirement choices, the universal pension produces an incentive for higher levels of income provision and an associated delay in retirement age. This incentive may give rise to additional taxation to offset the costs of a universal pension.[3]

Table 7. RETIREMENT AGE AND CHOICE OF ROUTE
(h = 0.25; α = 0.5; A1; CM) Universal Pension.

Route	Age at retirement										
	55	56	57	58	59	60	61	62	63	64	65
1	13	1	-	-	-	-	-	-	-	-	-
2	36	6	3	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	83	99	120	117	79	35	7	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-
8	1	-	-	-	-	-	-	-	-	-	-
9	-	1	-	5	3	1	1	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-
12	94	159	266	324	364	294	170	121	64	13	2
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	1	1	2	1
16	-	-	-	1	-	-	1	-	-	15	3
17	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-
19	1	-	1	3	2	8	3	1	1	-	1
20	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	1	2
23	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-
25	36	26	47	46	64	41	27	29	4	4	3
26	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-
28	1	-	4	13	24	38	34	12	10	4	-
29	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	2
36	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-
41	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-
Total	265	292	441	509	536	417	243	164	80	39	14

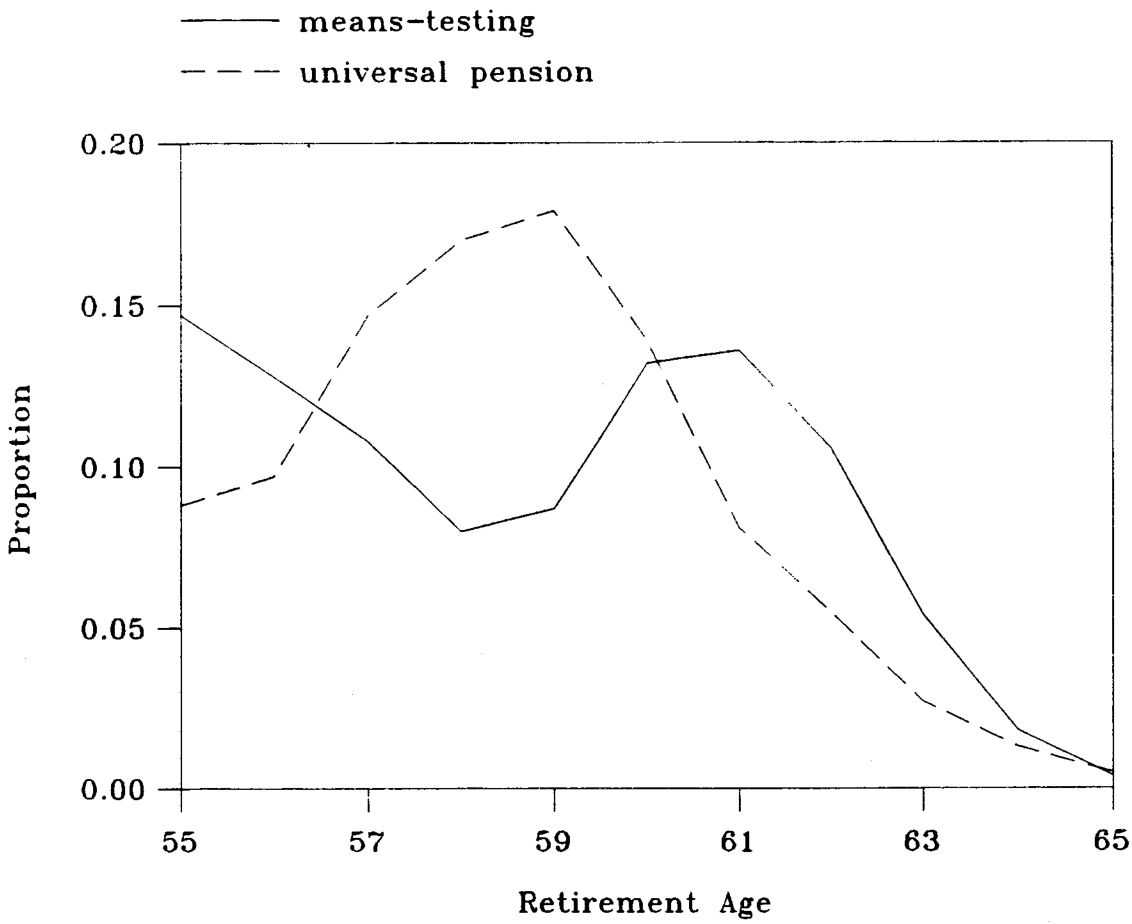

Fig 2. MEANS-TESTED vs UNIVERSAL AGE PENSION

Differential Mortality

Tables 8 and 9 show the optimal choices of the members of the cohort when subject to differential rather than common mortality, for annuity rates A1 and A2 respectively. Thus differences between the pair of Tables 5 and 8, and the pair of Tables 6 and 9, arise entirely from the change in mortality assumption. As might be expected, routes involving the bank account are chosen under the assumption of differential mortality. Those who die before the age of 80 retain a capital asset by using the bank account and would otherwise, if purchasing an annuity, experience a loss due to mortality.

With differential mortality there is also a drift towards retirement at the later ages (particularly 64 and 65) though the broad bimodal pattern is still observed, with modes again at age 55 and 61. The general pattern is unchanged, but those with mortality much higher than the average choose the bank options, and those whose longevity significantly exceeds the norm choose higher levels of annuity purchase. The number of individuals choosing Route 25 (all assets used to purchase an annuity) doubles.

Table 8. RETIREMENT AGE AND CHOICE OF ROUTE
(h = 0.25; α = 0.5; A1; DM)

Route	Age at retirement										
	55	56	57	58	59	60	61	62	63	64	65
1	7	-	-	-	-	-	-	-	-	-	-
2	19	1	-	-	-	-	-	-	1	-	-
3	-	-	-	-	-	-	-	-	-	-	-
4	4	-	-	-	-	-	-	-	-	-	-
5	49	34	13	10	1	4	2	1	2	-	1
6	-	-	-	-	-	-	-	-	-	-	-
7	4	-	-	-	-	-	-	-	-	-	-
8	13	1	1	1	3	7	22	28	10	1	1
9	15	13	8	4	13	27	53	56	19	3	2
10	-	-	-	-	-	-	-	-	-	-	-
11	34	-	-	-	-	-	-	-	-	-	-
12	124	144	128	45	6	3	3	2	1	-	2
13	-	-	-	-	-	-	-	-	-	-	-
14	4	1	-	-	-	-	-	-	-	-	-
15	17	29	32	26	44	75	85	72	37	13	4
16	6	8	13	21	41	55	70	61	36	19	5
17	-	-	-	-	-	-	-	-	-	-	-
18	47	52	56	49	10	-	2	3	-	-	-
19	7	10	4	3	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-
21	-	-	1	-	3	4	6	1	3	-	-
22	-	-	-	2	2	7	12	22	5	5	-
23	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-
25	35	31	29	5	5	14	21	33	44	30	110
26	-	-	-	-	-	-	-	-	-	-	-
27	22	14	3	3	-	-	-	-	-	-	-
28	7	7	2	-	-	-	-	1	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-
30	8	3	19	39	36	25	1	1	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	2	2	1	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-
35	1	-	-	-	-	-	3	8	1	-	3
36	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-
38	10	1	2	-	2	5	5	5	1	-	1
39	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	1	8	15	4	-
41	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-
43	-	-	6	17	39	63	68	32	8	5	-
44	-	-	-	-	-	-	-	-	31	66	-
45	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-
TOTAL	433	349	319	227	206	289	354	334	214	146	129

Table 9. RETIREMENT AGE AND CHOICE OF ROUTE
(h = 0.25; $\alpha = 0.5$; A2; DM)

Route	Age at retirement										
	55	56	57	58	59	60	61	62	63	64	65
1	7	-	-	-	-	-	-	-	-	-	-
2	30	-	3	-	1	-	1	1	1	1	-
3	-	-	-	-	-	-	-	-	-	-	-
4	4	-	-	-	-	-	-	-	-	-	-
5	68	37	35	12	3	2	4	4	3	-	1
6	-	-	-	-	-	-	-	-	-	-	-
7	3	-	-	-	-	-	-	-	-	-	-
8	21	2	3	1	4	9	31	35	6	2	-
9	15	11	8	8	12	17	41	57	33	9	3
10	-	-	-	-	-	-	-	-	-	-	-
11	41	1	-	-	-	-	-	-	-	-	-
12	149	145	140	74	15	2	3	2	2	-	2
13	-	-	-	-	-	-	-	-	-	-	-
14	5	-	-	1	-	-	-	-	-	-	-
15	27	14	25	26	45	54	87	46	29	8	4
16	6	10	11	13	29	41	53	40	31	7	2
17	-	-	-	-	-	-	-	-	-	-	-
18	57	35	49	43	17	2	2	2	-	-	-
19	7	6	9	1	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-
21	-	2	-	-	1	1	1	3	-	-	-
22	-	-	-	2	2	1	6	12	6	1	1
23	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-
25	62	34	47	23	11	17	32	35	53	41	131
26	-	-	-	-	-	-	-	-	-	-	-
27	32	12	11	5	-	-	-	-	-	-	-
28	8	5	5	3	-	-	1	1	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-
30	-	7	12	21	27	22	3	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	2	1	1	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-
35	2	-	-	-	-	1	1	7	5	1	1
36	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-
38	16	-	1	2	-	3	4	4	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	9	8	2	-
41	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-
43	-	-	1	4	28	54	54	20	1	3	-
44	-	-	-	-	-	-	-	-	31	64	-
45	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-
TOTAL	560	321	362	240	196	226	324	278	209	139	145

Another major difference when there is differential mortality is that some of the money purchase routes, notably 27, 35, 43 and 44, become optimal for a significant minority of the cohort. Further analysis of individuals and their characteristics suggest the following patterns. First, the money purchase routes involving bank accounts are only used by those of below average life expectancy, who leave an estate. Second, route 25, the 100% annuity route, is strongly favoured by high income, high longevity individuals. Third, earlier retirement ages are typically associated with those on low earnings, and with low ages of survival.

A general result with differential mortality is that the lower the earnings, the earlier the preferred age at retirement and vice versa. Thus the introduction of differential mortality has the following general effects by comparison with common mortality. First individuals with high incomes and low mortality are inclined to buy more annuity income and retire later. Second, individuals with low incomes and high mortality are inclined to buy less annuity income and retire earlier. The net effect is a flattening of the distribution of the age of retirement. This is a complimentary net effect to that of introducing a universal pension.

Table 9 shows the choices made using the cheaper annuity purchase rates, A2, and the difference relative to Table 8 is much the same as that between Tables 6 and 5. Essentially, those who are responding to the means-test thresholds are able to buy their optimal level of income for less. This is achieved either by retiring sooner (if the relative utility of their earnings is decreasing) or later (if the advantage of lower rates outweighs the falling utility of earnings). This effect depends on the individual's earnings profile.

The two fringe classes who lie outside the means-test influence are simply able to buy a higher level of income than before. The lower purchase rates result in a slight shift in that some will be brought up into the range of income influenced by the means-test and some will rise beyond it. Table 10 shows results of combining a universal pension with differential mortality. Again, the universal pension eliminates the lowest mode.

Table 10. RETIREMENT AGE AND CHOICE OF ROUTE
(h = 0.25; α = 0.5; A1; DM) Universal Pension.

Route	Age at retirement 55	56	57	58	59	60	61	62	63	64	65
1	6	-	-	-	-	-	-	-	-	-	-
2	23	2	9	9	6	4	3	2	1	-	-
3	-	-	-	-	-	-	-	-	-	-	-
4	4	-	-	-	-	-	-	-	-	-	-
5	64	46	47	58	39	32	16	21	7	5	-
6	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-
9	2	2	-	1	1	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-
11	28	2	-	1	-	-	-	-	-	-	-
12	101	123	183	151	143	119	70	39	17	6	2
13	-	-	-	-	-	-	-	-	-	-	-
14	1	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-
16	-	-	1	1	-	-	-	-	-	1	-
17	-	-	-	-	-	-	-	-	-	-	-
18	39	33	46	46	34	30	15	5	2	2	1
19	2	2	3	7	5	10	4	2	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-
25	16	21	31	56	73	102	86	84	61	47	98
26	-	-	-	-	-	-	-	-	-	-	-
27	41	25	18	12	7	4	-	-	-	-	-
28	9	5	23	23	34	32	21	11	1	1	-
29	-	-	-	-	-	-	-	-	-	-	-
30	3	2	2	1	3	12	9	14	6	4	-
31	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	3	8	6	8	1	1	1	-
34	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-
38	6	-	-	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-
41	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-
43	-	-	6	14	39	57	55	24	3	8	-
44	-	-	-	-	-	-	-	1	25	49	-
45	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-
Total	345	263	369	383	392	408	287	204	124	124	101

<u>Earnings profiles</u>

It was suggested above that a factor in the determination of the optimum retirement age, in addition to the tax and transfer structure, is the shape of the individual's earnings profile. The benefits of an extra year's earnings must be balanced against those of an extra year of leisure in retirement and the impact of the means-tested pension. Each individual in the simulations experiences a unique earnings profile, based on the use of a stochastic model of earnings estimated using Australian data; see Appendix 1 for further details. The model implies that, on average, those with relatively higher earnings experience their peak earnings relatively later than those with relatively lower earnings; for further discussion of this phenomenon, see Creedy (1985, p. 68). The parameters used in the above simulations imply, however, that an individual who experiences the median income of the cohort in each year of working life receives peak real earnings at about age 50 years, although nominal median earnings never fall over the relevant period. Arithmetic mean real earnings reach a peak about 3 ½ years later.

It is therefore worth considering the effects of somewhat steeper age-earnings profiles. Simulations were accordingly carried out for alternative parameters, given in Appendix 1, under which the median value of real earnings reaches a peak at about 62 years. The upper deciles reach a maximum substantially later, of course. Results are given in Table 11 for common mortality and annuity purchase rates A1. As expected the modal age of retirement increases and the lower mode disappears, although there remains a substantial amount of early retirement.

The effect of making the age pension universal is shown in Table 12. Again the distribution of age at retirement becomes more widely dispersed. The mode falls by one year although the lower tail contains fewer people. The average optimal retirement age is 61 for both means-tested and universal systems, however. Routes 25 and 28 become substantially more popular, especially among late retirees, as does route 12. The number for whom routes 15 and 16 are optimal falls dramatically; these involve the taking of lump sums (before purchasing an annuity) and consuming all that remains after

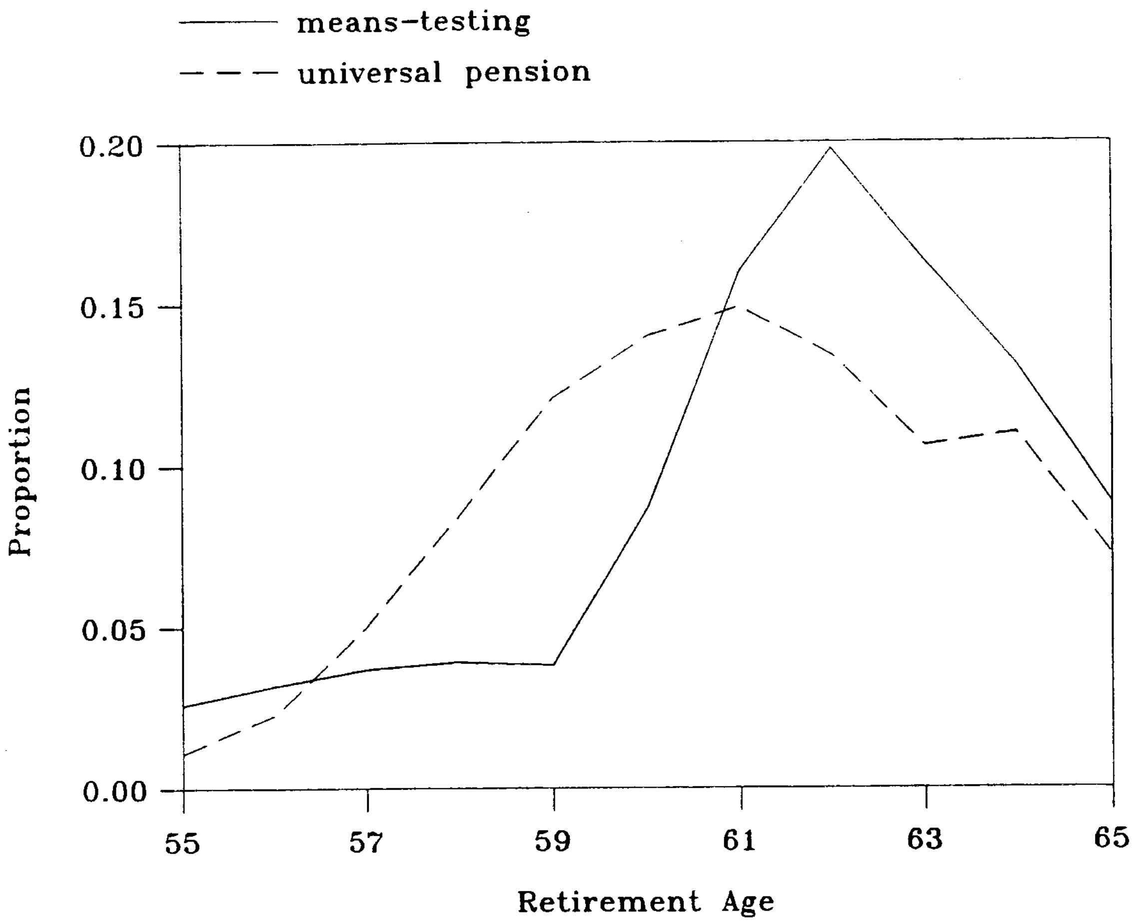

Fig 3. STEEPER EARNINGS PROFILE (MT vs UP)

purchasing a specified proportion (50 and 45% respectively) of final salary, and are obviously driven by the existence of the means-tests.

Contribution rates

An important issue, not mentioned so far, concerns the desirable level of the contribution rates in a mandated superannuation scheme such as the SGC. The scheme is introduced on the (paternalistic) argument that individuals are generally myopic and will not otherwise save enough for retirement. However, there is a possibility that some people are thereby forced to 'oversave'; decreasing marginal utility implies a preference for a smooth consumption stream. Contribution rates that are 'too high' tend to encourage early retirement rather than higher consumption during retirement. Any attempt to increase aggregate savings with such a mandatory scheme would thus be frustrated. It is therefore of interest to examine the implications of a mature scheme in which individuals are faced with lower contribution rates and save less out of disposable income in each year of the working life.

Suppose that the employee and employer SGC contribution rates are reduced to 2 and 6 per cent respectively (from the 3 and 9 per cent used above), and that individuals reduce their additional saving rate to 2.5 per cent (from 5 per cent assumed above). With the base values of $h_t = 0.25$ and $\alpha = 0.5$, and using the annuity rates A1, the average optimal age at retirement, with common mortality, is increased to 62, with the (single) mode increasing to age 64 (when almost a third of the cohort retire). The choice of routes through the maze is dominated by routes 15, 16 and 22 (the most popular among the late retirers). Each of these defined benefit routes involves the superannuation assets being taken as a lump sum before an annuity is purchased (to achieve 50, 45 and 35 per cent respectively of the average earnings over the final three working years), with the remaining assets (if any) being consumed at retirement.

The fact that the bank account is not used is driven by the assumptions of common mortality and the draw-down of the account, but it is likely that the use of the lump sums is driven by the tax treatment of annuities and the means test for the age pension. Where the age pension is universal, the average optimal retirement age is reduced by one year to 61, which in this case is also the mode. With a universal pension the optimal routes are dominated instead by 12, 19 and 28 since individuals are not penalised for replacing a higher level of income. The two defined benefit routes 12 and 19 use pre-tax money to purchase of an annuity, while route 28 involves all superanuation funds being used to purchase an annuity and all additional savings being consumed at retirement.

The alternative assumption of differential mortality introduces, as before, a richer range of optimal routes through the maze as more of the money purchase alternatives become optimal and the use of a bank account in retirement is more common. With differential mortality the average age at retirement continues to be 62 (with the mode at 64). Routes 15, 16 and 22 continue to be popular (as with common mortality), though the money purchase routes 40, 43 and 44, which involve the use of a bank account and possible bequests, are frequently used (the modal combination of age and route is in fact age 64 and route 44). The latter two routes do not involve the purchase of an annuity. The choice of routes 15 and 16 is clearly driven by the means test relating to the age pension; with a universal pension these routes virtually disappear and routes 25 and 28 become very popular, with 30 and 33 also being used more frequently. In this case the universal pension has the same mean and modal optimal retirement age, but the distribution is, as usual, more widely dispersed. The question of the appropriate contribution rate (along with the profile of the rate over the life cycle) warrants further investigation.

TABLE 11. RETIREMENT AGE AND CHOICE OF ROUTE
(h = 0.25; α = 0.5; A1; CM) Steeper Earnings Profiles

	Age at retirement										
Route	55	56	57	58	59	60	61	62	63	64	65
1	-	-	-	-	-	-	-	-	-	-	-
2	2	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	9	12	3	-	1	1	2	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-
8	1	2	1	-	1	-	-	-	-	-	-
9	3	7	6	10	9	17	7	2	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-
12	45	53	69	68	10	17	29	46	51	52	57
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-
15	-	6	15	30	68	149	211	143	55	20	-
16	-	2	3	6	17	58	165	269	203	115	14
17	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-
19	-	4	1	-	-	-	-	-	-	-	10
20	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	5	44	116	163	193	75
23	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-
25	13	5	8	2	9	15	21	18	18	11	95
26	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-
28	2	5	5	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-
35	2	-	-	-	-	-	-	-	-	-	8
36	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-	-	1	9
39	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-
41	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-
Total	77	96	111	116	115	262	479	594	490	392	268

TABLE 12. RETIREMENT AGE AND CHOICE OF ROUTE
(h = 0.25; α = 0.5; A1; CM) Universal Pension

Route	Age at retirement 55	56	57	58	59	60	61	62	63	64	65
1	1	-	-	-	-	-	-	-	-	-	-
2	3	-	1	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	7	24	33	31	29	21	1	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-
9	-	1	-	-	-	-	1	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-
12	19	41	102	197	269	292	314	260	188	145	51
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	1	-	-	-
16	-	-	-	-	-	-	-	-	2	1	-
17	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-
19	1	1	-	2	17	24	15	34	25	36	31
20	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	4	14	-
23	-	-	-	-	-	-	-	-	-	-	1
24	-	-	-	-	-	-	-	-	-	-	-
25	1	2	14	19	33	41	54	60	46	9	132
26	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	3	16	41	61	48	54	126	-
29	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-
41	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-
Total	32	69	150	252	364	419	446	403	319	331	215

IV. CONCLUSIONS

This paper has used a simulation model in order to examine the optimal choice both of the retirement age (between the ages of 55 and 65) and the allocation of assets at retirement, involving the route through what has been referred to as the retirement maze. Each simulated member of the cohort was assumed to maximise a lifetime utility function defined in terms of the present value of utility, with each years' utility independently defined as a Cobb-Douglas function of consumption and leisure in the year.

In view of the fact that individuals' preferences are not known and the simulation model requires a number of strong simplifications and assumptions, the results must be treated with caution. However, they suggest the existence of a significant incentive towards early retirement and a substantial impact of the age pension means-tests on the allocation of resources and optimal retirement age of individuals. The extent and nature of incentives were found to vary with the mortality assumption used, and depend on the means tests associated with the age pension. The assumptions of a universal pension encourages later retirement in a substantial proportion of the cohort. The simulations apply to a fully mature SGC scheme, such that the contribution rates apply for each year of the working life. This will not apply until individuals are retiring after approximately the year 2040.

The analysis raises the important question of the appropriate level of contribution rates in a mandated scheme, a subject that warrants further attention. Results were presented which suggest that lower contribution rates encourage a later preferred retirement age.

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APPENDIX 1. THE LITES MODEL

The model is designed to simulate the earnings, taxation, savings and superannuation contributions and benefits of a simulated cohort of individuals under a variety of conditions: for a full description see Atkinson, Creedy and Knox (1994).

Earnings profiles

Gross earnings in each year of working life are generated using a model of age-earnings profiles in which earnings in age group t are lognormally distributed as $\Lambda(\mu_t,\sigma_t^2)$, where μ_t and σ_t^2 are respectively the mean and variance of the logarithms of earnings. These two parameters are assumed to be quadratic and linear functions of t respectively, so that :

$$\mu_t = \mu_1 + (\theta + g)t - \delta t^2 \qquad \text{(A1)}$$

$$\sigma_t^2 = \sigma_1^2 + \sigma_u^2 t \qquad \text{(A2)}$$

where g is the nominal growth rate of earnings which affects all age groups equally. The five parameters μ_1, σ_1^2,θ,δ and σ_u^2 were estimated, using data for Australian male, by Creedy (1992), and are μ_1 = 9.98064, θ = -.0385, δ = -.00086, σ_1^2 = -.1817, σ_u^2 = -.00575, g = -.06. For the steeper earnings profiles, θ and δ were changed to -.04 and -.0006 respectively.

Age at Death

Where differential mortality is assumed, the number of years the individual survives after retirement, d, is obtained, following Creedy (1982), using the following formula:

$$d = \bar{d} + \beta \log \frac{\bar{X}}{M} + v \qquad (A3)$$

where $\bar{X}$ is the individual's annual average real earnings, M is the geometric mean value of the $\bar{X}$s, $\bar{d}$ is the average number of years individuals in the general population survive after retirement, and v is distributed as N(0, s_v^2). The values used to calibrate the model were taken from Cameron and Creedy (1995) and are:

$\bar{d} = 14.6$, $\beta = 8$, and $s_v^2 = 50$.

Tax and other rates

The relevant income tax rates and thresholds used, along with rebate levels, are those operating in Australia in 1994. They are indexed each year using the rates indicated below. Other major economic assumptions used in the simulation are shown in Table A1.

TABLE A1. ECONOMIC ASSUMPTIONS USED

Tax on super fund investment income	7.5%
Tax on savings fund investment income	25%
Annual increase in AWOTE	6%
Annual increase in income tax thresholds	5.5%
Annual inflation rate	5%
Gross annual investment rate of return on Super accumulation	9%
Gross annual investment rate of return on Savings accumulation	7%
Gross annual rate of return on Bank account during retirement	5%
Annuities purchased escalate in payment at	5%

APPENDIX 2. VARIATIONS IN α AND h

Tables A2.1, A2.2 and A2.3 illustrate the effects of changing the values of α and h_t from the base case, while retaining annuity rates A1 and the assumption of differential mortality. Comparing Tables 8 and A2.1 shows the effect of increase α alone; that is, attaching more weight to consumption compared with leisure. This is obviously expected to reduce the extent of early retirement. However, a less obvious result is that the importance of different routes through the maze changes substantially. With $\alpha = 0.6$, very few select routes 12, 5, and 27. Those retiring in their early 60s select mainly routes 8 and 9, along with 35. Later retirees prefer 25 and 44. The higher value of α also eliminates the bimodality in the distribution of optimal age at retirement.

A comparison of Tables A2.2 and 8 shows the effect of a higher value of h_t during the working life. There is a drift towards later retirement ages, resulting from the smaller increase in leisure on retirement, but there is little effect on the optimal choice of route.

Table A2.1. RETIREMENT AGE AND CHOICE OF ROUTE
(h = 0.25; α = 0.6; A1; DM)

Route	Age at retirement										
	55	56	57	58	59	60	61	62	63	64	65
1	3	3	5	2	-	2	2	1	2	4	5
2	1	5	3	4	-	-	1	1	1	2	12
3	-	-	-	-	-	-	-	-	-	-	-
4	-	1	1	2	3	-	-	-	-	1	2
5	-	-	-	-	-	-	-	-	1	-	7
6	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	3	3	4	-	-	-
8	1	1	3	5	18	32	57	114	110	189	52
9	-	-	-	1	-	2	10	29	29	81	63
10	-	-	-	-	-	-	-	-	-	-	-
11	-	2	6	6	6	-	1	1	-	1	3
12	-	-	-	-	-	-	-	-	-	-	2
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	2	5	1	2	2	-
15	-	-	-	-	-	1	1	3	19	68	44
16	-	-	-	-	-	-	-	2	2	31	33
17	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	1	-	-	-	-	2
19	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	1	5	14	83	-
22	-	-	-	-	-	-	-	-	-	8	11
23	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	1	-	-	9	11	15	293
26	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	1	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-
30	-	1	2	2	8	4	-	-	-	-	2
31	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	2
34	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	1	5	11	34	77	95	51	116
36	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-
38	-	1	2	2	1	6	4	16	6	-	-
39	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	2	4	11	14	8
41	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-
43	-	-	-	-	5	5	17	8	-	3	12
44	-	-	-	-	-	-	-	5	48	668	158
45	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-
TOTAL	5	14	22	25	47	69	139	280	351	1221	827

Table A2.2. RETIREMENT AGE AND CHOICE OF ROUTE
(h = 0.3; α = 0.5; A1; DM)

Route	Age at retirement										
	55	56	57	58	59	60	61	62	63	64	65
1	7	-	-	1	1	-	-	-	-	-	-
2	16	6	7	2	3	-	3	5	3	3	4
3	-	-	-	-	-	-	-	-	-	-	-
4	4	-	-	-	-	-	-	-	-	-	-
5	37	40	39	38	3	2	2	5	6	9	4
6	-	-	-	-	-	-	-	-	-	-	-
7	3	-	-	-	-	-	-	-	-	-	-
8	10	5	12	14	23	50	75	68	40	13	6
9	7	5	18	17	43	65	72	84	58	32	10
10	-	-	-	-	-	-	-	-	-	-	-
11	25	9	9	6	-	-	-	-	-	-	1
12	39	55	51	13	3	2	1	1	1	-	2
13	-	-	-	-	-	-	-	-	-	-	-
14	1	1	1	-	-	-	-	-	-	-	-
15	4	51	1	12	31	77	74	82	60	32	8
16	1	-	-	2	2	15	24	39	31	31	10
17	-	-	-	-	-	-	-	-	-	-	-
18	9	25	30	49	42	11	1	1	4	-	-
19	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	1	12	11	4	-	-
22	-	-	-	-	-	1	3	4	9	10	-
23	-	-	-	-	-	-	-	-	-	-	-
25	4	3	11	11	5	8	11	23	22	43	156
26	-	-	-	-	-	-	-	-	-	-	-
27	9	2	1	-	-	-	-	-	-	-	-
28	3	3	3	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-
30	3	1	6	18	28	15	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	1	-	1	-	-	-	-	1	-
34	-	-	-	-	-	-	-	-	-	-	-
35	1	-	-	1	-	1	14	21	9	1	9
36	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-
38	3	-	2	5	-	1	10	-	-	-	1
39	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	4	18	15	19	1
41	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-
43	-	-	1	13	32	50	84	34	21	19	1
44	-	-	-	-	-	-	-	1	32	199	6
45	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-
TOTAL	186	160	203	202	217	299	390	397	315	412	219

Table A2.3. RETIREMENT AGE AND CHOICE OF ROUTE
(h = 0.3; α = 0.6; A1; DM)

Route	Age at retirement										
	55	56	57	58	59	60	61	62	63	64	65
1	2	-	4	2	-	-	1	1	2	4	7
2	-	1	-	3	-	-	-	1	-	-	12
3	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	2	4	-	-	-	2	-	3
5	-	-	-	-	-	-	-	-	-	-	7
6	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	2	2	4	6	-	-
8	-	-	1	-	3	11	26	58	101	237	85
9	-	-	-	-	-	1	3	8	19	70	82
10	-	-	-	-	-	-	-	-	-	-	-
11	-	-	2	2	1	-	1	-	-	1	5
12	-	-	-	-	-	-	-	-	-	-	2
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	1	3	9	6	-
15	-	-	-	-	-	-	-	-	4	56	64
16	-	-	-	-	-	-	-	-	-	9	46
17	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	2
19	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	2	8	112	6
22	-	-	-	-	-	-	-	-	-	-	13
23	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-
25	-	1	-	-	-	1	-	7	8	13	308
26	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-
30	-	1	-	-	4	1	-	-	-	-	2
31	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	2
34	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	7	20	62	100	72	170
36	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-
38	-	1	1	3	2	5	11	23	23	7	-
39	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	1	5	8	6	14
41	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-
43	-	-	-	-	1	6	4	3	3	2	21
44	-	-	-	-	-	-	-	3	35	639	262
45	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-
TOTAL	2	4	8	12	15	34	70	180	328	1234	1113

FOOTNOTES

1. Kingston (1995) argued that this flow condition is a necessary but not a sufficient condition for retirement. He examined a 'stock' condition in a model of labour supply and portfolio choice. The approach followed below also amounts to the use of a stock condition.

2. Using the basic LITES model, Ryan (1995) examined these questions using three simulated individuals (those having the upper and lower quartiles, and the median, in each age over the life cycle) and two routes through the maze, where 'lifetime utility' was specified as a function of the present value of consumption and the number of years in retirement.

3. This is not the appropriate place to rehearse the arguments for and against the universal pension, thought it is worth stressing that the choice ultimately depends on value judgements. For further discussion of the issues see, for example, Barker et al (1994), Mitchell et al (1994) and Knox (1995).

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