DISCUSSION PAPER PI-9608

Annual Estimates of Personal Wealth Holdings in the United Kingdom since 1948

David Blake and J. Michael Orszag

1999

Annual estimates of personal wealth holdings in the United Kingdom since 1948

DAVID BLAKE and J. MICHAEL ORSZAG

The Pensions Institute, Birkbeck College, University of London, Gresse St, London W1P 2LL, UK

This paper derives estimates of seven categories of personal wealth holdings in the United Kingdom on an annual basis since 1948. The seven categories are: net financial wealth, housing wealth, consumer durable assets, basic state pension wealth, state earnings-related pension wealth, occupational pension wealth, and personal pension wealth. The objective of this exercise is to generate a data set that can be used to investigate the effects over time of wealth on other aspects of personal sector behaviour in the UK, e.g., the effects of different wealth components on personal sector consumption and retirement behaviour, or to investigate the causes of the changes in the composition of personal sector wealth over time.

I. INTRODUCTION

Official data sources for the UK do not provide either a complete or a sufficiently long run of data to undertake time series investigations of issues such as the impact of different types of wealth holdings on consumption and retirement behaviour or the distribution of wealth holdings by individuals across different asset categories. This paper fills in the holes in official sources and provides complete estimates of seven main categories of personal wealth holdings between 1948 and 1994: net financial wealth, housing wealth (including nonmarketable tenancy rights), consumer durable assets, basic state pension wealth, state earnings-related pensions wealth (SERPS), occupational pension wealth and personal pension wealth. The construction of data begins in 1948 because this was the year the modern state pension scheme started; indeed, one motivation for constructing this data is to be able to perform time series regressions of the effects of net pension wealth on consumption and related tests of Ricardian equivalence such as were undertaken in North America in the 1970s (c.f., Feldstein, 1974; Barro, 1978; Boyle and Murray, 1979).

The earliest postwar estimates of holdings by individuals of marketable wealth were contained in the Radcliffe Report (1959). The Inland Revenue has published annual estimates of wealth holdings by individuals since 1960. These were published first in the annual reports of the Board of Commissioners of the Inland Revenue beginning in 1962. Further interest in personal wealth was prompted by the Royal Commission on Income and Wealth (Diamond, 1975, 1976). This resulted in the annual publication, from 1975, of personal sector balance sheets in the *UK National Income Accounts* (Office for National Statistics) and periodic studies on the distribution of personal wealth (e.g., Dunn and Hoffman, 1978a; Good, 1990; Stewart, 1991). At about the same time, the Government Actuary's Department began to prepare regular annual estimates of the value of state and occupational pension rights and these have been published since 1976 in *Economic Trends*, although periodic estimates of these values are available back to 1966.

Holdings by individuals constitute the largest component (about 90%) of the wealth holdings of the personal sector in the UK. The personal sector also covers unincorporated businesses (such as retail shops, farms, solicitors and architects practices operated by sole traders and partners) and nonprofit-making bodies such as charities, trade unions and clubs. Frequently, official sources incorporate individual wealth holdings as part of personal sector wealth holdings, but some assets included in the personal sector total are essentially productive assets, e.g. agricultural land, commercial and industrial buildings, plant and machinery, vehicles,

stocks and work-in-progress, and trade credit. All these categories are excluded from our estimates of individual wealth holdings.

The construction of wealth data is a complex process. Even official data involve differing definitions, geographical coverages and estimation methods. For example, between 1960 and 1973, the Inland Revenue published estimates of the 'identified wealth' of individuals in Great Britain, i.e. excluding Northern Ireland (see *Annual Report of the Board of Commissioners of the Inland Revenue* for 1962 (Table 143), *Inland Revenue Statistics 1971* (Table 129) and *Inland Revenue Statistics 1975* (Table 105)). These estimates are based on the 'estate multiplier method' for calculating identified wealth. The Inland Revenue uses information on the individual estates that have applied for probate for the purpose of determining any inheritance tax liability (formerly estate duty). Currently about 250 000 out of 640 000 estates per year apply for probate. The Inland Revenue then attempts to infer the wealth holdings of the extant population by scaling up the reported asset holdings of deceased individuals using both 'sample multipliers' and 'reciprocal mortality multipliers'. At the same time, it makes an adjustment for 'under-recording' (i.e. under-reporting of wealth) and 'valuation' (e.g. undervaluation of life assurance policies while the policy holders are still alive). Between 1974 and 1977, the Inland Revenue published estimates of the identified wealth of individuals in the United Kingdom, i.e. including Northern Ireland (*Inland Revenue Statistics 1979* (Table 4.15)).

For 1996, 1971 and annually since 1974, the Inland Revenue has published estimates of the 'marketable wealth' of individuals in the UK (*Inland Revenue Statistics 1980* (Table 4.18), *Inland Revenue Statistics 1995* (Table 13.4)). Marketable wealth is 'adjusted identified wealth' plus 'excluded wealth'; excluded wealth is an estimate of the value of joint property in estates applying for probate, trusts and the small estates that do not apply for probate and hence do not come to the attention of the Inland Revenue. Marketable wealth is found by applying a 'grossing factor' to adjusted identified wealth. (Details of the exact procedures used by the Inland Revenue are given in Dunn and Hoffman, 1978b.)[1]

In Sections II–VIII we derive estimates of individual wealth holdings in the seven categories listed above. Section IX briefly analyses these estimates and Section X concludes the paper.

II. THE VALUE OF NET FINANCIAL WEALTH

Gross financial assets (FA_t) held by individuals comprise: notes and coin, government-backed deposits (National savings, defence bonds and tax instruments), government-backed bonds (gilts, Northern Ireland and other government bonds, local government bonds, public corporation bonds), deposits in banks, building societies, other financial institutions and miscellaneous instruments (e.g. funds lodged in court, cooperative funds, real estate funds, loans, accruals), company securities (ordinary and preference shares, debentures and loan stock, unit trusts), and life assurance policies. The gross financial liabilities (FL_t) of individuals comprise: bank borrowing, retailer credit, finance leases, miscellaneous loans and mortgages. Net financial wealth equals the difference between gross financial assets and gross financial liabilities:

$$WF_t = FA_t - FL_t \qquad (1)$$

The strategy adopted in this section is to take all the official Inland Revenue data on holdings of individual assets and liabilities, use grossing factors to convert 'identified wealth' components into 'marketable wealth' components and then use both interpolation and extrapolation to estimate the missing observations. The period of extrapolation is 1948 to 1957, the first year for which official (i.e. Radcliffe Report) data is available. The procedure adopted involves extrapolating trends backwards using the average compound growth rates observed during the period for which data first became available. While this is bound to involve errors, such errors are swamped by the size of the grossing factors needed to rescale whole sections of each data series during the early period. For some series, it is possible to get direct estimates back to 1948. For example, data on building society deposits is published in *The British Economy: Key Statistics 1900–1970* (London and Cambridge Economic Service) and these were used to preserve relativities between related series. Similarly data on life and annuity funds back to 1948 is published in the *Annual Abstract of Statistics* (Office for National Statistics). The resulting data on personal net financial wealth and its components are given in Table 1.

---

[1] The Office for National Statistics (formerly the Central Statistical Office) provides a different set of estimates of personal sector wealth, based on the 'balance sheet method'. This is an aggregate top-down approach and generally leads to higher estimates of personal sector wealth than the bottom-up estate multiplier method. The difference between the two estimates is known as the 'residual' and between 1979 and 1993, the residual averaged 3.5% of individual marketable wealth estimated using the estate multiplier method (see *Inland Revenue Statistics 1995* (Table 13.4)). However the balance sheet method does not generate estimates of holdings in individual asset categories.

Table 1. *Nominal value of personal net financial wealth 1948–1994*

Year	Cash (£bn)	Deposit accounts (£bn)	Bonds (£bn)	Shares + life assurance (£bn)	Gross financial assets (£bn)	Financial liabilities (excluding mortgages)	Mortgages (£bn)	Gross financial liabilities (£bn)	Personal net financial wealth (£bn)
1948	1.5	13.7	3.1	9.0	27.4	2.4	0.9	3.3	24.1
1949	1.6	14.2	3.2	9.5	28.4	2.5	1.0	3.5	24.9
1950	1.6	14.7	3.3	9.9	29.5	2.6	1.1	3.7	25.8
1951	1.6	15.2	3.4	10.4	30.7	2.7	1.2	3.9	26.8
1952	1.7	15.6	3.4	10.9	31.7	2.7	1.3	4.1	27.6
1953	1.7	16.1	3.5	11.5	32.8	2.8	1.5	4.3	28.5
1954	1.8	16.6	3.6	12.2	34.2	2.9	1.7	4.6	29.6
1955	1.8	17.4	3.7	12.8	35.7	3.0	1.9	4.9	30.8
1956	1.9	18.1	3.7	13.5	37.2	3.1	2.0	5.1	32.0
1957	1.9	18.8	3.7	14.4	38.9	3.2	2.2	5.4	33.4
1958	2.0	19.7	4.2	15.5	41.3	3.3	2.4	5.7	35.6
1959	2.0	20.5	4.6	16.7	43.8	3.4	2.7	6.1	37.7
1960	2.1	21.4	5.1	18.0	46.5	3.5	3.0	6.5	40.0
1961	2.4	22.7	5.3	19.2	49.6	3.3	3.3	6.6	43.0
1962	2.6	24.0	5.8	20.1	52.6	3.6	3.7	7.3	45.3
1963	2.2	25.2	6.2	23.6	57.3	3.9	4.2	8.0	49.2
1964	2.4	26.7	6.2	26.8	62.2	5.9	4.9	10.8	51.4
1965	2.6	26.9	5.7	26.3	61.4	5.2	5.6	10.8	50.7
1966	2.7	28.6	5.7	27.0	64.0	6.3	7.4	13.7	50.3
1967	3.3	31.1	6.3	29.6	70.3	6.0	8.4	14.4	55.9
1968	2.8	31.3	5.9	32.4	72.4	4.9	9.4	14.3	58.1
1969	2.4	30.2	5.7	35.3	73.7	5.7	10.3	15.9	57.7
1970	2.9	33.4	6.2	34.9	77.3	6.8	11.5	18.3	59.0
1971	3.7	38.1	6.7	39.1	87.7	6.7	13.3	20.0	67.7
1972	3.1	39.3	6.9	48.3	97.5	7.6	16.1	23.7	73.8
1973	4.1	46.5	6.7	51.2	108.5	8.7	19.0	27.7	80.9
1974	4.3	48.7	5.9	41.2	100.0	8.5	21.4	29.8	70.2
1975	4.8	56.5	7.6	45.9	114.8	9.4	25.2	34.6	80.3
1976	5.4	62.3	9.2	45.5	122.5	10.7	29.0	39.7	82.8
1977	6.3	70.9	12.2	61.7	151.1	12.5	33.2	45.7	105.3
1978	7.2	81.6	10.5	65.7	165.0	15.3	38.7	54.0	111.0
1979	7.7	96.5	12.3	71.8	188.3	20.0	45.2	65.2	123.2
1980	8.3	112.9	13.9	90.1	225.2	24.1	52.4	76.5	148.6
1981	8.8	129.1	14.4	96.6	249.0	29.2	62.3	91.5	157.5
1982	9.2	153.1	19.0	122.1	303.4	33.5	76.4	109.9	193.5
1983	9.7	169.8	19.7	147.9	347.1	39.0	91.3	130.3	216.8
1984	9.9	200.4	17.4	183.2	410.9	50.0	108.3	158.3	252.5
1985	10.4	223.1	17.3	205.6	456.4	57.7	127.4	185.1	271.3
1986	11.3	246.2	19.8	264.6	541.8	61.5	154.3	215.8	326.1
1987	12.0	270.7	18.1	302.8	603.7	72.3	183.6	256.1	347.6
1988	12.9	312.3	13.2	329.8	668.2	86.8	223.9	310.7	357.5
1989	13.7	357.1	10.0	398.2	779.0	102.7	258.0	360.7	418.3
1990	13.6	396.7	9.1	381.1	800.5	111.8	294.1	405.9	394.6
1991	14.1	426.2	10.8	441.0	892.1	112.6	319.9	432.5	459.6
1992	15.1	451.4	18.6	499.6	984.6	108.4	339.7	448.1	536.5
1993	16.0	466.1	16.1	665.4	1163.7	103.8	357.6	461.4	702.2
1994	17.1	484.0	16.4	671.5	1189.0	107.8	376.2	484.0	705.0

III. THE VALUE OF HOUSING WEALTH

The value of residential property has been published annually in the *UK National Income Accounts* (Office for National Statistics) since 1975. To estimate the value of residential property between 1948 and 1974, it is necessary to collect data on the stock of dwellings and on the average price of each dwelling. Data on the stock of dwellings back to 1961 is published in the *Annual Abstract of Statistics* (Office for National Statistics). Prior to this, the annual stock of dwellings has to be constructed using data also published in the *Annual Abstract of Statistics* (Office for

Table 2. *Data on dwellings 1961–1964* (*thousands*)

Year	Stock of dwellings (end year)	New dwellings	Scrapped dwellings	Ratio of scrapped to new dwellings
1961	16 806			
1962	17 020	314	100	0.318
1963	17 227	308	101	0.328
1964	17 505	383	105	0.274
Average				0.307

National Statistics) on the number of dwellings built each year since 1948 and an estimate of the number of dwellings scrapped each year as a proportion of new dwellings built. The latter estimate is found using the following information (in Table 2).

The number of dwellings scrapped in 1962 must equal the difference between the number of new dwellings built in 1962 and the change in the stock of dwellings between 1961 and 1962; similarly for the dwellings scrapped in 1963 and 1964. The ratio of scrapped to new dwellings averaged 0.307 between 1962 and 1964. Assuming this average ratio remains constant over time, we can use the following equation to estimate the stock of dwellings back to 1948:

$$Stock_{t-1} = Stock_t - 0.693 \, (New \ dwellings_t) \quad (2)$$

This equation appears to generate reasonably good estimates of the stock of dwellings for the earlier period: for example, our estimate for 1951 of 14.183 m corresponds very closely to the 1951 estimate of 14.177 m reported in the *Annual Abstract of Statistics* (see Table 3).

An annual index of house prices between 1943 and 1988 is published in Holmans (1990, Table A.1). This was rebased to 1990 and updated using the Department of the Environment's mix-adjusted house price index for existing houses at mortgage completion stage published in the *Compendium of Housing Finance Statistics* (Council of Mortgage Lenders). The average price of a dwelling in the UK in 1990 was £49 413. Using this information, we can derive the value of housing assets as:

$$WHTOT_t = £49\,413 \times PH_t \times Stock_t \quad (3)$$

where PH_t is the house price index (1990 = 1).

Equation 3 gives the total value of all dwellings in the economy including those rented out by local authorities and private landlords. Only the value of owner-occupied dwellings (WH_t) can be included directly in a measure of personal housing wealth:

$$WH_t = ROO_t \times WHTOT_t \quad (4)$$

where ROO_t is rate of owner occupation. ROO_t is published annually in the *Annual Abstract of Statistics* back to 1961

and Holmans (1987, Table V.I) publishes an estimate for 1951; we used (geometric) interpolation for the intervening years.

While tenants do not own the property they rent, they do enjoy certain rights as tenants. The *UK National Income Accounts* has published estimates of the value of nonmarketable tenancy rights ($NMTR_t$) since 1975. The value of these rights was 70% of the value of owner-occupied dwellings in 1975. We used this 1975 estimate to calculate the value of nonmarketable tenancy rights for the period back to 1948:

$$NMTR_t = 0.7 \times (1 - ROO_t) \times WHTOT_t \quad (5)$$

The total value of housing wealth is given by the sum of WH_t and $NMTR_t$ and is listed in Table 2. The net value of housing wealth could be found by subtracting the value of mortgages outstanding. However, a mortgage is a financial liability and the value of mortgages has already been taken into account in the calculation of net financial wealth above.

IV. THE VALUE OF CONSUMER DURABLE ASSETS

Data on the value of consumer durable assets (such as furniture, washing machines, televisions and dishwashers) has been published annually in the *UK National Income Accounts* since 1975. Between 1960 and 1973 there is official Inland Revenue data (from the same source as used to estimate net financial assets) on the value of household goods in Great Britain. Between 1973 and 1977 there is Inland Revenue data on the value of household goods in the UK as a whole. The *Economic Trends Annual Supplement 1996* presents annual data on consumer durable expenditure since 1948.

We used a grossing factor of 1.0159 to convert GB household goods to UK household goods (which equals the ratio for 1974). We used a grossing factor of 5.4754 to convert UK household goods into UK durable assets (which equals the average of the ratios for 1975 to 1977). We estimated the value of the stock of durable assets between 1948 and 1960

Table 3. *Nominal value of personal housing wealth 1948–1994*

Year	Stock of dwellings (m)	Rate of owner occupation (%)	House price index 1990 = 100	Av. price of dwelling (£)	Total value of dwellings (£bn)	Value of owner-occupied dwellings (£bn)	Non-marketable tenancy rights (£bn)	Housing wealth (£bn)
1948	13.7	33.0	1.98	978	13.4	4.4	6.3	10.7
1949	13.8	33.3	1.91	944	13.1	4.3	6.1	10.4
1950	14.0	33.7	1.98	978	13.7	4.6	6.4	11.0
1951	14.2	34.0	2.12	1048	14.9	5.1	6.9	11.9
1952	14.4	34.8	2.05	1013	14.6	5.1	6.7	11.7
1953	14.7	35.6	1.91	944	13.9	4.9	6.2	11.2
1954	15.0	36.5	1.84	909	13.6	5.0	6.1	11.0
1955	15.3	37.3	1.91	944	14.4	5.4	6.3	11.7
1956	15.5	38.2	1.98	978	15.2	5.8	6.6	12.4
1957	15.8	39.1	1.98	978	15.5	6.0	6.6	12.6
1958	16.0	40.1	1.98	978	15.7	6.3	6.6	12.9
1959	16.3	41.0	2.05	1013	16.5	6.8	6.8	13.6
1960	16.5	42.0	2.19	1082	17.9	7.5	7.3	14.8
1961	16.8	42.7	2.41	1191	20.0	8.5	8.0	16.6
1962	17.0	44.0	2.62	1295	22.0	9.7	8.6	18.3
1963	17.2	44.6	2.83	1398	24.1	10.7	9.3	20.1
1964	17.5	45.6	3.19	1576	27.6	12.6	10.5	23.1
1965	17.8	46.5	3.47	1715	30.5	14.2	11.4	25.6
1966	18.1	47.1	3.61	1784	32.2	15.2	11.9	27.1
1967	18.3	47.8	3.89	1922	35.3	16.9	12.9	29.7
1968	18.6	48.5	4.18	2065	38.5	18.7	13.9	32.6
1969	18.9	49.0	4.67	2308	43.6	21.4	15.6	36.9
1970	19.1	49.5	4.95	2446	46.8	23.2	16.6	39.7
1971	19.4	50.3	5.70	2817	54.7	27.5	19.0	46.5
1972	19.6	51.2	7.72	3815	74.9	38.4	25.6	63.9
1973	19.8	52.3	10.71	5292	105.0	54.9	35.1	90.0
1974	20.1	52.7	11.83	5846	117.2	61.8	38.8	100.6
1975	20.3	53.0	12.78	6315	128.2	68.0	42.8	110.8
1976	20.6	53.3	14.01	6923	142.3	75.8	47.8	123.7
1977	20.6	53.6	15.53	7674	159.7	85.6	51.5	137.1
1978	21.1	54.1	19.62	9695	204.2	110.5	66.6	177.1
1979	21.3	54.6	25.67	12684	270.6	147.7	89.7	237.4
1980	21.5	55.4	28.89	14275	306.6	169.9	96.8	266.7
1981	21.6	57.4	29.91	14779	319.6	183.6	93.5	277.1
1982	21.8	58.9	32.48	16049	349.9	206.1	96.7	302.8
1983	22.0	60.2	37.77	18663	410.4	247.1	101.7	348.8
1984	22.2	59.6	44.46	21969	487.6	290.6	100.0	390.6
1985	22.3	60.6	50.54	24973	557.7	338.0	108.0	446.0
1986	22.6	61.5	58.55	28931	652.5	401.3	117.1	518.4
1987	22.8	62.7	70.75	34960	796.4	499.4	138.0	637.4
1988	23.0	64.0	95.34	47110	1084.6	694.1	167.4	861.5
1989	23.2	65.2	102.08	50441	1172.6	764.5	178.9	943.4
1990	23.4	65.8	100.00	49413	1158.7	762.4	185.9	948.3
1991	23.7	66.0	98.98	48909	1157.5	764.0	188.4	952.4
1992	23.8	66.2	92.64	45776	1091.3	722.4	188.3	910.7
1993	24.0	66.5	94.01	46453	1115.9	742.0	188.4	930.4
1994	24.2	66.8	95.50	45213	1094.3	731.0	189.5	920.5

using the back projection equation:

$(Value\ of\ stock)_{t-1}$

$$= (Value\ of\ stock)_t - 0.3335(Durable\ expenditure)_t \quad (6)$$

assuming that the average value of the ratio of scrapped to new durables is 0.6665. The resulting estimates of the value of consumer durable assets are given in the third column of Table 12.

V. THE VALUE OF BASIC STATE PENSION WEALTH

The modern state pension scheme began in 1948 following the introduction of the 1946 National Insurance Act, which implemented the main recommendations of the 1942 Beveridge Report, *Social Insurance and Allied Services*. It was slightly modified by the 1975 Social Security Act which came into effect in 1978. Entitlement to the basic state pension (BSP) is based on the payment of national insurance contributions (NICs) at the fixed rate of 2% of the lower earnings limit (LEL) for payment of NICs (which always equals the value of the BSP). The BSP is uprated annually by the increase in the retail price index.

The Government Actuary's Department (GAD) provides annual estimates of the value of basic state pension rights. It does so on the basis of two assumptions that are not strictly correct but tend to be offsetting. First, it assumes that every member of the adult population (whether employed or unemployed) is entitled to receive the full pension; in practice, only those in work and paying or being credited with NICs on earnings at or above the LEL build up qualifying years towards the pension entitlement. Second, it assumes that the accrual of pension rights is based on a maximum working life of 49 years for men and 44 years for women; in practice, the accrual rate is based on the maximum number of qualifying years which is five years less than the maximum working life: 44 years for men and 39 years for women. The GAD argues that the effect of assuming a larger number of beneficiaries is at least partially offset by the assumption of a lower accrual rate. In any event, persons with insufficient contributions to receive the full BSP are entitled to receive income support. Since the value of income support is of the same order of magnitude as the BSP, the GAD is in effect estimating the full cost to the state of providing incomes for old people. The GAD's estimates of the value of BSP rights have been made since 1976 and are published in *Inland Revenue Statistics*. We can illustrate how these estimates are made using data on females for 1992; see Table 3.

The female population in work or retired above school leaving age is divided into five-year bands with median ages 18.0, 22.5, 27.5, 32.5, etc. The pension entitlement accrued during the year is calculated as follows:

Pension accrued

$$= \text{Weeks} \times \text{Benefit} \quad (\text{if age} \geqslant 60)$$
$$\quad \text{in year} \quad \text{rate per}$$
$$\qquad\qquad \text{week}$$

$$= \text{Weeks} \times \text{Benefit} \times \left(\frac{\text{Median age} - 16}{44} \right)$$
$$\quad \text{in year} \quad \text{rate per}$$
$$\qquad\qquad \text{week}$$

$$\qquad\qquad\qquad\qquad\qquad (\text{if age} < 60) \quad (7)$$

In 1992, the single person basic state pension was £2815.80 per year. Female pensioners receive this in full if they have been credited with a full record of contributions for 44 years. For those in work, the accrual rate is calculated on the basis of the excess of the median age (of each age group) above 16 years as a ratio of the maximum 44 year contribution period. For example, for a 32.5 year old woman, the accrual rate is 16.5/44 or 0.375. In the case of women these benefits are scaled by a factor known as the 'mean proportion of the standard rate' (MPnSR), which reflects the lower average level of benefit to women due to the married women's option of paying a lower rate of NICs in return for a lower level of pension based on their husband's contribution record. For example, for a 32.5 year old woman, the MPnSR is assessed at 0.88.

Having determined the accrued pension benefit in each age range, the next step is to calculate the annuity factor (i.e. present value of an annuity of £1 p.a.) for each age range. For women over the retirement age of 60, this is calculated as (see, e.g., Gerber, 1995, chap. 1):

$$A = \frac{1 - v^L}{\delta} \qquad (8)$$

where $v = 1/(1 + \rho) = $ discount factor; $\delta = \ln(1 + \rho) = $ force of (real) interest; ρ is assumed real interest rate; and L is pension length. The pension length is the expected duration of the pension in payment for a given median age. For example for a 62.5-year old female, it is 20.492 years. The pension length is based on English Life Tables No. 14 (ELT14, based on mortality experience between 1980 and 1982) rated down two years to reflect the increasing longevity of the population. Since the basic state pension is uprated annually in line with retail price inflation, and so is constant in real terms, the real pension benefits are discounted at a real rate of interest. The GAD produces estimates based on two real rates, 2.5% and 3%.

For women below retirement age, the annuity factor is calculated as:

$$A = \frac{1 - v^L}{\delta} \cdot v^{(60 - x)} \cdot P_{x, 60} \qquad (9)$$

where x is median age; and $P_{x, 60}$ is proportion surviving from median age x to state pension age (based on ELT14). For example, 92.9% of 32.5-year-old women can expect to survive until 60.

The value of basic state pension wealth in each age range is then found as:

$$WB_x = A_x \times \text{Pension accrued}_x$$
$$\times \text{Population in age group}_x \qquad (10)$$

For example, for women in the 30–34 age group the value of

Table 4. *Accrued rights to the basic state pension in 1992, females by age range*

Age range (yrs) (1)	Median age (yrs) (2)	Pension accrued (£) (3)	Mean proportion of standard rate (4)	Population ('000s) (5)	Proportion surviving to 60 (6)	Pension length (yrs) (7)	Annuity value (£bn) (at 2.5% real interest) (8)	Value of basic state pension rights (£bn) (at 2.5% real interest) (9)	Annuity value (£bn) (at 3% real interest) (10)	Value of basic state pension rights (£bn) (at 3% real interest) (11)
16–19	18.0	115.591	0.90	1362.1	0.924	22.515	5.6569	0.891	4.3897	0.691
20–24	22.5	375.669	0.90	2093.0	0.925	22.515	6.3313	4.978	5.0218	3.948
25–29	27.5	664.646	0.90	2294.3	0.927	22.515	7.1764	10.944	5.8323	8.894
30–34	32.5	932.431	0.88	2119.3	0.929	22.515	8.1376	16.023	6.7764	13.343
35–39	37.5	1187.372	0.86	1871.1	0.932	22.515	9.9362	20.520	7.8806	17.508
40–44	42.5	1429.470	0.84	1928.1	0.937	22.515	10.5020	28.945	9.1813	25.305
45–49	47.5	1658.725	0.82	1857.0	0.945	22.515	11.9827	36.911	10.7338	33.064
50–54	52.5	1875.136	0.80	1505.8	0.959	22.515	13.7575	38.846	12.6271	35.655
55–59	57.5	2132.004	0.80	1436.0	0.983	22.515	15.9548	48.845	15.0045	45.936
60–64	62.6	2260.438	0.80	1446.1	1.000	20.492	16.0817	52.569	15.3700	50.243
65–69	67.5	2373.459	0.84	1426.1	1.000	16.638	13.6439	46.181	13.1424	44.483
70–74	72.5	2458.226	0.87	1313.3	1.000	13.076	11.1750	36.076	10.8454	35.012
75–79	77.5	2542.992	0.90	1081.7	1.000	9.914	8.7938	24.190	8.5935	23.639
80–84	82.5	2684.270	0.95	832.2	1.000	7.258	6.6448	14.843	6.5323	14.592
85–89	87.5	2769.036	0.98	476.8	1.000	5.212	4.8905	6.457	4.8304	6.377
90–94	92.5	2797.292	0.99	175.4	1.000	3.841	3.6645	1.798	3.6310	1.782
95–99	97.5	2797.292	0.99	38.6	1.000	2.942	2.8377	0.307	2.8177	0.305
100 +	102.5	2797.292	0.99	5.2	1.000	2.124	2.0693	0.030	2.0587	0.030
Total								389.353		360.806

basic state pension wealth is (for $\rho = 2.5\%$):

$WB_{32.5} = 17.27137$	(annuity factor, i.e., present value of female pension of £1 p.a. from age $60 = (1 - v^L)/\delta$)
$\times 0.5071$	(discounted back to age $32.5 = v^{(60-32.5)}$)
$\times 0.929$	(proportion surviving from 32.5 to 60)
$\times 2815.80$	(basic state pension for 1992)
$\times 0.375$	(accrual rate for 32.5 year old female)
$\times 0.88$	(mean proportion of standard rate)
$\times 2.1193$ m	(number of females in age range 30–34)
$= £16.023$bn		(11)

Similar calculations are made in other age ranges, and these are all summed to give the value of basic state pension rights for women in 1992 of £389.353bn (see Table 4).

The calculation for men follows the same procedure, with the following three adjustments. First the accrual rate is:

$$Accrual\ rate = \frac{Median\ age - 16}{49} \qquad (12)$$

i.e. based on a maximum of 49 rather than 44 years. Second the pension age is 65, rather than 60. Third, there is no scaling by the MPnSR for men.

We attempted to replicate the GADs 1976 estimate of the value of basic state pension rights. To do this we collected data on male and female population by age range (from the *Annual Abstract of Statistics*) and the BSP in 1976; the GAD does not change the MPnSR over time. We also needed information on the proportion of the population in each age range surviving to retirement age and on the estimated pension length once retired. These are currently based on projections made by the GAD and uprated annually. Unfortunately, the GAD did not keep records of its projections made in 1976 or earlier years. All it could provide us with was data based on actual experience up to 1992 and projections thereafter. This is likely to lead to some bias in our estimates, since Shaw (1994) shows that recent UK national population projections have tended to overestimate both fertility and mortality rates and underestimate migration rates. In contrast, projections made just after the Second World War underestimated fertility rates and failed to predict the 1960s baby boom. This implies that our estimates, based on actual experience, will tend to overpredict the value of state pension rights in the early post-war period and underpredict them in the later years, compared with the estimates that would have been made at the time.

Using the data at our disposal, we derived an estimate of £185.3bn for the value for BSP rights in 1976 using a 2.5% real discount rate. This compares with the original official estimate (denoted the 'historical' estimate in *Inland Revenue Statistics*) of £185.9bn. This is impressively close. However, the original official estimate was subsequently revised downwards to £138.1bn (this is denoted the 'latest' estimate in *Inland Revenue Statistics*), reflecting the overestimates made in the earlier period.

We continued to use our model to derive estimates for the period 1948 to 1975 (assuming a real discount rate of 2.5%) but scaled them down by 0.7453 (i.e. the ratio 138.1/185.3). The estimate for 1948 was so rescaled and then halved to reflect the fact that the BSP scheme did not start until July of that year. The annual values of BSP rights for 1948–94 are given in the fourth column of Table 12.

VI. THE VALUE OF STATE EARNINGS-RELATED PENSION WEALTH

The current state earnings-related pension scheme (SERPS) was established by the 1975 Social Security Pensions Act and came into force in 1978. Employees with earnings above the lower earnings limit for the payment of NICs will automatically be members of SERPS unless they have specifically contracted-out of SERPS. Members of SERPS are entitled to receive a state pension that is related to earnings (within the earnings band between the lower and upper earnings limits), and this is known as the additional pension. The value of the SERPS pension was reduced as a result of the 1986 Social Security Act and further reduced by the 1995 Pensions Act. The GAD has published annual estimates of the value of SERPS rights since the scheme started, so fortunately we did not have to generate our own estimates. In this section, we demonstrate how the calculations are made.

The SERPS pension is based on the calculation of a 'surplus' for each year worked since 1978. The surplus for a SERPS member for year t accrued by year T was originally defined as:

$$Surplus_t = (Y_t \cdot NAE_{t,T} - LEL_t \cdot RPI_{t,T}) \qquad (13)$$

where $t = 1978, \ldots, T$; Y_t is earnings in year t up to the upper earnings limit (UEL) in the same year; $NAE_{t,T}$ is the earnings factor for year t, defined as the ratio of national average earnings in year of accrual (year T) to national average earnings in year t (known as Section 148 orders, after the section in the 1992 Social Security Administration Act in which they are specified); LEL_t is the lower earnings limit in year t; $RPI_{t,T}$ is the price factor for year t, defined as the ratio of the retail price index in year of accrual to the retail price index in year t. The surplus in Equation 13 has to be revalued to the retirement year of the individual based on

forecasts of wage and price inflation between the year of accrual and the year of retirement:

$$Surplus_t^r = (Y_t \cdot NAE_{t,R} - LEL_t \cdot RPI_{t,R}) \qquad (14)$$

where $NAE_{t,R} \equiv NAE_{t,T} \cdot NAR_{T,R}$ is the revalued earnings factor to year of retirement, R, with $NAE_{T,R}$ defined as the ratio of forecast national average earnings in the year of retirement to national average earnings in year T; the GAD assumes national average earnings grow by 6.575% p.a. between year T and year R (i.e. by 1.5% p.a. compound more than the forecast increase in retail prices of 5% p.a.); $RPI_{t,R} \equiv RPI_{t,T} \cdot RPI_{T,R}$ is the revalued price factor to year of retirement, with $RPI_{T,R}$ defined as the ratio of the forecast retail price index in the year of retirement to the retail price index in year T; the GAD assumes retail prices grow by 5% p.a. The accrued SERPS pension (Z_T) was then equal to 25% of the accumulated revalued surplus of the member between 1978 and the year of accrual (or the year of retirement, if earlier):

$$Z_T = 0.25 \sum_{t=1978}^{Min(T,R)} Surplus_t^r \qquad (15)$$

The accrued pension calculated in this way is equivalent to 1.25% of average revalued earnings within the earnings band for each year of membership of SERPS up to a maximum of 20 years. In practice, the accrual rate is adjusted to allow for incapacity benefit (formerly invalidity benefit) and home responsibility protection credits (see Haberman, 1985). The accrued SERPS pension in Equation 15 is then summed over all scheme members to get the total value of SERPS pension entitlements in year T.

The effect of the 1986 Social Security Act was to reduce the accrual rate from 25% of the revalued surplus accumulated after 1988 to 20% (equivalent to an annual accrual rate of 1%) for those retiring after 2009, where in addition the surplus is based on career-revalued earnings rather than revalued earnings for the best 20 years. The accrual rate for the post-1988 period remains at 25% for those retiring before 2000, but declines according to a sliding scale for those retiring between 2000 and 2009. For those retiring in 2000, the accrual rate is 24.5%, for those retiring in 2001 it is 24%, for those retiring in 2002 it is 23.5% and so on down to 20% for those retiring after 2009. For someone retiring in 2004, for example, the accrued pension in 1992 is calculated as:

$$Z_{1992} = 0.25 \sum_{t=1978}^{1987} Surplus_t^r + 0.225 \sum_{t=1988}^{1992} Surplus_t^r \qquad (16)$$

The 1986 Act also reduced the spouse's pension from 100% of the member's SERPS pension to only 50% if the member dies after 2000.

The effect of the 1995 Pensions Act was to change the definition of the surplus for those reaching state pension age after 2000 as follows:

$$Surplus_t = (Y_t - LEL_t) \cdot NAE_{t,T} \qquad (17)$$

Because earnings grow on average by an assumed 1.5% more than prices, this change has the effect of reducing the size of the surplus that accumulates each year.

Blake (1995) estimated that the effect of the 1986 Act was to reduce the cost of SERPS to the government by 25%. Disney and Johnson (1995) estimated that the effect of the 1995 Act was to reduce the cost by a further 50%, implying that after 2009 the value of SERPS benefits will be only just over one-third of what they would have been under the original rules of the scheme.

We can illustrate the calculation of the value of SERPS rights for 1992 in the case of men. For active members we need to forecast the value of their SERPS pension when they retire (i.e. in the year of award), based on the surplus that they have accumulated each year between 1978 and 1992 (i.e. the year of accrual). The surplus accumulated for each age group by 1992 must be revalued and survived to state pension age. For active males aged x in 1992, the total accrued SERPS pension in 1992 is given by:

$$
\begin{aligned}
Z_{x,1992} = \Bigg\{ &0.25 \sum_{t=1978}^{1987} (Y_{x,t} \cdot NAE_{t,R} - LEL_t \cdot RPI_{t,R}) N_{x,t} \\
&+ \alpha_R \sum_{t=1988}^{1992} (Y_{x,t} \cdot NAE_{t,R} - LEL_t \cdot RPI_{t,R}) N_{x,t} \Bigg\} \\
&\times P_{x,65}
\end{aligned}
\qquad (18)
$$

where $Y_{x,t}$ is the average earnings in year t of males who are in age group x in 1992; $N_{x,t}$ is the number of male SERPS members in year t who are in age group x in 1992; $R = 1992 + 65 - x$ is the year of retirement for males aged x in 1992; $NAE_{t,R}$ is the revaluation factor for earnings between t and state pension age; $RPI_{t,R}$ is the revaluation factor for prices between t and state pension age; $P_{x,65}$ is the proportion surviving from median age x to state pension age; α_R is the accrual rate for the post-1988 award of SERPS which depends on year of retirement.

We now have forecasts of the amount of SERPS pension that will be payable once active members have reached state pension age. In 1992, the SERPS pension was already being drawn by males aged between 65 and 78. Once in payment the SERPS pension is uprated by increases in the retail price index (this process is called dynamization). Future SERPS pension payments are discounted back to 1992 with the GAD assuming a real rate of interest of 3%. Since the GAD assumes retail prices increases by 5% p.a. in the future, this implies a nominal discount rate of 8.15% p.a. The value of SERPS wealth for male members aged x in 1992 is

calculated either as:

$$WS_x^M = \sum_{t=1992}^{\infty} \frac{Z_{x,1992} \cdot P_{x,s} \cdot RPI_{1992,t}}{(1.0815)^{t-1992}}$$

$$= \sum_{t=1992}^{\infty} \frac{Z_{x,1992} \cdot P_{x,s}}{(1.03)^{t-1992}} \quad \text{if } x \geqslant 65 \qquad (19)$$

or as:

$$WS_x^M = \sum_{t=R}^{\infty} \frac{Z_{x,1992} \cdot P_{x,s} \cdot RPI_{R,t}}{(1.0815)^{t-1992}}$$

$$= \sum_{t=R}^{\infty} \frac{Z_{x,1992} \cdot P_{x,s}}{(1.03)^{t-1992}} \quad \text{if } x < 65 \qquad (20)$$

where $s = x + t - 1992$; $P_{x,s}$ is the proportion of male SERPS members aged x in 1992 who are still alive at age s; once a SERPS member has reached retirement age, GAD assumes 5% lighter mortality.

When Equations 19 and 20 are summed over all age groups, we derive the value of SERPS rights for men. A similar exercise is performed on women, taking into account the fact that their state pension age increases from 60 to 65 over a ten year period beginning in 2010. Similar calculations are made for widows and widowers. In 1992, they received the full pension awarded to the active member. In terms of prospective widows (and *mutatis mutandis* widowers) the following factors must be taken into account: the proportion of male members in each age group who are married, survival probabilities for widows, the fact that women will receive the full SERPS pension of their husband if he dies before 2000, but only half this sum if he dies after this date. Summing over all age groups we derive the value of SERPS rights for SERPS members.

The GAD includes in the total value of SERPS rights, the component of the uprating of the GMP that is the responsibility of the state. The GMP is the guaranteed minimum pension that must be provided by an occupational pension scheme in order to contract out of SERPS. Once in payment the GMP is fully indexed to inflation, but the responsibility for ensuring this is shared between the scheme and the state. For pre-1988 accruals, the entire responsibility for indexing lay with the state. The payments required were added to the basic state pension payable. For post-1988 accruals, the state is responsible for indexing the GMP only if inflation exceeds 3% p.a. compound. The state is also responsible for revaluing the preserved GMPs of early leavers if national average earnings grow by more than 5% p.a. compound between the date of leaving the scheme and state pension

age and if schemes have a paid limited revaluation premium to the state. As a result of the 1995 Pensions Act the GMP ceased to accrue after April 1997 and the state's responsibility for indexing the GMP is now confined to accruals only up to April 1997.

In 1992, the total value of SERPS rights was £172.9bn. The GAD has published the value of SERPS rights annually since 1979, the first year for which SERPS rights began to accrue. These values are listed in the fifth column of Table 12.

There was an earnings-related predecessor to SERPS, the state graduated retirement pension scheme, which operated between 1961 and 1975 and was introduced by the 1959 National Insurance Act. Graduated (i.e. earnings-related) contributions were used to buy units of the graduated pension. The resulting pension, which is still being drawn, is very low and varied in 1995 between about £4 and £340 p.a. The GAD takes into account the value of graduated state pension rights by adjusting the value of basic state pension rights by raising the mean proportion standard rate for men to 1.0 from 0.98 at all age ranges, and by a similar amount for women. Hence the graduated scheme is already accounted for in the BSP calculations above. The GAD estimated that the value of the accrued rights in the graduated scheme amounted to £1764bn in 1975 (Diamond, 1975, p. 91).

VII. THE VALUE OF OCCUPATIONAL PENSION WEALTH

Occupational pension schemes were first established in the public sector in 1712 (for HM Customs and Excise officers) and in the private sector (by the East India Company and the Bank of England) following the introduction of actuarial tables by the Equitable Life Assurance Society in 1762. Most occupational pension schemes have been established as pension trust funds under the Superannuation and Other Trust Funds (Validation) Act of 1927.[2]

The GAD provides annual estimates of the value of occupational pension rights (in funded, notionally funded and unfunded schemes) using the accrued benefits method (or projected unit method). This method values the accrued rights of members up to the year of accrual based on projected final salaries at retirement, but ignoring future service.[3] We can illustrate how the GAD made the calculation for 1992, treating active members, deferred members and pensioners separately.

For active members, the following assumptions are made. The first concerns the probabilities of and average

---

[2] A number of occupational pension schemes, mainly from the public sector, have not established explicit funds to accumulate contributions. For example, the school teachers' and National Health Service schemes are based on notional funds, while the civil service and armed forces' funds are unfunded.

[3] This method is consistent with that used to value state pension rights, but contrasts with the prospective benefits method (or attained age method) which also takes into account the expected benefits that might accrue over the remaining working lives of members. The GAD changed its method for estimating the value of occupational pension rights in 1993. The new method is explained at the end of this section.

age of future withdrawal from scheme membership, which vary with the current age of the members as follows (and are based on an assumed average normal pension age of 62):

Current age of member (years)	Probability of withdrawal between current age and 62 (%)	Average age of withdrawal (years)
17	90	20
22	85	25
30	75	35
40	70	45
50	55	55
57	35	60

The information here originated from the *General Household Survey* (Office of Population, Censuses and Surveys, 1988) which asked people how long they had been members of their current pension scheme. The second set of assumptions concerns future earnings increases and increases in deferred pensions after withdrawal taking into account current legislation and scheme practice. The GAD assumes that future earnings of members increase at 1.8% less than the gross investment yield and that deferred pensions increase at 5% less than the gross investment yield. Thus a gross investment yield of 10% implies earnings increases of 8.2% p.a. and deferred pension increases of 5% p.a.

With these assumptions it is possible to derive, for each age group, discount factors that represent the expected present value of £1 to be received at normal pension age (62). For example, for a 22-year-old member, the discount factor with a gross investment yield of k is:

$$DF_{22} = 0.15 \left(\frac{1 + k - 0.018}{1 + k} \right)^{40}$$

$$+ 0.85 \left(\frac{1 + k - 0.018}{1 + k} \right)^{3} \left(\frac{1 + k - 0.05}{1 + k} \right)^{37}$$

$$= 0.15 \left(\frac{1}{1 + 0.018} \right)^{40} + 0.85 \left(\frac{1}{1 + 0.018} \right)^{3} \left(\frac{1}{1 + 0.05} \right)^{37}$$

$$= 0.206 \tag{21}$$

By using the approximation:

$$\frac{1 + y}{1 + z} \simeq \frac{1}{1 + z - y} \tag{22}$$

it is clear that the discount factors do not depend on the discount rate, k. In practice, the GAD uses a linear approximation for these discount factors which depend only on age (x):

$$DF_x = 0.0185(x) - 0.2 \tag{23}$$

For example, at age 22, this linear approximation generates a discount factor of 0.207. (Notice that the discount factor in not 'survived' to age 62, i.e. the GAD does not take into account survival probabilities between the member's current age and his expected retirement age.)

The next step is to derive pension annuity factors at age 62 for both men and women. These are based on Institute of Actuaries Tables PMA80 and PFA80 (tables used for pension annuitants),[4] allowing for average increases in pensions in payment of 4.25% less than the gross investment yield. In the case of a man, the annuity factor at age 62 is given by:

$$A_{62}^{M} = \sum_{j=1}^{\infty} P_{62,62+j}^{M} \left(\frac{1 + k - 0.0425}{1 + k} \right)^{j}$$

$$\simeq \sum_{j=1}^{\infty} P_{62,62+j}^{M} \left(\frac{1}{1 + 0.0425} \right)^{j} \tag{24}$$

$$= 12.59$$

where $P_{62,62+j}^{M}$ is the probability of a male aged 62 surviving to age $62 + j$. To this sum is added the annuity factor for a contingent spouse's pension, payable at half the rate of a man's pension, assuming that 85% of men are still married at age 62 to a woman three years younger. This is calculated as follows:

$$A_{62}^{MS} = 0.5 \times 0.85 \times \sum_{j=1}^{\infty} (1 - P_{62,62+j}^{M}) \times P_{59,59+j}^{F}$$

$$\times \left(\frac{1}{1 + 0.0425} \right)^{j} = 1.70 \tag{25}$$

where $P_{59,59+j}^{F}$ is the probability of a female aged 59 surviving to age $59 + j$, and Equation 25 includes a small additional amount to cover a guarantee period. The total annuity factor for a man aged 62 is therefore 14.29. The equivalent figure for a woman aged 62 is 15.00.

The population of occupational scheme members is divided into age groups as shown in Table 5. The number of active members in each age group was based on Table 2.3 in *Occupational Pension Schemes 1991: Ninth Survey by the Government Actuary* (HMSO, 1994). The data in this table was updated for 1992 using information in Table 24 of *Economic Trends* on numbers in employment. These updated figures were in turn revised downwards by 1.35% for men and upwards by 1.35% for women to account for the trend fall in occupational pension scheme membership by men and the trend rise in membership by women over recent years.

The average pension accrued in each age group is calculated in relation to the average earnings in the age group and years of service based on the sixtieths scale. So, for

---

[4] They differ from ELT14 used to calculate the value of state pension rights in that they reflect the lighter mortality experienced by the type of people with occupational pension rights.

Table 5. *Nominal value of pension wealth for active, deferred and retired members of occupational pension schemes, 1992, by age group*

Age range (yrs) (1)	Median age (yrs) (2)	Accrued pension (£) (3)	Active members (m) (4)	Annuity factor (5)	Discount factors (6)	Value of pension wealth-active members (£bn) (7)	Deferred members as prop. of active members (%) (8)	Deferred members (m) (9)	Value of pension wealth-deferred members (£bn) (10)	Retired members (m) (11)	Pension in payment (£p.a.) (12)	Annuity factor (13)	Value of pension wealth-retired members (£bn) (12)
Males													
20–24	22	650	0.62	14.29	0.207	1.2	10	0.06	0.0				
25–29	27	1350	0.90	14.29	0.300	5.3	20	0.18	0.4				
30–34	32	2450	0.91	14.29	0.392	12.7	30	0.27	1.3				
35–39	37	3500	0.81	14.29	0.485	19.9	40	0.32	2.7	0.00	3700	15	0.0
40–44	42	4500	0.94	14.29	0.577	35.4	50	0.47	5.9	0.02	4700	15	1.4
45–49	47	5100	0.78	14.29	0.670	38.6	60	0.47	7.7	0.06	5300	15	4.8
50–54	52	5350	0.67	14.29	0.762	39.6	70	0.47	9.2	0.11	5600	15	9.2
55–59	57	5550	0.54	14.29	0.855	37.1	75	0.41	9.3	0.29	5800	15	25.2
60–64	62	5650	0.31	14.29	1	25.4	75	0.23	6.3	0.57	5150	14	39.6
65–69	67	5650	0.02		1	1.5	0	0.00	0.0	0.95	4900	12	53.5
70–74	72									0.70	4550	10	30.3
75–79	77									0.53	4300	8	17.1
80–84	82									0.25	4050	6	6.1
85+	87									0.12	3800	5	2.1
Total			6.5			216.7		2.9	42.8	3.6			189.3
Females													
20–24	22	350	0.52	15.00	0.207	0.6	5	0.03	0.0				
25–29	27	700	0.61	15.00	0.300	2.0	35	0.21	0.2				
30–34	32	1150	0.52	15.00	0.392	3.8	50	0.26	0.6				
35–39	37	1600	0.46	15.00	0.485	5.7	50	0.23	1.0	0.01	2100	16	0.3
40–44	42	1950	0.61	15.00	0.577	11.0	50	0.31	1.8	0.02	2350	16	0.8
45–49	47	2350	0.50	15.00	0.670	12.6	50	0.25	2.1	0.05	2600	16	2.1
50–54	52	2700	0.40	15.00	0.762	13.2	50	0.20	2.2	0.09	2900	16	4.2
55–59	57	2950	0.30	15.00	0.855	12.1	50	0.15	2.0	0.23	3150	16	11.6
60–64	62	2850	0.08		1	3.4	0	0.00	0.0	0.67	2600	15	26.1
65–69	67									0.69	2600	13	23.3
70–74	72									0.50	2600	11	14.3
75–79	77									0.42	2600	9	9.8
80–84	82									0.25	2600	7	4.6
85+	87									0.17	2600	6	2.4
Total			4.00			64.4		1.6	10.0	3.1			99.5

example, the average accrued pension of £650 for a 22-year-old male is found by taking the average earnings of a 22-year-old male (£7800 in 1992) and multiplying this by 5/60ths, assuming five years' membership of an occupational scheme, starting at age of 17. The average earnings in each age group came from the 1988 *General Household Survey* uprated to 1992 by increases in national average earnings.

The total value of accrued male pension rights in each age group is given by

$$WO_x^M = Z_x^M \cdot N_x^M \cdot (A_{62}^M + A_{62}^{MS}) \cdot DF_x \qquad (26)$$

where Z_x^M is the accrued male pension at age x and N_x^M is the number of male occupational pension scheme members in the age group with median age x. For males in age group 20 to 24, this figure comes to £1.2bn and for active males in all age groups, the figure is £216.7bn (see Table 5).

Table 11.1 in *Occupational Pension Schemes 1991* (HMSO, 1994) showed that about 2.9m men and 1.6m women had deferred pensions with occupational schemes. The GAD allocates these individuals, somewhat arbitrarily, to age groups as given in columns 8 and 9 of Table 5. For example, 60 000 males in the age range 20–24 are assumed to be deferred members of occupational schemes, equivalent to 10% of total scheme membership in that age group. Deferred members are assumed to have deferred pensions equal to one-third of the size of the accrued pensions of active members in the same age range. The total value of the accrued rights of deferred male members was £42.8bn in 1992.

The next step is to calculate the value of pension rights for retired members of occupational schemes, including ill-health early-retired, widows and widowers. The following factors have to be taken into account. The annuity basis changes from year-of-birth to year-of-use 1992. The latter method assumes that mortality rates remain constant at 1992 figures; the former method takes into account improvements in mortality over time (i.e. builds in the fact that a 63-year-old retiree in 1993 (born in 1930), say, has a slightly longer life expectancy than a 63-year-old retiree in 1992 (born in 1929)) and so leads to higher annuity factors. Most young pensioners will be ill-health cases: they generally draw their pensions for longer than older normally-retired pensions, but the pensions are based on reduced service (although it is usually enhanced with respect to actual service accrued by the time of early retirement). The annuity factor also takes account of half-rate pensions to contingent spouses and proportions married at death (the proportion married falls as people get older because spouses die, but the widow/er still gets half the member's pension). Finally women in aggregate receive bigger pension increases than men because they are proportionally more numerous in the public sector. Making *ad hoc* adjustments for some of the above factors, the GAD used the information contained in columns 11 to 13 of Table 5 to estimate the value of occupational pensions in payment.

The numbers of pensioners in each age group were based on Table 3.3 of *Occupational Pension Schemes 1991* (HMSO, 1994). The data in this table exclude widows so an estimate for widows was found by taking the 1991 figure for total female pensioners and deducting the number of former female employees (non-widowed female pensioners in 1991). The data so adjusted was updated for 1992 by increasing the number of male pensioners by 3.6% and the number of female pensioners by 4.3% (which were the average annual increases in the number of male and female pensioners, respectively, between the 1987 and 1991 GAD occupational pension scheme surveys).

The average pensions in payment by age group came from the 1987 *Family Expenditure Survey* (Office for National Statistics). A single figure was given for men under 65, and for women under 60, so the GAD's estimates for younger age groups was 'very much guesswork', although pension increases since 1987 based on retail price inflation were allowed for. The drop in average pension in payment after 57 occurs because of the large number of small deferred pensions coming into payment at 60.

The value of occupational pension rights for retired male members is found by using Equation 26 (but with $DF_x = 1$ and $(A_{62}^M + A_{62}^{MS})$ replaced by $(A_x^M + A_x^{MS})$, the annuity factors for a male aged x) and then summing over all age groups. The figure for men in 1992 was £189.3bn.

Similar calculations are made for the three categories of female members of occupational schemes. Table 5 shows that the value of the pension rights of active, deferred and retired female members were respectively £64.4bn, £10.0bn and £99.5bn in 1992. The overall value of occupational pension rights in 1992 was recorded at £623bn.

The GAD has been able to apply this level of precision to the estimation of occupational pension rights only in recent years. The estimates for the earlier years were much more 'rough and ready'. For example, the 1976 value was £50bn. This was not based on any precise formula since there were no data available on important determinants of accrued pensions such as average length of scheme membership.

An attempt was made to replicate the 1976 value of £50bn employing the same methodology used for estimating the 1992 value of £623bn. At the same time, we constructed all relevant data between 1948 and 1976. The main factors to take into account for this earlier period are: lower accrued rights since schemes were newer and so periods of active membership were shorter, lower annuity factors to allow for heavier mortality, less good pension benefits (e.g. spouse's pensions were less common then), a retirement age of 65 for men and 60 for women (compared with the assumed retirement age of 62 for both sexes in 1992), smaller increases in pensions in payment, fewer deferred pensioners and deferred pensions much smaller in amount.

Data on membership of occupational schemes is published in the periodic surveys by the GAD. Using interpolation for intervening years, we can derive estimates of the

Table 6. *Numbers of active members of occupational pension schemes 1948–1976*

| Year | Men | | | Women | | | Total |
	Private sector	Public sector	Total	Private sector	Public sector	Total	(millions)
1936 (1)	1.3	0.8	2.1	0.3	0.2	0.5	2.6
1948	2.1	1.7	3.8	0.5	0.5	1.0	4.8
1949	2.2	1.9	4.0	0.5	0.5	1.0	5.0
1950	2.2	2.0	4.2	0.5	0.6	1.1	5.3
1951	2.3	2.1	4.4	0.6	0.6	1.2	5.6
1952	2.4	2.2	4.6	0.6	0.7	1.3	5.9
1953 (2)	2.5	2.4	4.9	0.6	0.7	1.3	6.2
1954	2.8	2.6	5.4	0.7	0.7	1.4	6.9
1955	3.1	2.7	5.8	0.7	0.8	1.5	7.4
1956 (2)	3.5	2.9	6.4	0.8	0.8	1.6	8.0
1957	3.8	2.9	6.7	0.8	0.8	1.6	8.4
1958	4.2	2.9	7.1	0.8	0.8	1.6	8.7
1959	4.5	2.9	7.4	0.8	0.8	1.6	9.1
1960	4.9	3.0	7.9	0.8	0.9	1.7	9.7
1961	5.4	3.0	8.4	0.8	0.9	1.7	10.1
1962	5.9	3.0	8.9	0.8	0.9	1.7	10.6
1963 (2)	6.4	3.0	9.4	0.8	0.9	1.7	11.1
1964	6.5	3.0	9.5	0.9	0.9	1.8	11.3
1965	6.6	3.0	9.6	1.0	0.9	1.9	11.6
1966	6.7	3.1	9.8	1.2	1.0	2.2	11.9
1967 (2)	6.8	3.1	9.9	1.3	1.0	2.3	12.2
1968	6.4	3.1	9.5	1.3	1.0	2.3	11.9
1969	6.1	3.1	9.2	1.3	1.0	2.3	11.6
1970	5.8	3.0	8.8	1.3	1.1	2.4	11.4
1971 (2)	5.5	3.2	8.7	1.3	1.1	2.4	11.1
1972	5.3	3.3	8.6	1.2	1.2	2.4	11.2
1973	5.2	3.4	8.6	1.2	1.4	2.6	11.2
1974	5.0	3.6	8.6	1.1	1.5	2.6	11.3
1975 (2)	4.9	3.7	8.6	1.1	1.7	2.8	11.4
1976	4.8	3.7	8.5	1.2	1.7	2.9	11.4
1979 (2)	4.6	3.7	8.3	1.5	1.8	3.3	11.6

Source: (1) *Ministry of Labour Gazette*, May 1938.
(2) *Occupational Pension Schemes 1991* (HMSO) (Table 2.1).

numbers of active members of occupational schemes between 1948 and 1976 as shown in Table 6.

The scheme members given in Table 6 needed to be allocated to age ranges. To do this we needed information on the age distributions of both the working population and pension scheme members. Data on proportions of the working population in each age group (denoted PWP_x) were obtained from Table 151 of *British Labour Statistics: Historical Abstract* for the years 1950 to 1968 (with extrapolation back to 1948) and from the *British Labour Statistics Yearbooks* and the *New Earnings Surveys* for later years. Data on the proportions of each age group who were members of occupational pension schemes (denoted $PMEM_x$) came from the *General Household Surveys* (Office of Population, Censuses and Surveys) for 1972, 1975 and 1976. Trends were used both to interpolate for 1973 and 1974 and to extrapolate back to 1948. Table 7 presents estimates of this data and reveals the huge increase in scheme membership during the early 1970s. The numbers of

occupational pension scheme members by age range is found using the formula (in the case of men):

$$N_x^M = \frac{PWP_x^M \cdot PMEM_x^M \cdot N^M}{\sum_x PWP_x^M \cdot PMEM_x^M} \qquad (27)$$

where N^M is the total number of (male) scheme members.

The next step was to calculate accrued pension rights for men and women in each age range for each year between 1948 and 1976. This required data on average annual earnings for each year for both men and women. The data was taken from the 'all industries' column of Table 41 of *British Labour Statistics: Historical Abstract* for the period 1948 to 1968 and from the *Yearbooks* for later years. Information on the age distribution of earnings is available in the *New Earnings Surveys*. The surveys indicated that the age distribution of earnings is fairly constant over time. We therefore applied the 1976 ratios of earnings in each age range to average earnings across all age ranges to the whole period

Table 7. *Membership of occupational pension schemes by age range* (*percentages*)

					Year					
Age range	1948–68	1969	1970	1971	1972	1973	1974	1975	1976	1983
Males										
20–24	22	24	26	28	28.9	32	35	37	44	42
25–29	46	48	50	52	53.6	57	60	63	73	67
30–34	46	48	50	52	53.6	57	60	63	73	67
35–39	53	55	57	59	60.6	63	66	68	76	73
40–44	53	55	57	59	60.6	63	66	68	76	73
45–49	59	61	63	65	66.6	69	71	73	78	77
50–54	59	61	63	65	66.6	69	71	73	78	77
55–59	53	55	57	59	60.6	63	66	69	73	74
60–64	53	55	57	59	60.6	63	66	69	73	74
Females										
20–24	12	15	18	21	24.2	28	32	36	38	41
25–29	28	31	34	37	40.0	44	49	53	65	65
30–34	28	31	34	37	40.0	44	49	53	65	65
35–39	24	27	30	33	35.6	41	47	53	60	61
40–44	24	27	30	33	35.6	41	47	53	60	61
45–49	31	34	37	40	42.7	47	51	55	65	65
50–54	31	34	37	40	42.7	47	51	55	65	65
55–59	20	23	26	29	31.8	37	43	48	57	63
60–64	20	23	26	29	31.8	37	43	48	57	63

Sources: *General Household Surveys* (Office of Population, Censuses, and Surveys) for 1972, 1975 and 1976 and interpolation or extrapolation for other years.

between 1948 and 1976:

Age range	21–24	25–29	30–39	40–49	50–59	60–64	65+
Males	0.81	0.95	1.06	1.08	1.01	0.90	0.80
Females	0.91	1.05	1.03	1.02	1.00	0.96	

When these ratios are multiplied by average earnings for the whole economy we derive estimates of the average earnings in each age range. Accrued pensions in each age range are found by taking earnings in each age range and multiplying by length of service in years (as a ratio of 60), assuming a scheme joining age of 22.

The 1972 *General Household Survey* (Table 3.7) provided some information on job turnover by age. From this we were able to derive estimates of the probability of leaving a pension scheme prior to retirement, as shown in Table 8. The table shows, for example, that 18.7% of 20-year-old males change jobs during the year, implying that the average length of job tenure for a 20-year old male is 5.3 years (i.e 1/0.187) and for a 40-year-old male is 8.1 years (i.e. 1/0.123). The probability of leaving prior to retirement is one minus the probability of remaining in the same job until retirement. For a 20-year-old male, the probability of leaving is $1 - (1 - 0.187)^5 (1 - 0.161)^{10} (1 - 0.123)^{10} (1 - 0.061)^{10}$ $(1 - 0.043)^{10} = 0.99$, while for a 40-year old male, the probability of leaving is $1 - (1 - 0.123)^5 (1 - 0.061)^{10}$ $(1 - 0.043)^{10} = 0.82$. This information can be used to calculate the discount factors at different ages, assuming that future earnings increase at 1.8% less than the gross invest-

ment yield and that deferred pensions increase at 5% less than the gross investment yield. The discount factors for 20-year old and 40-year old males are respectively given by:

$$DF_{20}^M = 0.01 \left(\frac{1}{1.018}\right)^{4.5} + 0.99 \left(\frac{1}{1.018}\right)^{5.3} \left(\frac{1}{1.05}\right)^{39.7}$$
$$= 0.134 \tag{28}$$

and

$$DF_{40}^M = 0.18 \left(\frac{1}{1.018}\right)^{25} + 0.82 \left(\frac{1}{1.018}\right)^{8.1} \left(\frac{1}{1.05}\right)^{16.9}$$
$$= 0.426 \tag{29}$$

From these we can derive a linear relationship between the discount factors and age:

$$DF_x^M = 0.0146(x) - 0.158 \tag{30}$$

A similar exercise for females yields the following equation for the discount factor:

$$DF_x^F = 0.0177(x) - 0.187 \tag{31}$$

We assumed that these discount factors could be applied to the whole period 1948 to 1976. These discount factors were survived until retirement age by multiplying by the probability that males and females in each age group survive until retirement age based on mortality experience during the 1948–76 period. The value of accrued pension

Table 8. *Probability of changing jobs prior to retirement*

Age	Probability of leaving per year (%)	Average length of job tenure (years)	Probability of leaving before retirement (%)
Males (retirement age = 65)			
20	18.7	5.3	99
30	16.1	6.2	96
40	12.3	8.1	82
50	6.1	16.4	53
60	4.3	23.5	20
Females (retirement age = 60)			
20	20.3	4.9	99.8
30	17.0	5.9	97
40	12.5	8.0	83
50	8.4	11.9	50

Source: *General Household Survey 1972* (Office of Population, Censuses, and Surveys) (Table 3.7).

rights for active members in each age group is given by (in the case of males):

$$WO_x^M = Z_x^M \cdot N_x^M \cdot A_{65}^M \cdot DF_x^M \cdot P_{x,65}^M \qquad (32)$$

where $P_{x,65}^M$ is the probability of a healthy male surviving from age x to retirement age 65. We ignored deferred pensions. The annuity factors A_{65}^M and A_{60}^F were determined residually to ensure that the total value of accrued pension rights calculated using our procedure equalled the official GAD 1976 figure of £50bn. In other words, A_{65}^M and A_{60}^F took on the role of scaling factors. Given the heroic nature of the assumptions made to derive our model, we did not feel confident enough to challenge the official estimate.

We must also take into account the accrued rights of pensioners. Data on occupational pensions in payment are also published in the periodic surveys by GAD. Again using interpolation for the intervening years, we could derive estimates of the numbers of pensions in payment for both former employees and widows between 1948 and 1976, as shown in Table 9. Data over time on the amount of pension in payment was more difficult to obtain. However the 1975 GAD survey indicated the following:

Basic state pension	£11.60 per week
Average member's pension	
private sector	£10.75 per week
public sector	£10.50 per week
Average widow's pension	
private sector	£7.75 per week
public sector	£4.00 per week

The average private sector member's pension was therefore 91% of the basic state pension, while the average public

sector member's pension was 93% of the BSP. The above figures also show that the average widow's pension was equal to 67% of the BSP in the private sector and 34% in the public sector. We applied these percentages for the whole period 1948–1976. Data from the Inland Revenue's *Survey of Personal Incomes* indicated that occupational pensions might be more generous than this. Table 22 from the 1975–76 survey suggested that single males and widowers received an average occupational pension of £14.22 per week (23% more than the BSP) while Table 23 indicated that single females and widows received an average occupational pension of £12.17 (5% more than the BSP). We nevertheless chose to maintain the more conservative assumption about the size of occupational pensions in payment.

The distribution of pensioners by age range for 1992 and the ratio of the pension in each age group to the average pension across all age groups were estimated by the GAD and results are shown in Table 10. In the absence of any specific information about the age distribution of pensioners for earlier years, we applied this distribution to the whole period. In reality, we might expect the distribution to be more concentrated in earlier years, with fewer very young and very old pensioners. Nevertheless, we disregarded this. We also assumed that the age distribution of pensions for the 1948–1976 period could be represented by the 1992 distribution. We had no real evidence that this assumption is reasonable, although, as mentioned above, we did have some evidence that the age distribution of earnings does not appear to change much over time.

The value of accrued pension rights for male pensioners in each age group is found using Equation 32 (but with $DF_x^M = 1$, $P_{x,65}^M = 1$ and A_{65}^M replaced by A_x^M and then summing over all age groups. Again A_x^M was used as a scaling factor as explained above. Similar calculations are performed for retired female members. An additional amount is allowed for widows based on the total number of widows and the average pension of widows in the year in question.

The official 1976 value of £50bn for occupational pension rights was found by summing the value of the rights of active and retired male and female scheme members and of widowers[5] on the basis of the following assumption concerning annuity factors: 8 for active males, 10 for active females, and the annuity factors by age range for retired male and female members given in Table 10. The GAD produced official estimates for the value of occupational pension rights for 1975 (£42bn), 1974 (£33bn), 1971 (£20bn) and 1966 (£12bn) (in *Inland Revenue Statistics 1980* (Table 4.18)). These estimates were used to generate the scaling factors of our model. The annuity factors were rescaled by the following multiples: 0.96 (1975), 0.91 (1974), 0.93 (1971) and 0.85 (1966). In other words, our unadjusted model overestimated the official estimates of occupational pension rights by 4% in 1975 and by 15% in 1966 compared with

---

[5] We ignored deferred members' pension rights which, as we stated above, would have been very low in those days.

Table 9. *Number of retired members of occupational pension schemes 1948–1976*

Year	Former employees						Total (3) + (6) (7)	Widows and other dependants			Total (millions) (11)
	Males			Females							
	Private sector (1)	Public sector (2)	Total (3)	Private sector (4)	Public sector (5)	Total (6)		Private sector (8)	Public sector (9)	Total (10)	
1936 (1)	–	–	–	–	–	–	0.2	–	–	–	0.2
1948	0.15	0.29	0.44	0.06	0.10	0.16	0.6	–	0.1	0.1	0.7
1949	0.15	0.29	0.44	0.06	0.10	0.16	0.6	–	0.1	0.1	0.7
1950	0.15	0.29	0.44	0.06	0.10	0.16	0.6	–	0.1	0.1	0.7
1951	0.17	0.36	0.53	0.07	0.10	0.17	0.7	–	0.1	0.1	0.8
1952	0.17	0.36	0.53	0.07	0.10	0.17	0.7	–	0.1	0.1	0.8
1953 (2)	0.20	0.42	0.62	0.07	0.11	0.18	0.8	–	0.1	0.1	0.9
1954	0.20	0.42	0.62	0.07	0.11	0.18	0.8	–	0.1	0.1	0.9
1955	0.27	0.54	0.81	0.08	0.11	0.19	1.0	–	0.1	0.1	1.1
1956 (2)	0.27	0.54	0.81	0.08	0.11	0.19	1.0	–	0.1	0.1	1.1
1957	0.27	0.54	0.81	0.08	0.11	0.19	1.0	–	0.1	0.1	1.1
1958	0.36	0.64	1.00	0.08	0.12	0.20	1.2	–	0.1	0.1	1.3
1959	0.36	0.64	1.00	0.08	0.12	0.20	1.2	0.1	0.1	0.2	1.4
1960	0.36	0.64	1.00	0.08	0.12	0.20	1.2	0.1	0.1	0.2	1.4
1961	0.39	0.70	1.09	0.08	0.13	0.21	1.3	0.1	0.2	0.3	1.6
1962	0.42	0.76	1.18	0.09	0.13	0.22	1.4	0.1	0.2	0.3	1.7
1963 (2), (3)	0.46	0.82	1.28	0.09	0.14	0.23	1.5	0.15	0.17	0.3	1.8
1964	0.46	0.82	1.20	0.09	0.14	0.23	1.5	0.2	0.2	0.4	1.9
1965	0.51	0.91	1.42	0.11	0.17	0.28	1.7	0.2	0.2	0.4	2.1
1966	0.54	0.95	1.49	0.12	0.17	0.29	1.7	0.2	0.2	0.4	2.1
1967 (2)	0.57	1.00	1.57	0.13	0.20	0.33	1.9	0.2	0.2	0.4	2.3
1968	0.59	1.05	1.64	0.14	0.22	0.36	2.0	0.2	0.2	0.2	2.4
1969	0.62	1.09	1.71	0.16	0.23	0.39	2.1	0.2	0.2	0.4	2.5
1970	0.69	1.09	1.78	0.17	0.25	0.42	2.2	0.2	0.3	0.5	2.7
1971 (2)	0.75	1.17	1.92	0.19	0.29	0.48	2.4	0.2	0.3	0.5	2.9
1972	0.78	1.21	1.99	0.20	0.31	0.51	2.5	0.2	0.3	0.5	3.0
1973	0.80	1.26	2.06	0.22	0.32	0.54	2.6	0.2	0.3	0.5	3.1
1974	0.83	1.29	2.12	0.23	0.35	0.58	2.7	0.2	0.4	0.6	3.3
1975 (2)	0.85	1.33	2.18	0.25	0.37	0.62	2.8	0.2	0.4	0.6	3.4
1976	0.86	1.36	2.21	0.25	0.38	0.63	2.8	0.2	0.4	0.6	3.4
1979 (2), (4)	0.90	1.39	2.29	0.30	0.43	0.73	3.0	0.2	0.5	0.7	3.7
1983 (5)	1.4	1.6	3.0	0.4	0.6	1.00	4.0	0.3	0.7	1.0	5.0

Sources:
(1) *Ministry of Labour Gazette*, May 1938.
(2) *Occupational Pension Schemes*, 1991 (Table 3.1).
(3) *Occupational Pension Schemes*, 1963 (Table T10) for separation of 1963 pensions in payment between men and women.
(4) *Occupational Pension Schemes*, 1979 (Table 3.2) for separation of 1979 pensions in payment between men and women.
(5) *Occupational Pension Schemes*, 1983 (Table 3.2) for separation of 1983 pensions in payment between men and women.
Assumptions:
a) 1% p.a. fall in the ratio of male pensioners of total pensioners between 1948 and 1963; 0.7% fall in this ratio between 1964 and 1976.
b) Private sector male pensioners estimated at 33% of total male pensioners between 1948 and 1957, 36% of total between 1958 and 1969, and 39% of total between 1970 and 1976.
c) Private sector female pensioners estimated at 40% of total female pensioners.

the official estimates (which themselves are recognized as being rough and ready). We conclude therefore that our modelling framework, despite all the assumptions made, is a reasonable one for determining the value of occupational pension rights back to 1948. Interpolation was used to determine the scaling factors back to this date.

In 1993, the GAD changed the method by which it estimated the value of occupational pension rights. The new method is based on the value of pension scheme assets, in contrast with the earlier method which estimated the value of pension scheme liabilities. While the calculations involved are much easier, the new method is less satisfactory

Table 10. *Assumptions concerning pensioners by age range*

Age range	Proportion of pensioners in age range (%)		Ratio of pension in age range to average pension		Annuity factor	
	Males	Females	Males	Females	Males	Females
35–39	0.00	0.32	0.78	0.80	8	10
40–44	0.01	0.65	1.00	0.90	8	10
45–49	1.67	1.61	1.12	1.00	8	10
50–54	3.06	2.90	1.19	1.11	8	10
55–59	8.06	7.42	1.23	1.21	8	10
60–64	15.83	21.61	1.09	1.00	7	9
65–69	26.39	22.26	1.04	1.00	6	7
70–74	19.44	16.13	0.97	1.00	5	5
75–79	14.72	13.55	0.91	1.00	3	3
80–84	6.94	8.07	0.86	1.00	2	2
85–89	3.33	5.48	0.81	1.00	0.5	0.1

Source: *Occupational Pension Schemes 1991* (HMSO).

than the earlier one, since the value of pension rights is more naturally associated with the present value of pension liabilities than with the current value of pension assets. Nevertheless this is the new official method and in any event various pieces of legislation constrain the extent to which pension assets and liabilities can diverge: the 1986 Finance Act prevents assets from exceeding liabilities by more than 5% (of the value of liabilities) and the 1995 Pension Act severely limits the extent to which and also the period of time over which the value of assets can fall below that of liabilities.

We can illustrate the new method for 1994. The new method involves estimating the pension rights in both funded and unfunded schemes, where funded schemes are divided between schemes administered by insurance companies and schemes that are self-administered.

For schemes administered by insurance companies, the calculation is based on the 'amount of mathematical reserves for group business' as listed in the *Department of Trade and Industry Regulatory Returns* from insurance companies. The estimate for 1994 is calculated as follows:

Pension rights in insurance-company administered schemes for 1994
= Mathematical reserves for group business in 1994
= Reserves for group business for top 60 companies

$$\times \frac{\text{Total reserves for all companies}}{\text{Total reserves for top 60 companies}} \quad (33)$$

$$= £61.515\text{bn} \times \frac{£209.201\text{bn}}{£195.510\text{bn}}$$

$$= £65.823\text{bn}$$

The pension rights in self-administered schemes are calculated using information published by the Office for Na-

tional Statistics in *Business Monitor MQ5* (Table 4.2) and *Financial Statistics* (Table 9.1):

Pension rights in self-administered schemes for 1994 (end year)
= Net assets of pension funds
 − Investment in insurance managed funds
= £443.468bn − £19.486bn   (34)
= £423.982bn.

This figure is for the end of 1994, whereas the GAD data is for mid-year. The following adjustment is made (where the ONS estimate for pension rights at the end of 1993 is £459.6bn):

Pension rights in self-administered schemes for 1994 (mid-year)

$$= \{(£459.6\text{bn})(£423.982\text{bn})\}^{1/2}$$

$$= £441.4\text{bn} \quad (35)$$

The GAD estimated the pension rights in unfunded schemes (which is defined as 'past service reserves for active members of the schemes, pensioners, dependants receiving pensions and those who left service with entitlement to preserved benefits') to be £236bn in 1994. The total volume of occupational pension rights in 1994 is £743bn (equal to the sum of £65.823bn, £441.4bn and £236bn).[6]

VIII. THE VALUE OF PERSONAL PENSION WEALTH

Personal pension schemes have been available since July 1988 as a result of the 1986 Social Security Act. Such schemes are available to employees who do not wish to become members of their employer's occupational pension

[6] For an actuarial view on the problems with valuing occupational and state pensions, see Field (1983) and Stewart (1983).

scheme or of SERPS. Personal pensions are the only schemes available to the self-employed. Before July 1988, the self-employed (and those not in pensionable employment) could take out retirement annuity contracts written under sections 226 and 226A of the Income and Corporation Taxes Act 1970. Prior to this, there were approved deferred-annuity contracts written under the 1956 Finance Act. Between 1988 and April 1993, all employees who took out personal pensions were given a subsidy in the form of a Department of Social Security rebate. Since April 1993, the DSS rebate has been available only on an age-related basis.

The first official estimates of personal pension wealth were published in the July 1997 issue of *Insurance Trends* (Association of British Insurers) (Table 2, p. 10). They were prepared by the Government Actuary's Department, based on Department of Trade and Industry returns. However, these estimates are only for 1986 onwards. In order to construct estimates of personal pension wealth between 1956 and 1985, we need data on contribution inflows (net of management expenses and commissions) into personal pension schemes, benefit outflows from schemes and rates of return on contributions. The data comes from the Association of British Insurers, the Association of Unit Trusts and Investment Funds, the Association of Investment Trust Companies and the Association of Friendly Societies. Banks and building societies also provide personal pensions, but according to the British Bankers Association and the Building Societies Association, this business is conducted via insurance subsidiaries of banks and building societies or as agents of independent insurance companies and hence is already included in the ABI data. The ABI reckons that its figures (supplied by both members and the most important non-members of the ABI) account for 99% of insurance-related personal pension business.

We will first estimate the value of assets in personal pension schemes arranged by the ABI. The annual contributions into personal pension schemes comprise regular premiums (including any pre-arranged annual uprating on existing contracts), new single premiums, additions to existing regular premium policies which count as new single premiums, the DSS rebates and incentives on personal pension schemes, and free-standing additional voluntary contributions which supplement existing occupational schemes (first permitted by the 1987 Finance Act). Data on total yearly premiums into personal pension schemes is published in Table 30 (Personal Pension Business in Force at Year End, Ordinary Branch Business) of the ABI *Insurance Statistics Yearbook* 1984–1994. Data on new single premiums into schemes is published in Table 29 (New Pensional Pension Business, Ordinary Branch Business) of the *Yearbook*. Information on the DSS rebate towards these schemes is published in *Inland Revenue Statistics*. FSAVCs do not attract any DSS rebate and information on yearly premiums towards these is published in Table 32 (FSAVCs in Force at Year End, Ordinary Branch Business) of the *Year-*

book. Data on contributions to personal pension schemes going back to 1966 are available in a series of ABI publications: *Life Assurance in the UK* (between 1966 and 1980), *Insurance Statistics* (between 1981 and 1991) and *Insurance Review – Statistics* (after 1990). While information on premium income received in respect of total annuity business is published in the ABI's *Catalogue of Statistics: Historical Data* (Appendix I) back to 1956, there is no breakdown that enables us to identify personal pension business alone. We therefore calculated the average annual compound growth rate in yearly premiums and new single premiums between 1968 and 1978 (9.49% and 18.39% p.a. respectively) and assumed that these growth rates could be applied to earlier years back to 1956. (FSAVCs and the DSS rebate first came into effect in 1988, and so did not need to be estimated back to 1956.)

Table 11 (column 1) shows the total annual contributions into insurance-company run personal pension schemes, rescaled to account for the fact that the ABI collects information on only 99% of ABI business. Included in these figures are the contributions from friendly societies. Friendly societies have been providing personal pensions for as long as insurance companies. However data from the annual reports of the largest friendly society, the Liverpool Victoria (which accounts for more than half the premium income of all friendly societies), indicates that friendly societies did not become seriously involved in the provision of personal pensions until 1985 and even then their contribution is tiny when compared with insurance companies. Table 117 of the ABI *Yearbook* provides information on the total premiums collected and benefits paid out by friendly societies, while the annual reports of the Liverpool Victoria Friendly Society provide information on the proportions of the premiums and benefits that are due to personal pension schemes.

The figures in column 1 give gross contributions. From these management expenses and commissions have to be subtracted to give the net contributions available for investment. Total costs are calculated from the management expenses and commissions columns of Table 9 (Other Long-Term Income and Expenditure, Ordinary Branch Business) of the *Yearbook*. These are then expressed as a proportion of the total premium income collected by the ordinary branch business of life companies given in Table 1 (UK Long-Term Insurance Market Statistics) of the *Yearbook* (column 2 of Table 11) and used to calculate net contributions (column 3):

Net contributions = Gross contributions

$$\times \left(1 - \frac{Costs}{Total\ premium\ income} \right) \quad (36)$$

The annual cash outflows from personal pension schemes comprise pension annuities (or 'periodical payments' in insurance parlance), lump sums on maturity, death claims and surrender refunds. Data on individual pension annuities in payment is published in Table 28 (Pension

Table 11. *Nominal value of personal pension wealth*

Year	Gross pension courtributions (1) (£bn)	Management charges (%)	Net pension contributions (£bn)	Gross pension benefits (2) (£bn)	Net funds invested (3) (£bn)	Return on net funds invested (%) (4)	Unit trust pensions (5) (£bn)
1956	0.01	12.00	0.01	0.00	0.01	−0.28	0.00
1957	0.01	12.30	0.01	0.00	0.01	−0.95	0.00
1958	0.01	12.50	0.01	0.00	0.01	24.83	0.00
1959	0.01	12.70	0.01	0.00	0.01	17.29	0.00
1960	0.01	12.90	0.01	0.00	0.01	−0.07	0.00
1961	0.01	13.10	0.01	0.00	0.01	−1.04	0.00
1962	0.01	13.40	0.01	0.00	0.01	17.71	0.00
1963	0.01	13.60	0.01	0.00	0.01	11.32	0.00
1964	0.02	13.80	0.01	0.01	0.00	0.70	0.00
1965	0.02	14.10	0.01	0.01	0.00	9.32	0.00
1966	0.02	14.30	0.02	0.01	0.01	3.97	0.00
1967	0.02	14.60	0.02	0.01	0.01	17.43	0.00
1968	0.02	14.80	0.02	0.01	0.01	16.22	0.00
1969	0.02	15.90	0.02	0.02	0.00	−0.66	0.00
1970	0.03	16.30	0.02	0.03	−0.01	4.92	0.00
1971	0.03	16.60	0.03	0.03	0.00	31.22	0.00
1972	0.06	14.40	0.05	0.03	0.02	11.06	0.00
1973	0.08	16.80	0.06	0.04	0.02	−9.31	0.00
1974	0.09	18.60	0.07	0.05	0.02	−25.71	0.00
1975	0.10	22.10	0.08	0.05	0.03	59.85	0.00
1976	0.14	22.00	0.11	0.08	0.03	6.45	0.00
1977	0.20	21.00	0.16	0.08	0.08	42.65	0.00
1978	0.28	20.00	0.23	0.09	0.14	10.58	0.00
1979	0.35	19.50	0.28	0.11	0.17	11.26	0.00
1980	0.44	20.30	0.35	0.16	0.19	24.52	0.00
1981	0.64	19.90	0.51	0.21	0.30	10.02	0.00
1982	0.79	21.40	0.62	0.30	0.32	31.82	0.00
1983	0.98	21.50	0.77	0.40	0.37	19.88	0.00
1984	1.34	20.50	1.06	0.56	0.50	18.18	0.00
1985	1.81	20.60	1.44	0.77	0.67	16.62	0.00
1986	1.98	19.80	1.59	1.10	0.49	19.97	0.00
1987	2.45	19.80	1.97	1.41	0.56	14.12	0.00
1988	3.64	23.40	2.79	1.51	1.28	15.42	0.00
1989	7.56	19.50	6.09	1.58	4.51	24.07	0.01
1990	9.14	20.50	7.27	2.17	5.10	−2.24	0.01
1991	11.11	18.70	9.03	2.16	6.87	14.50	0.02
1992	13.41	17.80	11.02	4.34	6.68	16.66	0.03
1993	13.69	16.70	11.41	4.50	6.91	24.01	0.10
1994	12.05	18.10	9.87	4.26	5.61	−4.22	0.11

Notes:
1. Personal pension business of life assurance companies and friendly societies; includes: yearly premiums, single premiums, DSS rebates, free-standing additional voluntary contributions.
2. Includes: pension annuities, lump sums, and surrenders.
3. Equals net pension contributions minus gross pension benefits.
4. Rate of return (income plus capital gains) on life assurance long term funds over the period.
5. Official figures have been collected only since 1991; estimates for earlier years based on annual growth rate of 63% (equal to 1991–92 average).

Annuities in Force in Course of Payment, Ordinary Branch Business) of the *Yearbook*. Data on individual pension annuities back to 1968 is available in the other ABI publications listed above. Between 1956 and 1967, we assumed that personal pensions in payment grew at an annual rate of 20.6% p.a., the same as the annual average growth rate between 1968 and 1978.

Table 8 of the *Yearbook* (Breakdown of Benefits Paid on UK Long-Term Insurance, Ordinary Branch Business) decomposes total pension benefits paid into the four components listed above. It does this for all pension benefits paid out, both for individual and group schemes. Periodical payments averaged 18.5% of total pension benefits paid out between 1984 and 1994. Between 1970 and 1983, it is

only possible to derive information on total annuities as a proportion of total outgo (annuities + maturity lump sums + death claims + surrender refunds) denoted by α_t in Equation 37. We assume that the proportions derived here can be applied to personal pension business, so that

$$\begin{array}{c} Total\ personal \\ pension\ benefits \\ paid_t \end{array} = \frac{Personal\ pension\ annuities\ in\ payment_t}{\alpha_t} \tag{37}$$

Table 11 (column 4) shows the annual pension benefits paid by both insurance company and friendly society personal pension schemes, rescaled to account for the fact that the ABI collects information on only 99% of insurance company business.

The difference between total premium income collected every year and the pension benefits paid out gives net funds invested (column 5). We assume that these funds are invested in investment assets in the proportions implied by the 'total long term business funds' panel of Table 109 (Life Offices Investment Holdings) of the *Yearbook*. Combining data in Table 109 on total asset holdings with data in Table 9 (Other Long-Term Income and Expenditure) on investment income gross of tax, revaluation of assets (i.e. capital gains or losses) and other items (i.e. realized investment gains and losses; currency adjustments for overseas business; and transfers to and from special and general reserves for policy holders), we can calculate the rate of return on asset holdings (R_t) as follows (see column 6 of Table 11):

$$R_t = \frac{Investment\ income_t + Revaluation\ of\ assets_t + Other\ items_t}{Total\ long\ term\ business\ funds_t} \tag{38}$$

If we denote the total net inflow into personal pension schemes from all sources in year t as Y_t, then the value of personal pension assets in year t can be estimated as follows

$$WP_t = \sum_{s=1}^{t} Y_s \prod_{j=s}^{t} (1 + R_j) \tag{39}$$

Banks, building societies, unit trusts and investment trusts have only been permitted to provide personal pensions since July 1988. The data on banks and building societies are included above with those on insurance companies. Data on the value of authorized personal pension unit trusts has been collected only since 1991. Estimates back to 1988 are based on the growth rate of 63% between 1991 and 1992 (see column 7 of Table 11). Investment trusts began offering personal pensions only in 1994, beginning with the largest Foreign and Colonial; two more investment trusts, Flemings and Dunedin, became providers in 1995.

The estimates of personal pension wealth calculated using Equation 39 for 1986 and 1987 were compared with those calculated by the GAD for the same years. Our estimates were smaller than those of the GAD by a factor of 2.69. We therefore rescaled our figures accordingly. The estimates of personal pension wealth are presented in Table 12.
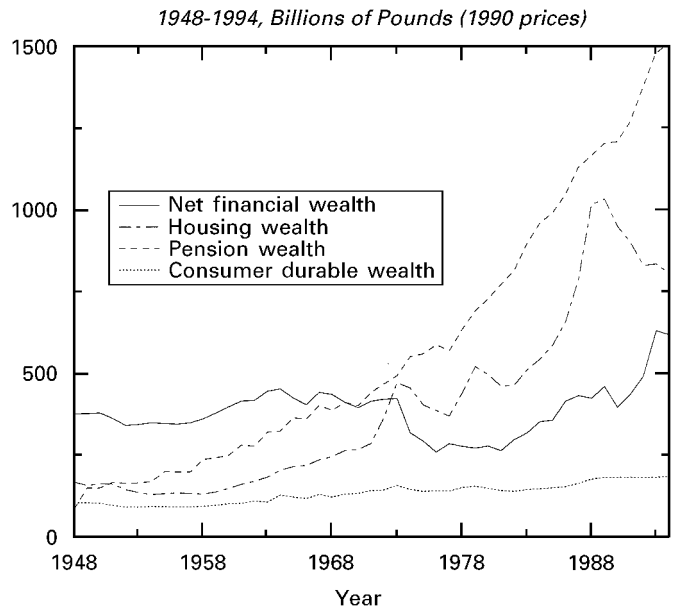

Fig. 1. *Personal wealth in the UK*

IX. ANALYSIS

The data on the seven components of personal wealth holdings are presented collectively in Table 12. In this section we briefly analyse the data.

Figure 1 shows the real value of four categories of personal wealth holdings in the UK over the period 1948 to 1994. The real value of net financial wealth was relatively constant up until the early 1970s. But the high inflation of that decade caused the personal sector to reduce substantially its real holdings of financial assets. It took 20 years for the real value of net financial wealth to recover to its earlier level and the very low inflation of the 1990s has induced the personal sector to increase its net financial assets above this earlier level (although as we shall see later, its share in total wealth has still been falling over the period). Real housing wealth was also relatively constant during the 1950s and 1960s, but has been on a sharply rising trend since then. The housing booms of the early 1970s, late 1970s and late 1980s are also clearly discernible in the figure. Consumer durables have followed a generally rising trend during the period although the following deviations from trend are discernible: the stagnation of the 1950s, the effect of the stop-go policies of the 1960s, and the Barber, Healey and Lawson booms of the early 1970s, late 1970s and late 1980s, respectively. Perhaps the most remarkable feature of the figure is the huge increase in pension wealth over the post-war period, as a result of the increasing membership of and rising contributions into Britain's pension schemes. Pension wealth used to be the great 'unknown' source of wealth in the UK and it has only recently been 'discovered'. For example, in the case of divorce, it used to be the case that

Table 12. *Nominal values of seven categories of personal wealth 1948–94*

Year	Net financial wealth (£bn)	Housing wealth (£bn)	Consumer durable assets (£bn)	Basic state pension wealth (£bn)	SERPS pension wealth (£bn)	Occupational pension wealth (£bn)	Personal pension wealth (£bn)
1948	24.1	10.7	6.7	4.2	0.0	1.3	0.00
1949	24.9	10.4	6.9	8.5	0.0	1.4	0.00
1950	25.8	11.0	7.0	8.6	0.0	1.6	0.00
1951	26.8	11.9	7.2	10.4	0.0	1.9	0.00
1952	27.6	11.7	7.4	11.1	0.0	2.2	0.00
1953	28.5	11.2	7.6	11.3	0.0	2.4	0.00
1954	29.6	11.0	7.9	11.4	0.0	2.9	0.00
1955	30.8	11.7	8.2	14.2	0.0	3.5	0.00
1956	32.0	12.4	8.5	14.4	0.0	4.0	0.01
1957	33.4	12.6	8.8	14.6	0.0	4.4	0.03
1958	35.6	12.9	9.2	18.4	0.0	4.9	0.05
1959	37.7	13.6	9.6	18.7	0.0	5.3	0.07
1960	40.0	14.8	10.1	19.0	0.0	6.0	0.09
1961	43.0	16.6	10.5	22.1	0.0	6.9	0.10
1962	45.3	18.3	11.8	22.4	0.0	7.6	0.14
1963	49.2	20.1	11.6	26.6	0.0	8.7	0.17
1964	51.4	23.1	14.4	27.0	0.0	9.6	0.19
1965	50.7	25.6	14.4	32.4	0.0	11.0	0.23
1966	50.3	27.1	14.5	32.7	0.0	12.0	0.26
1967	55.9	29.7	16.3	37.3	0.0	13.3	0.33
1968	58.1	32.6	16.1	37.6	0.0	13.9	0.40
1969	57.7	36.9	18.2	42.3	0.0	15.3	0.41
1970	59.0	39.7	19.6	42.7	0.0	17.0	0.43
1971	67.7	46.5	22.9	51.9	0.0	20.0	0.57
1972	73.8	63.9	24.9	58.8	0.0	22.9	0.68
1973	80.9	90.0	29.7	68.0	0.0	25.9	0.67
1974	70.2	100.6	31.8	88.6	0.0	33.0	0.54
1975	80.3	110.8	37.9	111.5	0.0	42.0	0.96
1976	82.8	123.7	44.7	138.1	0.0	50.0	1.11
1977	105.3	137.1	51.4	145.6	0.0	65.0	1.86
1978	111.0	177.1	60.2	164.5	0.0	90.0	2.45
1979	123.2	237.4	70.2	189.1	5.6	120.0	3.22
1980	148.6	266.6	78.8	228.2	12.3	150.0	4.60
1981	157.5	277.1	84.2	263.9	19.5	180.0	5.92
1982	193.5	302.8	90.1	288.0	26.8	215.0	8.78
1983	216.8	348.8	97.6	320.0	35.0	255.0	11.60
1984	252.5	390.6	104.6	346.8	43.8	295.0	15.19
1985	271.3	446.0	112.8	365.2	53.5	330.0	19.66
1986	326.1	518.4	119.4	391.1	65.7	360.0	25.00
1987	347.6	637.4	130.1	421.8	78.8	401.0	30.00
1988	357.5	861.5	147.7	440.9	91.7	441.0	35.00
1989	418.3	943.4	164.7	468.9	104.3	503.0	50.00
1990	394.7	948.3	179.7	505.2	119.4	556.0	60.00
1991	459.6	952.4	191.1	563.1	135.0	605.0	75.00
1992	536.5	910.7	197.1	659.0	172.9	623.0	95.00
1993	702.2	930.4	201.7	685.5	177.8	711.0	130.00
1994	705.0	920.5	208.7	703.0	201.5	743.0	140.00

financial, housing and durable assets were taken into account in the divorce settlement, but pension wealth was ignored. Only in the 1990s have pension assets begun to be taken into account as well.

Figure 2 presents the breakdown of pension wealth into its four components. For most of the postwar period, the value of pension wealth has been dominated by the value of basic state pension wealth. Until the 1970s, state pension wealth was more than twice the size of private sector pension wealth. However, the rapid growth of occupational pension scheme membership from the 1970s has resulted in basic state and occupational pension wealth having the same order of magnitude by the mid-1990s. The figure also shows SERPS wealth. SERPS
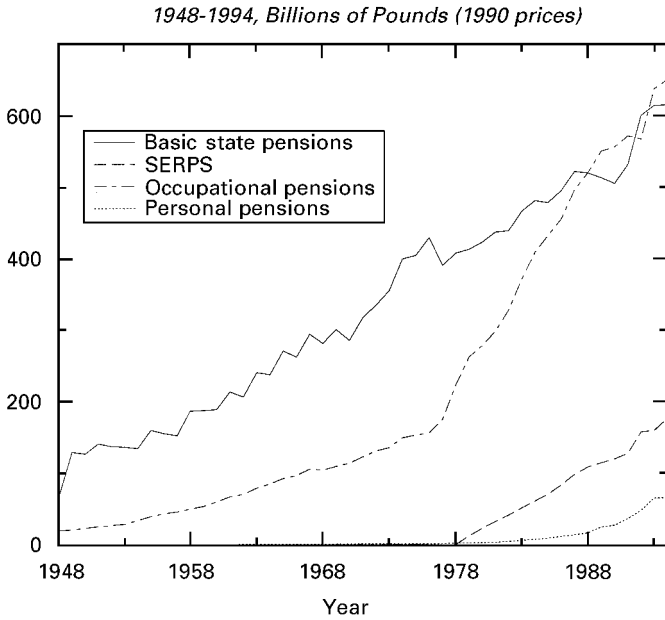
1948-1994, Billions of Pounds (1990 prices)

Fig. 2. *Pension wealth in the UK*

Fig. 3. *Distribution of wealth in 1950*
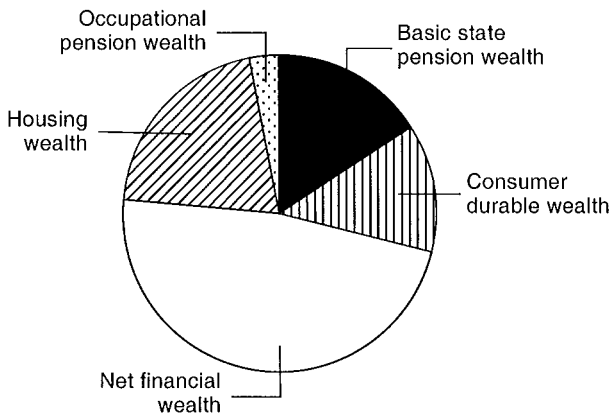

Fig. 4. *Distribution of wealth in 1970*
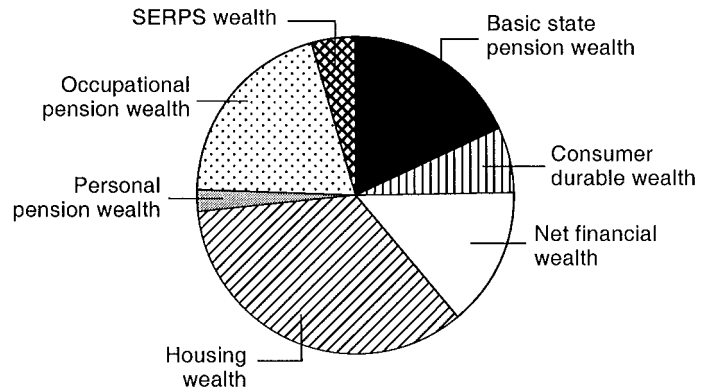
Fig. 5. *Distribution of wealth in 1990*

began in 1978, but within ten years the government was encouraging members to transfer into personal pensions: the effect of this is clearly discernible by the end of the period. The rapid growth of personal pensions from the late-80s can also be clearly seen.

Figures 3–5 show how the distribution of wealth has changed over the sample period. In 1950, personal sector assets were dominated by net financial assets (48% of total personal sector wealth); pension assets constituted 19%, housing assets 21% and consumer durable assets 13% of total wealth. By 1970, net financial and consumer durable assets had fallen to 33% and 11% of total wealth respectively, while pension and housing assets had risen to 34% and 22% respectively. By 1990, net financial and consumer durable assets had fallen further to 14% and 7% respectively, whereas pension and housing assets had risen to 44% and 35% respectively. The postwar increase in the relative share of pension assets in total wealth has been truly remarkable.

X. CONCLUSION

The principal purpose of this paper has been to generate time series on seven components of personal wealth holdings in the UK since 1948. We have used official data where this is available and we have used the same methods (e.g. actuarial methods, estate multiplier methods) as employed by official agencies to construct the data for years in which official data are not available. In short, we believe that we have constructed the same data set that would have been constructed had official agencies been commissioned to perform this task.

Nevertheless, the data set is not without inconsistencies, and many of these arise from official procedures. For example, the GAD assumes a real discount rate of 2.5% or 3% for the basic state scheme, 3% for SERPS and 5% for

occupational pension schemes. Similarly, it at times takes into account survival probabilities to retirement age, while at other times it does not. Sometimes, it calculates annuity factors using continuous discounting, while at other times it calculates them using discrete discounting. We have also had to make heroic assumptions. For example, the use of interpolation and extrapolation has meant that an artificial regularity has been introduced into some of the time series. Similarly, estimates of important parameters (e.g. job turnover by age) made for a particular year (e.g. 1972) were applied to the whole sample period. Unfortunately, assumptions such as these were unavoidable: there were no alternative sources of information that could be used to improve the estimates. All this merely reflects the notorious difficulties involved with the construction of wealth data.[7]

We hope that other investigators will find the data set useful in their own studies. Two obvious studies suggest themselves: examining the impact of the different wealth components on personal sector consumption and retirement behaviour and modelling the composition of personal sector wealth (Blake, 1998, 1999).

ACKNOWLEDGEMENTS

REFERENCES

Association of British Insurers, *Catalogue of Statistics*: *Historical Data*, ABI, London.
Association of British Insurers, *Insurance Review-Statistics*, ABI, London.
Association of British Insurers, *Insurance Statistics Yearbook*, ABI, London.
Association of British Insurers, *Insurance Statistics*, ABI, London.
Association of British Insurers, *Insurance Trends*, ABI, London.
Association of British Insurers, *Life Assurance in the UK*, ABI, London.
Barro, R. J. (1978) *The Impact of Social Security on Private Saving*: *Evidence from the US Time Series*. American Enterprise Institute, Washington, DC.
Beveridge, W. (1942) *Social Insurance and Allied Services*, Cmd. 6404, HMSO, London.
Blake, D. (1995) *Pension Schemes and Pension Funds in the United Kingdom*, Oxford University Press, Oxford
Blake, D. (1998) The impact of wealth on consumption and retirement behaviour in the UK, Pensions Institute Discussion Paper, Birkbeck College, London.
Blake, D. (1999) Modelling the composition of personal sector wealth in the UK, Pensions Institute Discussion Paper, Birkbeck College, London.
Board of Commissioners of the Inland Revenue (1962) *Annual Report*, HMSO, London.
Boyle, P. and Murray, J. (1979) Social security wealth and private savings in Canada, *Canadian Journal of Economics*, **12**, 456–68.
Building Societies Association, *Compendium of Building Society Statistics*, BSA, London.
Council of Mortgage Lenders, *Compendium of Housing Finance Statistics*, Council of Mortgage Lenders, London.
Department of Employment (1971) *British Labour Statistics*: *Historical Abstract 1886–1968*, HMSO, London.
Department of Employment, *British Labour Statistics Yearbook*, HMSO, London.
Department of Employment, *New Earnings Survey*, HMSO, London.
Department of Social Security, *Abstract of Statistics for Social Security Benefits and Contributions and Indices of Prices and Earnings*. Department of Social Security (Analytical Services Division), HMSO, Norwich.
Department of Social Security, *Social Security Statistics*, HMSO, London.
Diamond, Lord (Chairman) (1975) *Initial Report on the Standing Reference*, Report No. 1 of the Royal Commission on the Distribution of Income and Wealth, Cmnd. 6171, HMSO July, London.
Diamond, Lord (Chairman) (1976) *Second Report on the Standing Reference*, Report No. 4 of the Royal Commission on the Distribution of Income and Wealth, Cmnd. 6626, October, HMSO, London.
Disney, R. and Johnson, P. (1995) The strange death of a pension scheme, *Financial Times*, 3 February.
Dunn, A. and Hoffman, P. (1978a) The distribution of personal wealth, *Economic Trends*, November, 101–16.
Dunn, A. and Hoffman, P. (1978b) Current developments in Inland Revenue estimates of personal wealth, *Studies in Official Statistics No. 35*, pp. 41–51.
Feldstein, M. S. (1974) Social security, induced retirement and aggregate capital accumulation, *Journal of Political Economy*, **82**, 905–26.
Field, J. L. (1983) Projections of the costs of occupational and state pensions, *Journal of the Institute of Actuaries*, **110**, 243–69.
Gerber, H. (1995) *Life Insurance Mathematics*, Springer-Verlag, Berlin.

---

[7] As a result of this, we did not feel that a sensitivity analysis would have been an exercise worth pursuing.

Good, F. J. (1990) Estimates of the distribution of personal wealth I: marketable wealth of individuals 1976 to 1988, *Economic Trends*, October, 137–49.

Government Actuary's Department (1994) *Occupational Pension Schemes 1991: Ninth Survey by the Government Actuary*, HMSO, London.

Haberman, S. (1985). Home responsibility protection and married women's pension rights, *Insurance: Mathematics and Economics*, **4**, 1–18.

Holmans, A. E. (1987) *Housing Policy in Britain*, Croom Helm, London.

Holmans, A. E. (1990) House Prices: Changes Through Time at National and Sub-National Level, Government Economic Service Working Paper 110, Department of Environment, January.

Inland Revenue, *Inland Revenue Statistics*, HMSO, London.

Inland Revenue, *Survey of Personal Incomes*, HMSO, London.

Institute of Actuaries and Faculty of Actuaries *a(55) and a(90) Tables for Annuitants*, Institute of Actuaries and Faculty of Actuaries, London and Edinburgh.

Institute of Actuaries and Faculty of Actuaries *PMA (80) and PFA(80) Tables for Male and Female Pension Annuitants*, Institute of Actuaries and Faculty of Actuaries, London and Edinburgh.

London and Cambridge Economic Service. (1974) *The British Economy: Key Statistics 1900–1970*, Department of Applied Economics, Cambridge.

Ministry of Labour (1938) *Gazette*, **May**, HMSO, London.

Office for National Statistics, *Annual Abstract of Statistics*, Office for National Statistics, HMSO, London.

Office for National Statistics, *Business Monitor MQ5 (Insurance Companies' and Pension Funds' Investments)*, HMSO, London.

Office for National Statistics, *Economic Trends Annual Supplement*, HMSO, London.

Office for National Statistics, *Family Spending (formerly Family Expenditure Survey)*, HMSO, London.

Office for National Statistics, *Financial Statistics*, HMSO, London.

Office for National Statistics, *Key Data: UK Social and Economic Statistics*, HMSO, London.

Office for National Statistics, *United Kingdom National Income Accounts* (Blue Book), HMSO, London.

Office of Population Censuses and Surveys, *English Life Tables*, HMSO, London.

Office of Population, Censuses, and Surveys, *General Household Survey*, HMSO, London.

Radcliffe, Lord (Chairman) (1959) *Report of the Committee on the Working of the Monetary System*, Cmnd. 827, HMSO, London.

Shaw, S. (1994) Accuracy and uncertainty of the national population projections for the United Kingdom, *Population Trends 77*, HMSO, London, pp. 24–32.

Stewart, C. M. (1983) Pension problems and their solution, *Journal of the Institute of Actuaries*, **110**, 289–313

Stewart, I. (1991) Estimates of the distribution of personal wealth II: marketable wealth and pension rights of individuals 1976 to 1989, *Economic Trends*, November, 99–100.