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# THE EARNINGS-RELATED STATE PENSION, INDEXATION AND LIFETIME REDISTRIBUTION IN THE U.K.

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The redistributive impact of the U.K. state pension scheme is examined. Benefit-cost ratios are calculated using individual lifetime earnings profiles constructed for a cohort of men drawn from cross-section data. The scheme is investigated at maturity and revenue neutrality is imposed in order to isolate the intra-generationally redistributive effects of the pension scheme.

The results suggest that differences in returns to the pension scheme are driven by differential mortality, which outweigh the redistributive effect of the two-tier benefit structure. Various reforms of the pension scheme are then simulated, and solved for revenue neutrality. The results suggest that a great deal of care is needed in formulating reforms if redistributive objectives are to be achieved.

## I. INTRODUCTION

How much will it cost to provide public pensions in the future? Who benefits most from pension schemes among any given cohort of individuals? What are the redistributive impacts of widely canvassed reforms of the public pension scheme? Current and expected pension benefits are of growing importance among wealth holdings in industrialised countries,[1] and these questions are of importance to public debates concerning optimal pension policy. However, answers to them require detailed microsimulation models of pension schemes.

Those involved in pensions policy-making have often bemoaned the absence of such models and the enforced reliance on aggregate official simulations which yield neither clear distributional interpretations nor behavioural content (Peacock,

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[1]On the United States, see *inter alia* Wolff, 1983; Hurd and Shoven, 1985; Quinn, 1985; and Hurd, 1990. On the United Kingdom, see Dunn and Hoffman, 1983; and Johnson *et al.* 1992. On Canada, see Wolfson, 1987; on France, Kessler and Masson, 1987; and on Germany, see Schmahl, 1989.

1992). However, microsimulation models of this type are hard to construct given the complexity of most public pension schemes, and the difficulty of simulating or estimating by regression methods realistic individual longditudinal earnings and event histories from which to calculate benefit entitlements and tax or "contribution"payments. Care, too, must be taken in defining redistribution in a consistent and plausible manner. The application of microsimulation techniques is discussed in Orcutt *et al.* (1986), but there are still few studies which use these methods to model pension schemes.[2] This paper represents one contribution to that literature.

We report the results of a disaggregated simulation of some significant aspects of the public pension scheme operating in the United Kingdom. The primary focus is to illustrate how the two tiers of the benefit scheme and the contribution rules in the U.K. interact to generate redistributive outcomes, and how these interactions are affected by pre and post-retirement indexation rules. Pension schemes in OECD countries typically impose non-linearities of benefit entitlements and contribution levels over eligible earnings, and the consequences of these for the redistributive impacts of the schemes are not always appreciated.[3]

To render the simulation reasonably tractable, we have focussed on a single cohort of men, who are assumed to have uninterrupted employment histories from their entry to the workforce until they reach state pensionable age at 65 in the year 2025. Lifetime earnings profiles are constructed for a sample of men in this cohort obtained from nine years of the *Family Expenditure Survey* (1978–86). The exact details of the U.K. public pension scheme are then modelled, and individual benefit and contribution histories, as well as net and gross lifetime earnings, are calculated.

The pension scheme is examined at maturity; that is, in steady state. Revenue neutrality is imposed by setting the accumulated sum of aggregate contributions to retirement equal to the aggregate value of discounted benefits at retirement. The calculated individual benefit-cost ratios thereby permit exact measures of intragenerational redistribution across the sample. The framework can then be used to examine the redistributive consequences of alternative benefit and tax (contribution) structures, as well as indexation arrangements. By solving the model for revenue neutrality, the steady state aggregate costs of the alternative proposals can be obtained.

Although the simulations undertaken here provide detailed distributional information as to a range of policy options, the present study does not examine several aspects of the U.K. pension scheme. The distributional implications of pensions for women are ignored, although it is known from stylised earnings and employment profiles that the U.K. scheme implies significant redistribution from men to women (Hemming and Kay, 1982; Owen and Joshi, 1990). Forecasting

[2]In addition to the present work on the U.K. Pudney (1992) is in the early stages of an ambitious simulation of both event histories and earnings histories with which to calculate some salient features of the U.K. pension scheme. Richard Wertheimer and his colleagues have been undertaking a dynamic simulation of the U.S. scheme for some time (see Orcutt *et al.*, 1986, and Zedewski, 1984). The authors have seen some unpublished French work which partially disaggregates pension projections.

[3]A brief summary of various schemes is contained in Heller, Hemming and Kohnert (1986), Appendix II. A recent discussion of the non-linearities in the U.S. system is Aaron *et al.* (1989), pp. 26–30.

employment histories for women is however fraught with difficulties: past experience may offer little guide to the future participation of youthful cohorts of women. For similar reasons, the consequences of divorce are ignored (see Joshi and Davies, 1991, for stylistic evidence).

Most problematic is the issue of survivors' benefits. A central issue in the present paper is the consequence for intragenerational redistribution of differential longevity among men, but the differential survival of spouses is an important determinant of *ex post* redistribution (Aaron, 1985). The issue of spouses' survival covariances is however beyond the remit of the present paper.

## II. Background; Pensions in the U.K. and Methodology

### *Public Pension Provision in the United Kingdom*

This sub-section and the Appendix describe the components of the public pension scheme in the U.K. which are necessary to understand the operation of the microsimulation model and the distributions generated by it; for full details of the scheme see Tolley's (1990), and Ogus and Barendt (1988). The key facets, notably the interaction of the two components of the scheme of pension benefits and the floor and ceiling of the contribution schedule, are described briefly here.

The social insurance scheme of pension benefits in the U.K. has two components: a flat rate pension, and the state earnings-related pension, known by the acronym SERPS. Individuals qualify for both components of the pension scheme by paying an earmarked tax, the National Insurance (NI) contribution. With an uninterrupted earnings history, an individual will obtain both a flat rate (lump sum) pension, the level of which relative to earnings will depend on the movement of earnings and prices in the future, and a SERPS pension equal to 20% of eligible average pre-retirement earnings

NI contributions are payable above an earnings floor, the Lower Earnings Limit (LEL), set approximately equal to the level of the basic flat rate state pension for a single person. This is currently around 15% of male average earnings. In recent years, the value of the pension (and therefore the NI floor) has been indexed in line with price inflation, which has lagged considerably behind earnings growth in the U.K.[4] The employees' component of the NI contribution is payable only up to a ceiling, the Upper Earnings Limit (UEL), which has in recent years been set at around seven and a half times the LEL.[5]

Entitlement to the basic flat rate pension depends on earnings being greater or equal to the LEL in any year. However entitlement to SERPS is derived in a more complex manner. For each year for which earnings are above the LEL, earnings up to the UEL are eligible for SERPS entitlement. These earnings are revalued to pensionable age in line with the growth of average economy-wide earnings. On reaching state pensionable age, these revalued earnings are cumulated and averaged, and the value of the LEL *in the year prior to reaching state*

[4]From 1973 to 1981, the pension and the earnings limits were indexed in line with the faster of earnings or price inflation.

[5]The ratio of the UEL to the LEL is fixed by statute at a ratio of between 6.5 and 7.5. The UEL is currently around the value of male mean earnings.

*pensionable age* is deducted (remember that this is the approximate value of the basic flat rate pension). The SERPS entitlement is then determined by multiplying the net revalued earnings figure by the cohort and sex-specific accrual rate.

The specific two-tier structure of pension benefits in the U.K. is unusual, although a similar arrangement exists in Japan (Shimono and Tachibanaki, 1985). However, the interaction between contribution and benefit earnings thresholds, and the application of differential indexation arrangements to various aspects of the pension calculation, are not unusual internationally. Note for example that in the U.K., future pension entitlements will be governed by individual earnings growth, price inflation and economy-wide earnings growth. The relative rates of growth of these variables have complex effects, which can be intuitively considered in the context of two simple "reforms" of the U.K. pension system.

Suppose, for example, that the government decided to index the basic flat rate pension post-retirement to average earnings growth rather than prices, so as to maintain pensioner living standards relative to earnings. This would also raise the floor, and ceiling, between which NI contributions were made, and thus change the segment of the earnings distribution on which contributions are levied and SERPS benefits received. Very low earners would fall outside the pension scheme, while higher earners find a greater segment of their earnings liable to NI contributions but also eligible for SERPS benefits (Disney and Whitehouse, 1991*a*). On the other hand, a greater value of the LEL would be deducted from the SERPS entitlement at pensionable age. Clearly, the redistributive implications of this change are complex. In similar vein, a proposal to abolish the UEL in order to improve the revenue-elasticity of the NI contribution system would also affect the future SERPS entitlements of high earners.[6] These are among the reforms considered in Section III below.

*Measuring Intragenerational Redistribution*

Before proceeding to the simulation, it is necessary to consider briefly what is meant by redistribution. One important distinction, made for example by Aaron (1985), is between *ex ante* and *ex post* redistribution. The latter looks at the past lifetime earnings, event history, benefits and contributions of a retired cohort. Strictly, with living members there can be no complete *ex post* analysis, but some aspects of the pension system, such as dependants', survivors' and disability benefits, can be examined more accurately. Although data of this kind are extremely useful, they give only limited information as to the expected pensions of those currently in the workforce.

In contrast, the drawback of an *ex ante* study is the uncertainty concerning outcomes, such as age of death of the contributor and spouse and health status, which tend to have substantial *ex post* redistributive effects. However, the present study is unusual in taking explicit account of differences in expected mortality,[7]

[6]Both these policies (raising the basic state pension immediately and indexing it to earnings rather than prices, and abolishing the UEL) were proposed by the Labour Party at the 1992 General Election in the U.K.

[7]We have been unable to find other studies of pension redistribution which take account of *ex ante* differences in expected longevity (see, however, Creedy, 1982), although differential mortality will of course be important where pensions (annuities) are not explicitly risk-rated, as is typically true in a public pension scheme.

and in generating future expected lifetime earnings profiles. This goes some way towards offsetting the limitations of *ex ante* studies of redistribution between individuals.

A second issue involves two interrelated aspects: the treatment of steady state or mature schemes, and the imposition of revenue neutrality. In a comparison between cohorts in a pay-as-you-go framework, in which annual revenue neutrality is imposed, any measure of overall redistribution would contain both inter- and intragenerational components.[8] However, when examining the returns to different members of the same cohort, an assumption of lifetime average revenue neutrality is more appropriate. This requires that, in the aggregate, accumulated contributions to retirement equal discounted benefits at retirement. Without this restriction, comparisons of reforms can prove highly misleading; a practical example is given by Kennedy (1990). The restriction is equivalent to treating the pension scheme as if it were fully funded. Furthermore, returns must be compared in the scheme's mature or steady state.

Treating the pension scheme as fully-funded may appear at odds with the pay-as-you-go character of the scheme in practice, but as Aaron argues, setting the discount rate equal to the rate of growth of earnings in a mature *pay-as-you-go scheme* (which is done here) is sufficient to obtain a measure of intragenerational redistribution purged of the effects of accelerated accrual and inter-generational redistribution (with zero population growth). Thus it is the steady state assumption, and the treatment of the discount rate, rather than the funding issue, which are crucial. A further attraction of the present procedure is that it calculates the change in the average contribution rate needed to finance a given reform.

Failure to retain revenue neutrality can generate misleading measures of inequality, as is illustrated with a simple example. Take a two-period case in which the budget constraint equates the pension per person with the accumulated contributions per person. If $b$ is a flat-rate pension, $c$ the contribution rate, $\hat{y}$ average income and $r$ the discount rate, then

(1) $$b = c\hat{y}(1+r), \text{ so that } c = \frac{b}{\hat{y}(1+r)}.$$

Net income, $z$, is given by:

(2) $$z = \hat{y}(1-c) + \frac{b}{(1+r)}.$$

It can be shown that the coefficient of variation of $z$, $\eta_z$, is given by:

(3) $$\eta_z = \eta_y \left[1 + \frac{b}{(1+r)(1-c)\hat{y}}\right]^{-1}.$$

[8]It is well known that early cohorts tend to earn higher rates of return in state pension schemes due to accelerated accrual of pension benefits. As schemes mature, these "excess" returns disappear (Aaron, 1985). For a demonstration in the U.S context, see Hurd and Shoven (1985); in the U.K. context, Disney and Whitehouse (1993*b*). The cohort used here has an accrual rate close to the "steady state" rate for the U.K. pension scheme as revised in the Social Security Act, 1985.

However, substituting the revenue neutral condition, (1) into (2):

$$\eta_z = \eta_y \left[1 - \frac{b}{(1+r)\hat{y}}\right] \tag{4}$$

and differentiation gives:

$$\frac{d\eta_z}{db} = \frac{-\eta_y}{\hat{y}(1+r)} = \frac{-\eta_z}{\hat{y}(1+r)-b}. \tag{5}$$

The reduction in the inequality of net earnings relative to gross earnings is less in absolute terms when the cost of financing the reform is ignored, than in equation (5), where the correct budget constraint is inserted.[9] This result applies notwithstanding the fact that the contribution schedule is proportional and suggests that the redistributive effect of any tax-and-transfer scheme, or any reform thereof, does not depend on the progressivity or otherwise of any single part of the scheme but on the structure of the scheme as a whole, and the application of the appropriate budget constraint.

## III. The Simulation Model

### *Earnings Profiles*

The model of lifecycle earnings underlying the pension simulation is based on a sample of over 30,000 male employees drawn from a nine year pool of Family Expenditure Survey data for the years 1978 to 1986. The procedure used to calculate earnings profiles is described in detail in Disney and Whitehouse (1991*b*). Broadly speaking, regression equations disaggregated to the level of industry and occupation are used to estimate cross-section age-earnings profiles. Given actual observed earnings within the 1978–86 sample, movements in occupation and industry differentials are projected to the present.

In addition to age-earnings effects, two percent per annum real earnings growth is assumed in the future. Information on labour market entry date is utilised in the simulations. Mobility between industries and occupations, and within income groups for industries and occupations are not modelled. Despite these limitations, there is a high degree of variation in individual age-earnings profiles among our sample.

One cohort, born in 1960, entering the labour market on or after 1978 and retiring in 2025, was selected for the present analysis, comprising 824 individuals.[10] Entry to the labour market of members of this cohort without tertiary schooling coincides with the introduction of SERPS. A frequency distribution of their calculated gross lifetime earnings discounted at 2 percent (the rate of average earnings

[9]In essence, the increase in the contribution rate which is needed for budget balance reduces the importance of the first RHS term in (2) relative to the weight of the second. However, since the benefit is flat rate, the overall inequality measure is generated by the weight attached to the first term.

[10]17 individuals did not report any earnings at or above the LEL and are excluded from the distributional comparisons. There is a slight sample selection problem on individuals drawn from the earliest FESs: those still in tertiary education in 1978–81 will not appear in the sample so that higher earners are slightly unrepresented as a whole. This reflects the trade-off between duration of SERPS tenure and sample balance.

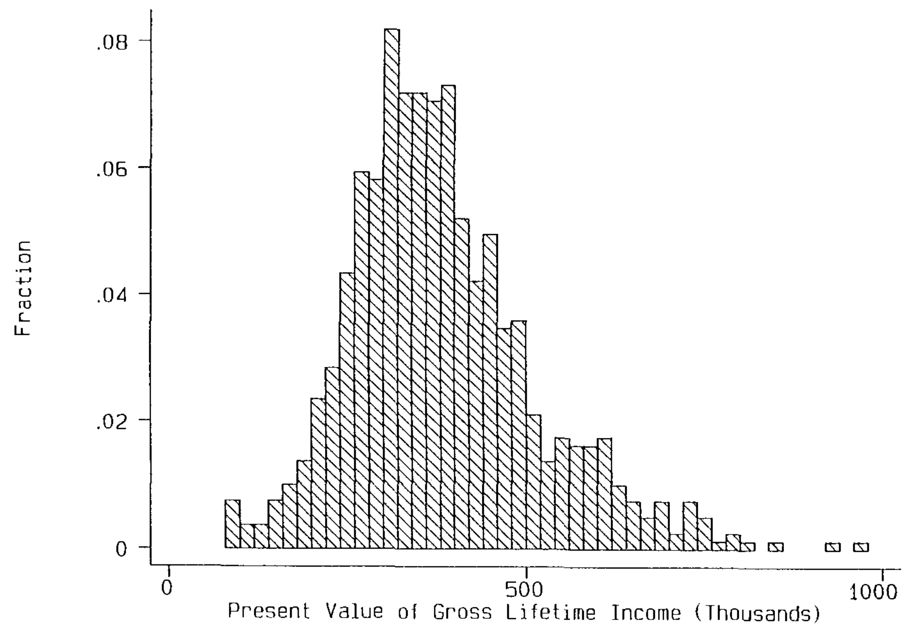


Figure 1. Distribution of Gross Lifetime Income

growth assumed post-1990) is depicted in Figure 1. The distribution exhibits the expected positively skewed shape, suggesting that the simulation yields a plausible distribution.

*Differential Mortality*

An important determinant of an individual's return on pension contributions is age at death. Therefore the extent of intragenerational redistribution is affected by systematic differential mortality given the absence of individual risk-rating in most public pension schemes. It is known that age at death differs systematically among industries and occupations. The expected length of life can therefore be obtained using the industry and occupation-specific standardised mortality ratios (SMRs) described in OPCS (1990). The expected values are applied to the individuals in the simulated cohort.

As shown later, the assumption of differential mortality plays a major part in lifetime pension redistribution, and no studies to our knowledge have addressed this issue at a disaggregated level. However our method involves two strong assumptions. The first, of no mobility between occupations and industries, will overstate the dispersion of pension entitlements if there is regression to mean longevity by occupational mobility.[11] The second is that everyone within the industry and occupation dies at the same age, i.e. we do not estimate the occupational

[11]For example, most coal miners would die before reaching pensionable age, and many transfer to less onerous occupations prior to pensionable age. Those occupations in turn have reduced longevity because of the presence of ex-coal miners. However, it is not self-evident that all occupational mobility is mean-regressing.

and industry-specific hazard functions. By not doing so, we probably understate the degree of redistribution because our method ignores the possibility of zero benefits stemming from death in service.[12]

A further possible weakness is that mortality may differ systematically *within* occupations and industries, related to, say, lifetime earnings. It is interesting however to note the relationship between annual average lifetime earnings ($Y$) and the expected age of death, $D$, given by these SMRs, for the sample as a whole. The following regression was obtained:

$$\ln D = \underset{(2.47)}{64.66} + \underset{(0.429)}{2.253} \ln Y \tag{6}$$

$$n = 824 \quad R^2 = 0.0325 \quad \text{RMSE} = 6.244$$

Unadjusted standard errors in parentheses

Expected age at death is sensitive to earnings through occupational and industrial affiliation, and this has a major impact on expected returns on pension contributions, as shown below. Interestingly, the approximate magnitudes of the coefficient on income in equation (6), and the descriptive statistics, confirm the simulation of Creedy (1982). In attempting to derive parameter values for the impact of earnings dispersion on mortality rates consistent with the observed survival curve (ignoring occupational and industrial affiliation), Creedy found that a value of the coefficient on $Y$ of 2, and a MSE of 36 (RMSE of 6) were consistent with the observed curve.

Creedy's values from an earnings-based simulation are consistent with those estimated by regression analysis on industrial and occupational average earnings here, suggesting that the positive relationship between longevity and earnings derives largely from occupation and industry affiliation. In fact the coefficient in (6) is slightly higher than Creedy found, which may indicate either that higher earners (presumably harder workers) in an occupation or industry die earlier, or that occupational and industrial mobility is slightly reducing the dispersion in age of death. However the effects of these factors would appear to be small.

*Pensions, Contributions and Benefit-cost Ratios*

Given the rules governing pension entitlements, the payment of contributions (section II), the derivation of individual lifetime earnings profiles and the impact of differential mortality through SMRs, it is possible to model pension entitlements, contributions and rates of return. These are steady state revenue-neutral comparisons, with future benefits and contributions discounted at a rate of 2 percent per annum where appropriate. Table 1 illustrates the baseline means, coefficients of variation, Gini coefficients and Atkinson Inequality measures (for inequality aversion values of 0.5, 1 and 3) for the various income, pension and contribution measures, as well as the baseline model assumptions. These assume that the UEL is a multiple of seven times the LEL, which is slightly less than the current ratio.

[12] Again, following the previous footnote, we assumed all workers in the coal and mineral industry would live to 65 even though the mean expected age is lower than pensionable age (65).

TABLE 1

BASELINE ASSUMPTIONS AND DISTRIBUTIONS

| | | | |
|---|---|---|---|
| Present Value of Gross Earnings | | | |
| Mean | Coefficient of Var. | Atkinson Measure (0.5, 1.0 and 3.0) | Gini |
| 384,314.5 | 0.3548 | 0.0295 0.0591 0.1920 | 0.1887 |
| Annual Average Gross Earnings | | | |
| Mean | Coefficient of Var. | Atkinson Measure (0.5, 1.0 and 3.0) | Gini |
| 13,762.7 | 0.3613 | 0.0304 0.0608 0.1956 | 0.1915 |
| Distr. of Post-contribution Lifetime Earnings | | | |
| Mean | Coefficient of Var. | Atkinson Measure (0.5, 1.0 and 3.0) | Gini |
| 367,338.6 | 0.3648 | 0.0309 0.0618 0.1977 | 0.1935 |
| Distribution of Accumulated Contributions | | | |
| Mean | Coefficient of Var. | Atkinson Measure (0.5, 1.0 and 3.0) | Gini |
| 41,384 | 0.1683 | 0.0087 0.0190 0.0930 | 0.0877 |
| Distribution of Pensionable Earnings | | | |
| Mean | Coefficient of Var. | Atkinson Measure (0.5, 1.0 and 3.0) | Gini |
| 16,210.2 | 0.1683 | 0.0087 0.0190 0.0930 | 0.0877 |
| Discounted Benefits to Retirement | | | |
| Mean | Coefficient of Var. | Atkinson Measure (0.5,1.0 and 3.0) | Gini |
| 41,472.1 | 0.4718 | 0.0600 0.1258 0.4274 | 0.2642 |
| Distribution of Net Lifetime Income | | | |
| Mean | Coefficient of Var. | Atkinson Measure (0.5, 1.0 and 3.0) | Gini |
| 384,350.5 | 0.3550 | 0.0294 0.0587 0.1891 | 0.1881 |

| | |
|---|---|
| Rate of Interest: | 0.02 |
| Initial Lower Earnings Limit | 1,818.14 |
| Ratio of UEL to LEL (Contributions) | 7.00 |
| Ratio of UEL to LEL (Pension) | 7.00 |
| Employees NI Contribution Rate | 0.0555 |
| Proportional SERPS Pension Rate | 0.200 |
| Pension Adjustment Post Retirement | 0.000 |
| Pensionable Earnings Adjustment Rate | 0.020 |
| Rate of Adjustment to LEL, UEL | 0.000 |
| Sample Size | 807 |

The contribution rate, of 5.55 percent, is derived as a solution of the model under the assumption of revenue neutrality. The indexation assumptions, set at 0 percent, are normalised on price inflation.

There are a number of interesting features of Table 1. First, the discounted mean value of gross earnings and the discounted mean value of net lifetime income (that is, net of pensions receipts and contributions payments) are approximately equal.This reflects the imposition of revenue neutrality. The dispersion of gross and net incomes is also very close, although the coefficient of variation, when compared to the various values of the Atkinson inequality measures and the Gini coefficient, give opposite rankings.[13] It might be thought surprising, and is

[13]The coefficient of variation tends to be sensitive to the values of the *upper* end of the distribution, Atkinson measures to the *lower* end.

certainly illuminating, that net lifetime incomes are not significantly more equal than gross lifetime earnings under the present scheme.

Second, the inequality measures for accumulated contributions and pensionable earnings are equal. This is no coincidence, as can be easily shown. Define accumulated contributions, $C$, over $R$ years as:

$$C = c[(1+r)^{R-1} y_1 + \ldots + y_R]. \tag{7}$$

If total pensionable earnings are revalued at a rate $w$, in line with real earnings growth, then average pensionable earnings, $Y_p$, are:

$$Y_p = 1/R[(1+w)^{R-1} y^1 + \ldots + y_R]. \tag{8}$$

If, as is assumed here, the rate of discount, $r$, is equal to the rate of real earnings growth, $w$, and the LEL and UEL are identical for contributions and pension entitlements, accumulated contributions are proportional to average pensionable earnings and the dispersions are equal, as reflected in Table 1.

A final issue of some interest is the dispersion of discounted benefits to retirement. This has the highest inequality measure, illustrating the impact of differential mortality. Given the flat-rate component to the scheme of pension benefits, then in the absence of differential mortality the dispersion of pension benefits would be less than that of pensionable earnings. In practice, the correlation of length of life with earnings, and pension benefits, is sufficient to swamp the impact of the flat-rate benefit component. Without differential mortality, the required contribution rate would be 0.0615, and under various measures of dispersion about 3.5 percent of the variation in net lifetime income, and between 88 and 98 percent of the variation in pension benefits, are attributable to differential mortality.[14]

Table 1 provides the summary measures for the differential mortality case but it is interesting to look at individual values of contributions and benefits, and benefit-cost ratios, for the cohort. Figure 2 therefore illustrates the individual values of contributions discounted to the start of working life. The pronounced curvature at higher values of lifetime income reflects the truncation of earnings by the Upper Earnings Limit. The variation in present values among higher earners indicates that, with revalued earnings, the interaction of different individual cross-section age-earnings profiles with the UEL, falling in value relative to earnings over time, produces a high degree of dispersion.

The impact of the falling value of the UEL relative to earnings is highlighted by Figure 3, which depicts individual pension benefits discounted to retirement. These are static above a fairly low threshold of earnings for each occupation and industry; most of the variation in benefits derives from differential mortality among these groups. Finally, Figure 4 combines pensions and contributions in the form of benefit-cost ratios. For each occupation and industry, the progressivity of the benefit formula, incorporating the flat-rate benefit, is clear. However differential mortality again generates a high degree of residual variation: there is only

[14]In the uniform mortality case, for the PV of net lifetime income, the CV, A (I) 1.0 and Gini coefficients are 0.3492, 0.0567 and 0.1852 respectively. For discounted pension benefits to retirement, they are 0.0561, 0.0021 and 0.0128.

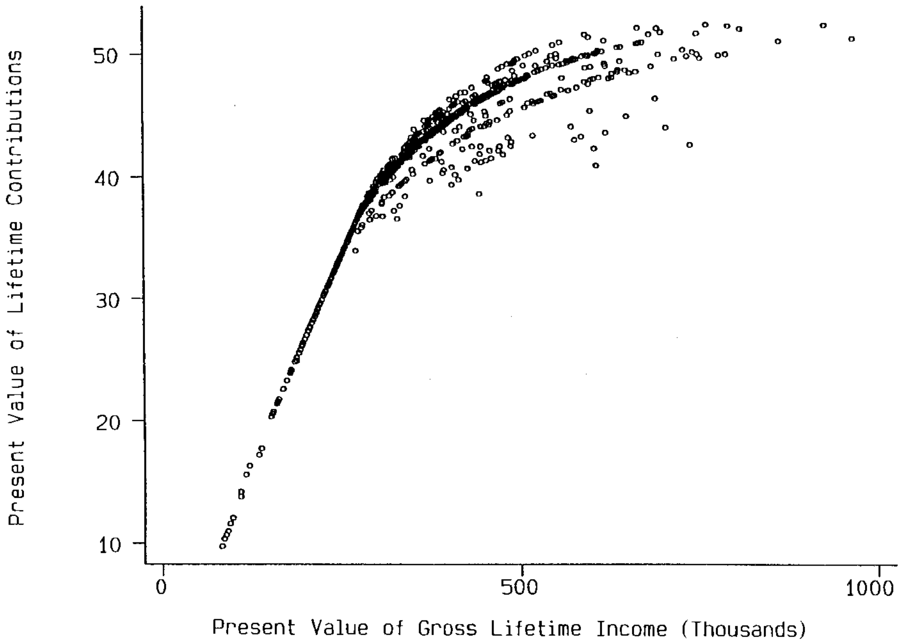


Figure 2. Lifetime Contributions by Gross Lifetime Income

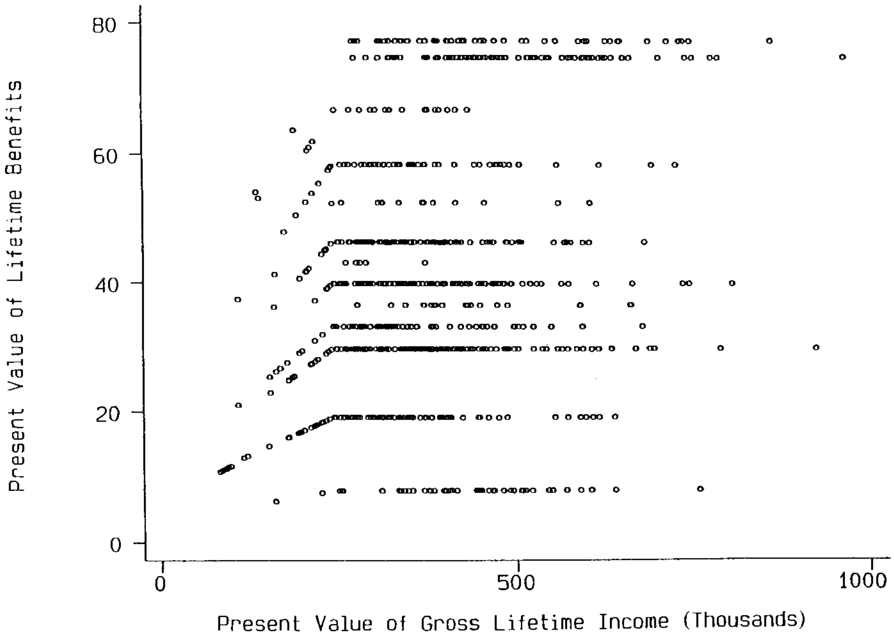


Figure 3. Lifetime Benefits by Gross Lifetime Income

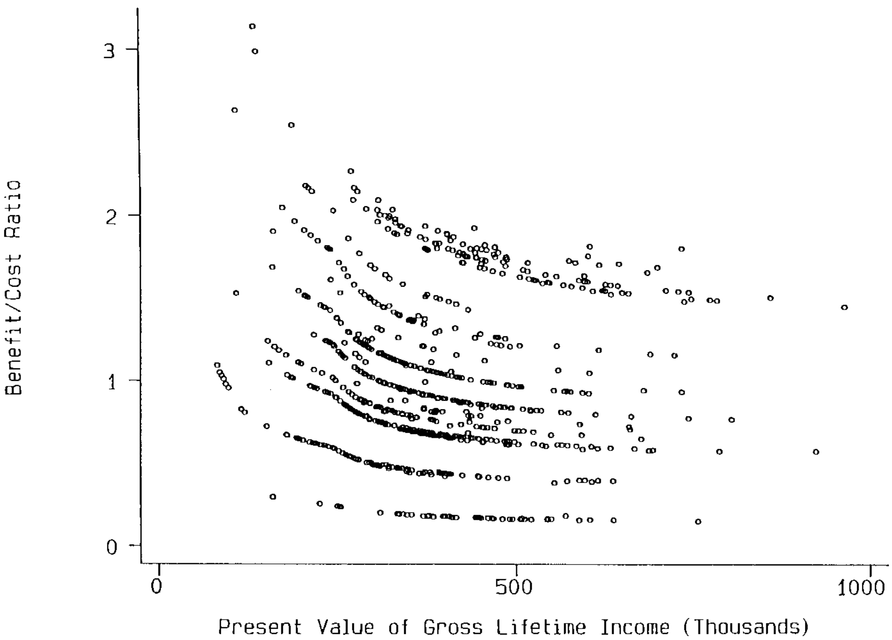


Figure 4. Benefit/Cost Ratio by Gross Lifetime Income

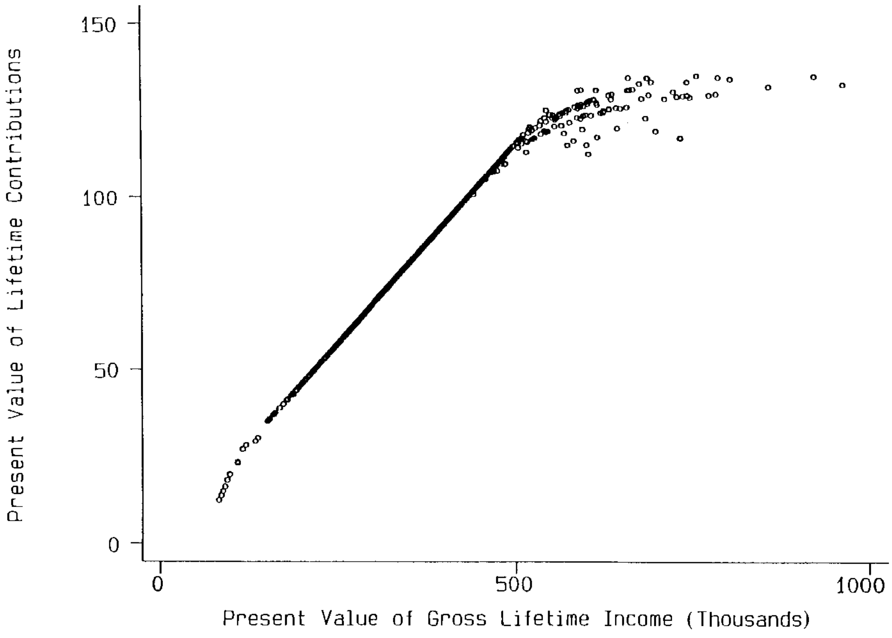


Figure 5. Lifetime Contributions by Gross Lifetime Income Earnings Indexation of Earnings Limits

a weak negative correlation between lifetime gross income and the benefit-cost ratio.

## IV. Alternative Pension Schemes

*Indexation Methods*

In producing Table 1 and the various illustrative figures it was assumed that the whole pension scheme is indexed to price inflation. When real earnings growth is 2 percentage points above price inflation, as assumed here (a reasonable assumption on recent trends in the U.K.), the value of the pension post-retirement falls relative to earned incomes, as does the revenue-raising capacity of the National Insurance system given the position of the LEL and the UEL in the income distribution (Disney and Whitehouse, 1991*a*). A logical response to both these problems is to index the whole structure, including the basic pension post-retirement (but not the earnings-related pension), the LEL and the UEL, to earnings growth.

The consequences of this reform are illustrated in Table 2, which shows that, relative to the baseline, net lifetime earnings are more unequally distributed according to the coefficient of variation, less according to higher values of the Atkinson measure, and the Gini coefficient is constant. This reflects the fact that

TABLE 2

Reform 1: Indexation of Basic Pension, LEL and UEL to Earnings Growth

| | | | |
|---|---|---|---|
| Distr. of Post-contribution Lifetime Earnings | | | |
| | Coefficient | Atkinson Measure | Gini |
| Mean | of Var. | (0.5, 1.0 and 3.0) | |
| 349,056.0 | 0.3634 | 0.0304 0.0605 0.1925 | 0.1912 |
| Distribution of Accumulated Contributions | | | |
| | Coefficient | Atkinson Measure | Gini |
| Mean | of Var. | (0.5, 1.0 and 3.0) | |
| 85,954.3 | 0.2881 | 0.0227 0.0478 0.2010 | 0.1638 |
| Distribution of Pensionable Earnings | | | |
| | Coefficient | Atkinson Measure | Gini |
| Mean | of Var. | (0.5, 1.0 and 3.0) | |
| 19,669.2 | 0.2881 | 0.0227 0.0478 0.2010 | 0.1638 |
| Discounted Benefits to Retirement | | | |
| | Coefficient | Atkinson Measure | Gini |
| Mean | of Var. | (0.5,1.0 and 3.0) | |
| 86,185.6 | 0.5606 | 0.0776 0.1575 0.4691 | 0.3077 |
| Distribution of Net Lifetime Income | | | |
| | Coefficient | Atkinson Measure | Gini |
| Mean | of Var. | (0.5, 1.0 and 3.0) | |
| 384,409.1 | 0.3566 | 0.0293 0.0584 0.1849 | 0.1881 |
| Ratio of UEL to LEL (Contributions) | | | 7.00 |
| Ratio of UEL to LEL (Pensions) | | | 7.00 |
| Employees NI Contribution Rate | | | 0.095 |
| Proportional SERPS Pension Rate | | | 0.200 |
| Basic Pension Adjustment Post Retirement | | | 0.020 |
| SERPS Pension Adjustment Post Retirement | | | 0.000 |
| Pensionable Earnings Adjustment Rate | | | 0.020 |
| Rate of Adjustment to LEL, UEL | | | 0.020 |

at high values, the Atkinson measure is close to a maximin measure, so the higher real value of the basic flat rate pension is given extra weight. Not surprisingly, the distributions of individual components: accumulated contributions, pensionable earnings and discounted benefits, are all more unequal than the baseline case, and the revenue neutral contribution rate is considerably higher, at 9.5 percent.

Again the pictorial evidence is illuminating. Figures 5 to 7 provide the individual values analogous to Figures 2 to 4 but for the case where almost all parameters are indexed to earnings. The reduced impact of the UEL on contributions (Figure 5) and pension benefits (Figure 6) is clear. Less clear cut, however, is the change in benefit-cost ratios when comparing Figures 4 and 7. One way of illustrating the difference is to consider what happens to the distribution of net relative to gross lifetime earnings when we switch to earnings indexation. This is depicted in Figure 8. Remembering that revenue neutrality is imposed, it is apparent that the distributional consequences are complex. Low earners, irrespective of their industry and occupation, appear to be net beneficiaries from the higher value of the basic flat-rate pension. But amongst higher earners, only those with longer lives benefit. Those with short lives lose because they fail to live long enough to benefit from their higher contributions. Since there is a general positive correlation between length of life and earnings, as shown in equation (6), this significantly limits the inequality-reducing character of the reform.

In the second reform, the link between the Earnings Limits for contributions and pensions is broken. It is assumed that there is no UEL on contributions but that the UEL on pensions is retained, with the remaining limits and the basic pension indexed to earnings as in the previous case. This reform, which is consistent with current Labour Party policy, would appear to generate more revenue, so lowering the revenue-neutral tax rate, and to be more redistributive.

The relevant distributions are given in Table 3. This case is indeed less unequal relative to the baseline: the distribution of net lifetime earnings is unequivocably lower than that of gross lifetime earnings in the base case. Note, too, that the dispersion of accumulated contributions and pensionable earnings are no longer equal; this is expected in the light of the discussion at the end of section III. However, the impact on the contribution rate of this reform is very small, relative to the last case. The required contribution rate, at 9.2 percent, is still well above the baseline case; there is no sense in which the abolition of the UEL "pays for" the increased flat-rate benefit resulting from earnings indexation, as has sometimes been suggested.

*Flat-rate and Earnings-related Pensions*

In the light of the last case, a more radical reform suggests itself. This is to take the contribution rate in reform 1 (Table 2), and apply the proceeds to raising the basic flat-rate pension, whilst abolising SERPS. This could of course be extended by abolishing the UEL on contributions as well. By comparing this case and reform 1, it is possible to show how the redistributive impact of the pension scheme is constrained by the presence of an earnings-related component to pension benefits (see also Creedy, 1982; Creedy and Disney, 1985).[15] The distributional

[15]A more radical proposal still of course is to abolish SERPS and to integrate the tax and benefit scheme entirely. The distributional effects are very close to those investigated here.

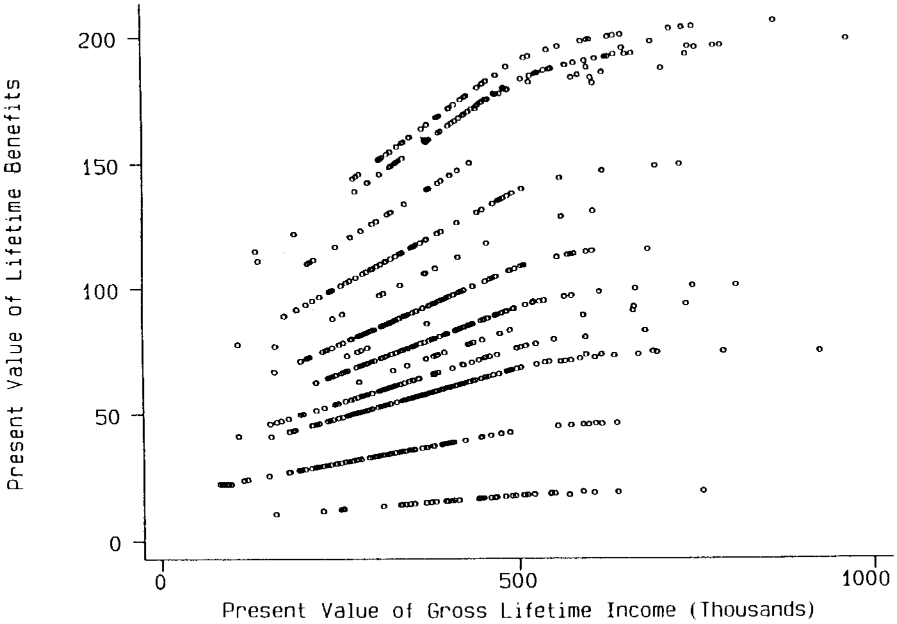


Figure 6. Lifetime Benefits by Gross Lifetime Income Earnings Indexation of Earnings Limits

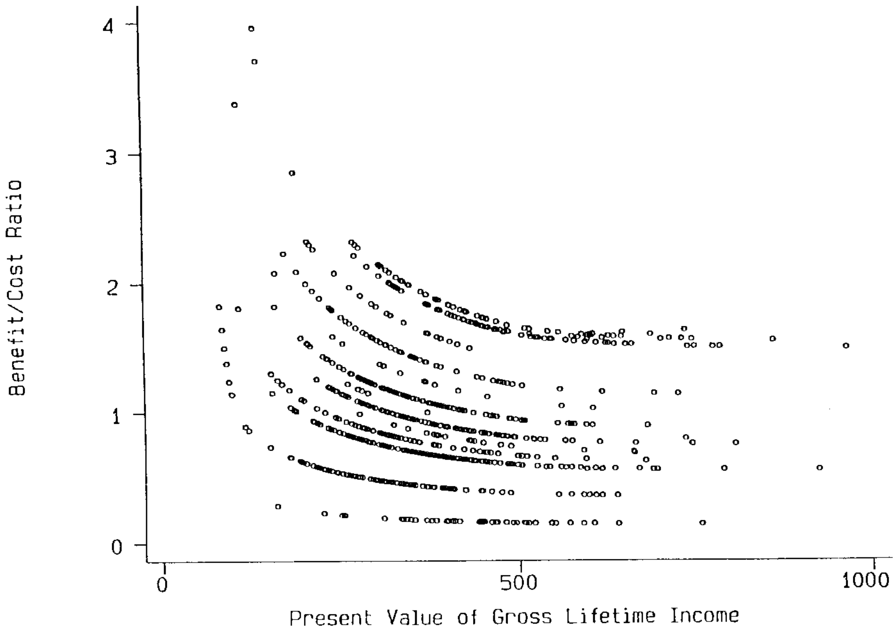


Figure 7. Benefit/Cost Ratio by Gross Lifetime Income Earnings Indexation of Earnings Limits

TABLE 3

REFORM 2: INDEXATION OF BASIC PENSION, LEL AND UEL ON SERPS PENSION TO EARNINGS GROWTH; NO UEL ON CONTRIBUTIONS

| | | | |
|---|---|---|---|
| Distr. of Post-contribution Lifetime Earnings | | | |
| | Coefficient | Atkinson Measure | Gini |
| Mean | of Var. | (0.5, 1.0 and 3.0) | |
| 348,976.7 | 0.3546 | 0.0295 0.0590 0.1900 | 0.1886 |
| Distribution of Accumulated Contributions | | | |
| | Coefficient | Atkinson Measure | Gini |
| Mean | of Var. | (0.5, 1.0 and 3.0) | |
| 86,148.0 | 0.3561 | 0.0302 0.0610 0.2242 | 0.1893 |
| Distribution of Pensionable Earnings | | | |
| | Coefficient | Atkinson Measure | Gini |
| Mean | of Var. | (0.5, 1.0 and 3.0) | |
| 19,669.2 | 0.2881 | 0.0227 0.0478 0.2010 | 0.1638 |
| Discounted Benefits to Retirement | | | |
| | Coefficient | Atkinson Measure | Gini |
| Mean | of Var. | (0.5,1.0 and 3.0) | |
| 86,185.6 | 0.5606 | 0.0776 0.1575 0.4691 | 0.3077 |
| Distribution of Net Lifetime Income | | | |
| | Coefficient | Atkinson Measure | Gini |
| Mean | of Var. | (0.5, 1.0 and 3.0) | |
| 384,329.4 | 0.3487 | 0.0285 0.1570 0.1827 | 0.1857 |
| Ratio of UEL to LEL (Contributions) | | | no UEL |
| Ratio of UEL to LEL (Pension) | | | 7.00 |
| Employees NI Contribution Rate | | | 0.092 |
| Proportional SERPS Pension Rate | | | 0.200 |
| Basic Pension Adjustment Post Retirement | | | 0.020 |
| SERPS Pension Adustment Post Retirement | | | 0.000 |
| Pensionable Earnings Adjustment Rate | | | 0.020 |
| Rate of Adjustment to LEL, UEL | | | 0.020 |

effects of such a reform are shown in Table 4. The increase in the basic pension consequent upon this proposal can be seen by comparing the values of the Lower Earnings Limit in Tables 1 and 4: the latter is some 66 percent higher. The distributions of pensionable earnings and net lifetime earnings are significantly less unequal than any of the other cases in Tables 1 to 3, as is the dispersion of discounted benefits (although the Atkinson inequality measure at an index of 3 perversely shows an increase).

This comparison shows that if it is accepted that a higher contribution rate is needed to finance higher pensions through a change to the indexation procedures, a much lower dispersion in net lifetime earnings could be achieved if the revenue raised were used wholly to finance the basic pension. This trade-off between earnings-related and flat-rate benefits has been noted in the past (Creedy, 1982; Creedy and Disney, 1985; Shimono and Tachibanaki, 1985) but is well worth reiterating when reforms which involve raising contribution rates significantly are again on the agenda.

## V. CONCLUSION

This paper has used a microsimulation approach in order to examine the redistributive impact of the U.K. public pension formula for a cohort of men,

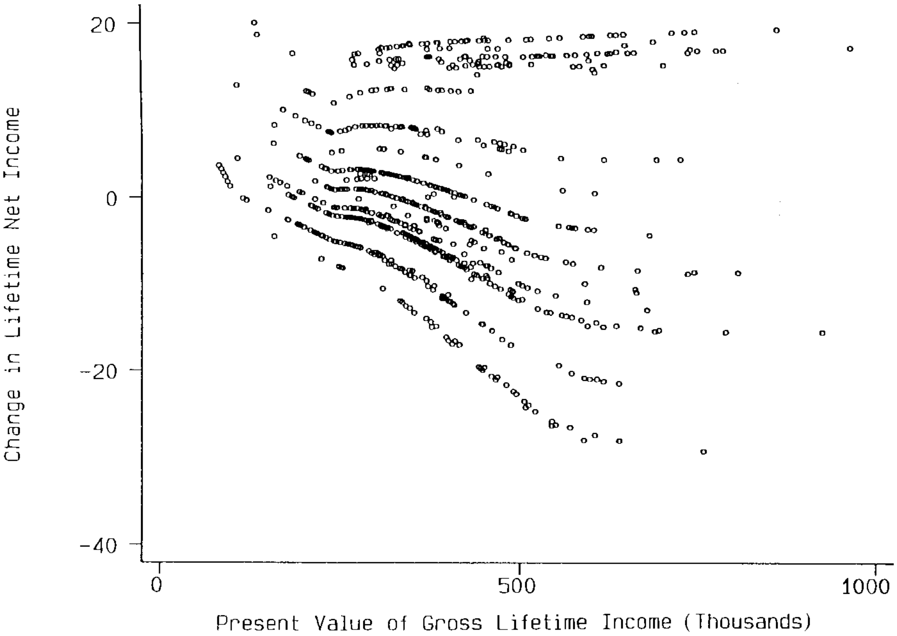


Figure 8. Change in Lifetime Net Income by Gross Lifetime Income Switching from Price to Earnings Indexation of Earnings Limits

TABLE 4

REFORM 3: INDEXATION OF BASIC PENSION, LEL AND UEL ON CONTRIBUTIONS TO EARNINGS GROWTH; RISE IN BASIC PENSION FINANCED BY ABOLITION OF SERPS

| | | | |
|---|---|---|---|
| Distr. of Post-contribution Lifetime Earnings | | | |
| | Coefficient | Atkinson Measure | Gini |
| Mean | of Var. | (0.5, 1.0 and 3.0) | |
| 348,078.8 | 0.3551 | 0.0292 0.0582 0.1818 | 0.1883 |
| Discounted Benefits to Retirement | | | |
| | Coefficient | Atkinson Measure | Gini |
| Mean | of Var. | (0.5,1.0 and 3.0) | |
| 88,485.0 | 0.5257 | 0.0713 0.1472 0.4722 | 0.2907 |
| Distribution of Net Lifetime Income | | | |
| | Coefficient | Atkinson Measure | Gini |
| Mean | of Var. | (0.5, 1.0 and 3.0) | |
| 384,375.0 | 0.3374 | 0.0263 0.0523 0.1618 | 0.1787 |
| Initial Lower Earnings Limit | | | 3,025.00 |
| Ratio of UEL to LEL (Contributions) | | | 7.00 |
| Employees NI Contribution Rate | | | 0.095 |
| Basic Pension Adjustment Post Retirement | | | 0.020 |
| Rate of Adjustment to LEL, UEL | | | 0.020 |

where the pension scheme is at maturity and revenue neutrality is imposed. Some frequently proposed reforms to the indexation arrangements and to the benefit formula are simulated, and the overall and individual distributive impacts analysed. In some ways, the work parallels recent studies which utilise disaggregated models to simulate the distributive effects at an individual level of tax and benefits changes in the static context. However work on pension schemes which has been able to examine distributions at this degree of disaggregation, and to examine the "costs" of scheme changes, has been comparatively rare.

Among the factors affecting individual entitlements and benefit-cost ratios, it is clear that differential mortality is central. Omitting this aspect imputes to the pension scheme an excessively redistributive stance. Redistribution is considerably smaller in practice given the positive correlation of length of life and income. It is often implied that measures to reduce the inequality of life chances within cohorts are prohibitively expensive or require individual behavioural changes (as to diet, smoking and so on) which are hard to enforce. In which case, the reduction in the inequality of net lifetime incomes might require provisions which risk-rate benefits to variations in life expectancy (as individual annuities do) or provide some other redistributive instrument, such as death and survivors' benefits.[16]

Reverting to the benefit formula itself; the greater the emphasis on the flat-rate benefit, the greater the reduction in net lifetime income inequality relative to gross earnings, *ceteris paribus*. On the question of indexation, a switch to earnings-related indexation requires a much higher contribution rate (even when contributions are uncapped) and only mildly reduces the degree of inequality of lifetime earnings. Nevertheless the form of the indexation arrangement again turns out to be an important determinant of the capacity of the pension scheme to generate intragenerational redistribution. Measures intended to induce *intergenerational* redistribution or to increase the revenue elasticity of the contributory scheme, such as a change in the indexation arrangements, may have unanticipated and apparently perverse effects on the capacity for intragenerational redistribution. The case for detailed microanalysis of pension provision is heightened by these results.

## Appendix

### *Entitlement*

Entitlement to a full basic pension is conditional on having acquired a minimum value of contributions in each year for up to nine-tenths of the working years. The condition is modified for those with "home responsibilities" and a partial contribution record. Individuals with reduced pension entitlements, but with insufficient other sources of financial support may also be entitled to means-tested benefits such as Income Support. Those with a contribution record, but with long term sickness or disability may be entitled to receive Invalidity Benefit (IVB) for up to five years after reaching pensionable age. Unlike the state retirement pension, IVB is not treated as taxable income.

Individuals may contract out of the earnings-related tier of the state pensions, SERPS, and pay a lower rate of NI contribution into the state

[16] The importance of survivors' benefits in these calculations, described in the introduction, is emphasised again by this point. However, depending on the covariances of spouses' lengths of life, provision of survivors' benefits may not reduce pension inequality due to differential mortality. Likewise, forms of compensatory bequest provisions are hard to administer and not necessarily redistributive if family longevities are inter-generationally correlated; unless, as one of our referees suggested, the values of such inter-family transfers are negatively linked to length of life of the original claimant.

scheme. Such individuals either belong to an occupational pension scheme, which may exact a contribution from them, or else have at least the minimum of the contracted-out rebate paid into a private money purchase pension scheme such as a Personal Pension. In this paper we examine pension entitlements assuming that all individuals are always contracted-in to SERPS. Disney and Whitehouse (1993*a*) examine the return to contracting-out with the earnings microsimulation model used here; other relevant sources are Hemming and Kay, 1981, 1982; Creedy, 1982; and Disney and Whitehouse, 1992.

*Earnings-related Pension Benefits*

To look at the calculation of SERPS entitlements in the U.K. pension scheme in more detail, it is useful to use some notation. Define:

$S$ = Total SERPS entitlement at pensionable age (£ per week). Increments in SERPS accrued per time period are denoted $s$ and time indexed.

Time is indexed by tax year 0 (1978) . . . $t$ . . . $R$ where $R$ = year of reaching pensionable age and refers to *end year* values. Thus $y_R$ refers to earnings in the preceding tax year.

$y$ = individual earnings in nominal terms.
$w$ = average economy-wide earnings in nominal terms.
$x$ = pension accrual rate (specific to each $R$).[17]
LEL and UEL = Lower and Upper Earnings Limit respectively.

We assume that earners retire on reaching state pensionable age (currently 65 for men and 60 for women).

The four possible outcomes for any period $t$ are described in equations (A1) to (A4), with total SERPS entitlement given by (A5):

(A1) $$s_t = 0 \quad \text{for all } t \text{ where } y_t < \text{LEL}_t$$

(A2) $$s_t = 0 \quad \text{for all } t \text{ where } (w_R/w_t) \,.\, y_t < \text{LEL}_R$$

(A3) $$s_t = \{(w_R/w_t) \,.\, y_t - \text{LEL}_R\} \,.\, x_R \quad \text{for all } t \text{ where } \text{LEL}_R \leq (w_R/w_t) y_t < \text{UEL}_t$$

(A4) $$s_t = \{(w_R/w_t) \,.\, \text{UEL}_t - \text{LEL}_R\} \,.\, x_R \quad \text{for all } t \text{ where } w_t \geq \text{UEL}_t$$

and

(A5) $$S = \sum_{t=0}^{R} s_t$$

Equation (A1) simply indicates that earnings must reach the LEL in each year as a necessary condition to pay NI contributions and to qualify for a pension entitlement. Equation (A2) illustrates the theoretical possibility that, if the LEL (basic flat rate pension) rises faster than economy-wide average earnings growth, then earnings on which NI contributions were paid in the year they were received might not qualify for SERPS entitlements once the LEL in the year prior to

[17]A complication is that from 1978–86 individuals accrued SERPS entitlements at a more generous accrual rate so $x$ should strictly be indexed to $R$ and $t$. Although we take account of this in the calculation of factual entitlements, we quote the "steady state" formula.

retirement was deducted. The rationale for the deduction of the LEL in the penultimate year is that some earnings might otherwise be double counted towards both the flat-rate pension and the SERPS pension, but this consequence has not always been appreciated by policy-makers, and especially by proposals for pension reform.

Equation (A3) denotes the case where earnings were above the LEL, in both the current and final year, but below the UEL. In this case all earnings count towards SERPS. In equation (A4), eligible earnings are truncated from above by the UEL, a situation which becomes increasingly likely as price inflation (to which the UEL is linked) tends to be slower than individual earnings growth.

As suggested in the text, the value of the SERPS pension therefore depends on the relative rates of growth of prices, individual earnings, and average earnings. Differential price and earnings growth can cause earnings which counted towards SERPS at time $t$ to be debarred subsequently (equation A2), but the reverse process cannot happen: earnings which were too low to count at time $t$ (equation A1) cannot subsequently be included in the pension calculation because the value of the LEL in year $R$ was lower (relative to earnings growth).

*National Insurance Contributions*

National Insurance (NI) contributions are notionally levied on both the employee and the employer. The extent to which all social security contributions are borne by the employee is an issue that has been discussed at some length: see, for example, Beach and Balfour, 1983. The issue is complicated in the U.K. by the fact that the contribution structure is different for the employee's and employer's component (see Dilnot and Webb, 1989). The latter has a graduated rate structure, with no upper earnings limit. The structure of the former is similar to that by which SERPS entitlements are calculated with a UEL, although of course because the National Insurance scheme is a pure pay-as-you-go scheme, no revaluation procedure takes place.

The structure of the employee NI contribution, with one minor simplification, is outlined in equations (A6) to (A8).[18] The major simplification of the system is to assume that the contribution structure in these equations is the only contribution structure. In principle and in practice (Disney and Whitehouse, 1993*a*), the analysis can be extended to simulate the structure of both the employee's and the employer's NI contributions, although this extension involved a pay-as-you-go measure of revenue neutrality obtained from aggregate forecasts rather than by solving the simulation model, as in the present paper. Furthermore, assumptions have to be made as to the future allocation of the NI revenues among various NI benefits other than pensions. In the present case, denoting the contribution rate

[18]A further simplification is that we ignore the attempt to alleviate the threshold effect of the contribution structure at the LEL introduced in the 1989 Budget, by which earnings below the LEL are assessed at a lower contribution rate for those at or above the LEL than that applied to subsequent earnings; see Dilnot and Webb (1989).

therefore as c, then;

(A6) $$c_t = 0 \quad \text{for all } t \text{ where } y_t < \text{LEL}_t,$$

(A7) $$c_t = cy_t \quad \text{for all } t \text{ where } \text{LEL}_t \leq y_t < \text{UEL}_t,$$

(A8) $$c_t = c\text{UEL}_t \quad \text{for all } t \text{ where } \text{UEL}_t \geq y_t.$$

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