# Can “Compulsory” Annuities Provide a Fair Pension?

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**Abstract**

This discussion paper finds that since 2002 compulsory annuities no longer provide an actuarially fair pension. Hence annuities are a poor investment giving returns of less than 85% in present value terms.

The paper uses a data base of annuity rates collected from MoneyFacts monthly reports since 1994. This includes all products available on the market for Male Only aged 55 to 75 in 5 year increments. The present value of future annuity streams and their resultant moneys worth values (MW) are calculated and analysed, with particular attention to the actuarial aspects. The approach and results are independently confirmed giving a high degree of confidence in the findings. The analysis progresses on from the literature review of recent published work

The paper plots historic trends of annuity payout rates and their MW values and highlights some significant characteristics of the annuity market. While annuity rates can be expected to fall as life expectation rises no logical reason can be found to also justify the recent and significant reduction in their MW value below the actuarially fair value of 1.0.

This research provides a valuable insight for developing strategies to guide the pensioner when formulating his income drawdown plans, especially in the light of. recent A-day changes.

**Key words** annuity rates, moneys worth, actuarially fair annuity rate (AFAR), expected present discount values (EPDV*)*

**JEL Classification** G20, G23

# 1 Introduction

With the demise of the defined benefit schemes, the rising costs and inadequate funding of the PAYG state system, in the future most people will be in a defined contribution arrangement. This is designed to generate a fund which will provide an income for their retirement. Although most pension funds are managed by the major insurance companies, the individual has the opportunity to take direct control of investment strategies by investing / transferring existing pension savings into an unsecured pension (USP) such as a SIPP (Self Invested Pension Plan). However, in order to ensure that earlier tax privileges are used to generate retirement income, UK legislation restricts the drawdown of the pension fund. Income drawdown under regulated conditions, including taking a tax free lump sum, is permitted from age 50 (55 in 2010) to 75. Before April 2006 the individual's pension fund had to be converted to a life annuity[1] by the age of 75.

From A –Day (6th April 2006) there is an alternative to converting pension funds into an annuity at 75. One can opt for an alternatively secured pension (ASP) which is similar to a USP, but the level of drawdown is severely reduced (by 55%) and no further age related adjustments are made. This is regarded as an incentive to purchase an annuity

Accordingly, the UK now has one of the largest annuity markets in the world. The Association of British Insurers advise that in 2004 the premiums invested in compulsory annuities were £7,478 million and in voluntary annuities were £56.4 million.

[1] An annuity provides a stream of income until one's death in return for an initial premium.

The industry continues to refer to the product as Compulsory Purchase Annuities (CPA) but more accurately they are Annuities Purchased from a Pension Fund or Pension Funded Annuities. To avoid confusion the term “Compulsory“Purchased Annuity is used throughout the discussion paper

The purchase of an annuity remains a one-off decision and the capital remains with the provider even if the annuitant only survives for a short period. Hence the management of this process decides the difference between relative comfort and poverty in old age for a large number of people.

Orsag (2000) identifies **perceptions** as one of the 4 problems with annuity markets in the UK, namely “the belief that annuities are poor value for money or that insurers act as a cartel which exploited mandatory annuitisation requirements to make excess profits” (p1)

The **primary object of this discussion paper** is to re-examine the evolving market situation in order to determine whether that perception of poor value for money has been vindicated or discredited over the past five years.

The **methodology** used is to calculate the Present Value (PV), designated in the literature as the Expected Present Discount Value (EPDV), of the payment stream generated by an initial premium. This is similar to the PV calculation used to evaluate commercial products but additionally takes into account the probability that the annuitant will survive to collect his payment at a given future date.

Hence there are three inputs:

- Annuity payout rate (£) or the annuity rate per premium £
- Interest rates that are used to discount future payments

- Mortality rates to calculate life expectancy for each payment on a probability basis.

It is common practice to adopt two evaluation reporting techniques for the EPDV

- Moneys Worth (MW) = EPDV / PREMIUM
- Internal Rate of Return (IRR) which is the discount rate which makes the EPDV equal to the premium. This has the advantage tha no assumptions are needed regarding the discount rates to be used

Both Murthi (1999 p21) and Finkelstein (2002 p35) argue that a MW of 1.0 represents the actuarially fair value of an annuity (AFAR). However, we shall see that in recent years it has been in significant decline along with the annuity payout rates and is no longer available.

Focus is on the "compulsory" annuity for males at age 65, the typical retirement age, and at age 75, when the pension fund had to be annuitised or now one can opt for an ASP with its drawdown restrictions.

The discussion paper is **organised** as follows

The **next Section** is a brief literature review

**Section 3** discusses annuity payout rates[1]. Comprehensive monthly data was obtained from Moneyfacts from 1994 up to the present date and this is the basis of of our work. The nature of the annuity market and its products is noted and some annuity rate trends since 1994 are plotted and reviewed

[1] June 2005 annuity rates have been used throughout. However in Section 5 current data (June 6th 2006) was adapted so that the derived investment policies and strategies are current

.

**Section 4** describes the EPDV methodology used to calculate the Moneys Worth on an annuity. Current MW values are presented and trends are plotted since 1994.

**Section 5** derives the policies and strategies from the EPDV analysis to assist the pensioner select the appropriate pension drawdown plan based on getting value for money. In order for the guidance to be relevant current MoneyFacts data is used ( 5th June 2006)

**Section 6** draws together the main conclusions and focuses on changes in the market over recent years and whether they now offer better or poorer value for money.

## 2 Literature review

The bibliography shows that there are a limited number of authors active in this area and that this subject is “young”.

On the wider aspect of pensions, the work by Davis (2004 Geneva paper) is the most authoritative and comprehensive available. Its Section 9, “A crises in annuities?”, provided a valuable reference. Davis also notes (p18) that “In the UK there is mandatory annuitisation - justified in turn by tax privileges and a possible moral hazard as the sums are dissipated leaving the state to prevent individuals falling into poverty”.

Early work by Murthi (1999) et al in the UK and Mitchell (1999) in the USA introduce and develop the concept of calculating the present value of future annuity cash flow streams and using a Monies Worth ratio as a criteria of value. They provided a detailed explanation of the techniques used to calculate MW including a discussion on the application of mortality tables to determine the probability of individual survival both for the general population and for cohorts of pensioners.

Murthi also provides some useful results which are used to check the validity of the results from the EPDV Calculator (Appendix A1)

The Murthi team which included Orszag and Orszag produced a further four papers in subsequent years. Their paper “Annuity Margins in the UK” (2000) is of special interest as it is the definitive work on using Internal Rate of Return (IRR), and its derivative of Annuity Margin, as a criteria for evaluating annuities in much the same way that investment projects are assessed.

Finkelstein (2002) follow this up by extending earlier works to include different categories of annuities that had then become available, especially those designed to protect future payments and to mitigate against the loss of funds on early death. They also use a term structures of interest rates, rather than a constant value, for discounting purposes.

Cannon (2004 Financial History Review) provide the best reference on the problems associated with collecting and making sense of historic annuity rates. They generated an annuity time series for a 65 year old male with the data going back to 1957. This is a composite of a median annuity rate without guarantee from 1957 up to 1973 and a mean annuity level rate with five years guarantee up to 2002. . They also identified the existence of **stale / unused data** and included only the firms whose annuity rates had changed since the previous month in their data. This “market phenomena” was also observed in our data when analysing the maximum annuity rates available in virtually all annuity products (see Section 3).

Lunnon ( 2001 ICA) and Cardinale (2002) described the different approaches adopted by the pensions industry worldwide.

The “**value for money**” issue was referenced by a number of authors. Cannon (2004 Geneva) consider pensions in two phases, accumulation and decumulation /drawdown in their paper on pension repayment ratios. They find that on average from 1957 to 2002 the Monies Worth was just less than 1.0 and so fair. Indeed their Table 3 (p 29) showed that the mean MW 95% confidence interval was 0.9811 to 0.9978.

The two authors, Murthi (1999) and Finklestein (2002), who carried out cross section analysis, see AppendixA1, were agreed that any MW < 1.0 reflects the administration

and other costs incurred by the provider. Murthi (pp7) provides a comprehensive explanation why pension costs at annuitisation stage are low. MW values of 0.97 or higher was considered reasonable, especially as Murthi (2001) observed that “Insurance Companies invest in riskier but more rewarding assets such as European Investment Bonds” (pp13).

Lunnon (2001) contributed a useful and timely examination of the alternatives to compulsory annuities, including drawdown

This paper builds on the above by updating the findings and expanding the scope of these earlier references using the established methodology for calculating EPDV and MW

In particular

- A comprehensive database of payout rates for all 5 annuity products is created for ages 55, 60, 65, 70, and 75. This concentrates on the Male Only category and is monthly since August 1994.
- An Excel based EPDV Calculator is developed, tested and used to calculate MW and other related parameters, including the number of years the pensioner has to receive his annuity payments in order to “get his money back” in real terms, for various retirement scenarios.
- It is used to derive and plot MW trends for review. Current annuity payout rates are analysed and strategies developed to guide the pensioner in selecting the optimum pension drawdown plan with a view to obtaining the best value for money

## 3 "Compulsory" Annuity Payout[1] Rates

The author approached some 20 organisations and institutions and found that at present there is only one source that provides **consistent time series data**, namely MoneyFacts – publishers of Investment Life and Pensions. This is a monthly trade journal but only available to subscription holders. The British Library is the only one to keep back copies. Hence MoneyFacts are the only source of historic annuity data. Unfortunately, the available data only goes back to August 1994

Table 3.1 gives a breakdown of all the companies offering compulsory annuities in June 2005. A relatively large number (6) offered **impaired life annuities** - a significant increase since 1995 when only 2 special case rates were offered. Hence the market has become increasingly specialised and more sensitive to the needs of annuitants with short life expectation. This compartmentalisation "drives down" the rates for the rest of the group. These payout rates, which are highlighted light blue, are deleted from the database to avoid serious distortion of the market analysis..

The benefits are considerable for the impaired life annuitant. A maximum annuity payout of £886 was offered by PAFS to a 65 year old as compared with the market maximum of £691 for the typical pensioner (Friends Provident).

[1] Annuity Payout rates are annual payments per £10,000 premium. They are also quoted as % rates eg £691 = 6.91%

| | Moneyfacts Data | | | | | | Impaired Life Annuities Deleted | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| Provider | Provider | Age | | | | | Age | | | | |
| Number | Name | 55 | 60 | 65 | 70 | 75 | 55 | 60 | 65 | 70 | 75 |
| 1 | AXA 5 | 495 | 546 | 616 | 715 | 861 | 495 | 546 | 616 | 715 | 861 |
| 2 | B&CE Insurance a | 603 | 687 | 809 | 988 | 1247 | | | | | |
| 3 | Canada Life 2 | 542 | 600 | 681 | 795 | 965 | 542 | 600 | 681 | 795 | 965 |
| 4 | Clerical Medical | 518 | 580 | 669 | 798 | 998 | 518 | 580 | 669 | 798 | 998 |
| 5 | Friends Provident 2 | 517 | 592 | 691 | 823 | 997 | 517 | 592 | 691 | 823 | 997 |
| 6 | GE Life (Smoker) 2 | 557 | 641 | 763 | 945 | 1238 | | | | | |
| 7 | GE Life (Special) 2 | 568 | 652 | 773 | 955 | 1248 | | | | | |
| 8 | Just Retirement (Smoker Plus) | 579 | 660 | 777 | 946 | 1195 | | | | | |
| 9 | Just Retirement (Enhanced) | 602 | 701 | 841 | 1036 | 1343 | | | | | |
| 10 | Legal & General | 542 | 601 | 672 | 771 | 906 | 542 | 601 | 672 | 771 | 906 |
| 11 | Norwich Union | 541 | 603 | 680 | 815 | 1003 | | | | | |
| 12 | PAFS 7 | 767 | 739 | 886 | 1034 | 1422 | | | | | |
| 13 | Prudential 2 | 542 | 615 | 682 | 794 | 997 | 542 | 615 | 682 | 794 | 997 |
| 14 | Scottish Equitable 6 | | | | | | | | | | |
| 15 | Scottish Widows | 540 | 606 | 685 | 798 | 996 | 540 | 606 | 685 | 798 | 996 |
| 16 | Standard Life | 540 | 606 | 679 | 783 | 945 | 540 | 606 | 679 | 783 | 945 |
| | | | | | | | | | | | |
| | **Statistical Analysis** | | | | | | | | | | |
| | **Average** | 569 | 626 | 722 | 860 | 1080 | 530 | 593 | 672 | 785 | 958 |
| | **Median** | 542 | 606 | 684 | 807 | 998 | 540 | 601 | 680 | 795 | 981 |
| | **Max** | 767 | 739 | 886 | 1036 | 1422 | 542 | 615 | 691 | 823 | 998 |
| | **5th Large** | 569 | 652 | 773 | 946 | 1238 | 540 | 600 | 679 | 794 | 965 |
| | **Minimum** | 495 | 546 | 616 | 715 | 861 | 495 | 546 | 616 | 715 | 861 |
| | | | | | | | | | | | |
| | **Std dev** | 60 | 51 | 76 | 105 | 173 | 18 | 22 | 24 | 32 | 51 |
| | **Dispersion** | 0.50 | 0.32 | 0.40 | 0.40 | 0.56 | 0.09 | 0.11 | 0.11 | 0.14 | 0.14 |

**Table 3.1 Male Level Annuity Payout Rates For 16 June 2005 - £'s**

This leaves 9 providers of **non-specialised annuities** in the 2nd section of the Table. Each offers a full spectrum of products from Level to RPI linked for males aged 55, 60, 65, 70 and 75. As columns list all the providers and annuity payout rates for a given product, it is easy to calculate their statistical properties. For example, the average rate offered to a male aged 65 for a Level annuity was £672.28 and the maximum was £691 (Friends Providential) an increase of £18.72 or 2.78%. The minimum was £616 (AXA) giving a difference (max – min), of £56.28 or 9.13%. So as FSA suggests, it is well worth shopping around , especially for an AXA customer as the additional 9.13% would be for the rest of his life.

Money£acts provide data on 5 annuity products.

- Level,
- Annuities escalating at 5% per annum
- RPI indexed annuities.
- Level with 5 year guarantees,
- Level with 10 year guarantees

Table 3.2 shows annuity payout rates for level, RPI indexed linked and 5% p.a. escalation as applicable to both 65 and 75 year old Males as of June 2005. Their maximum rates are highlighted in yellow in the statistical analysis

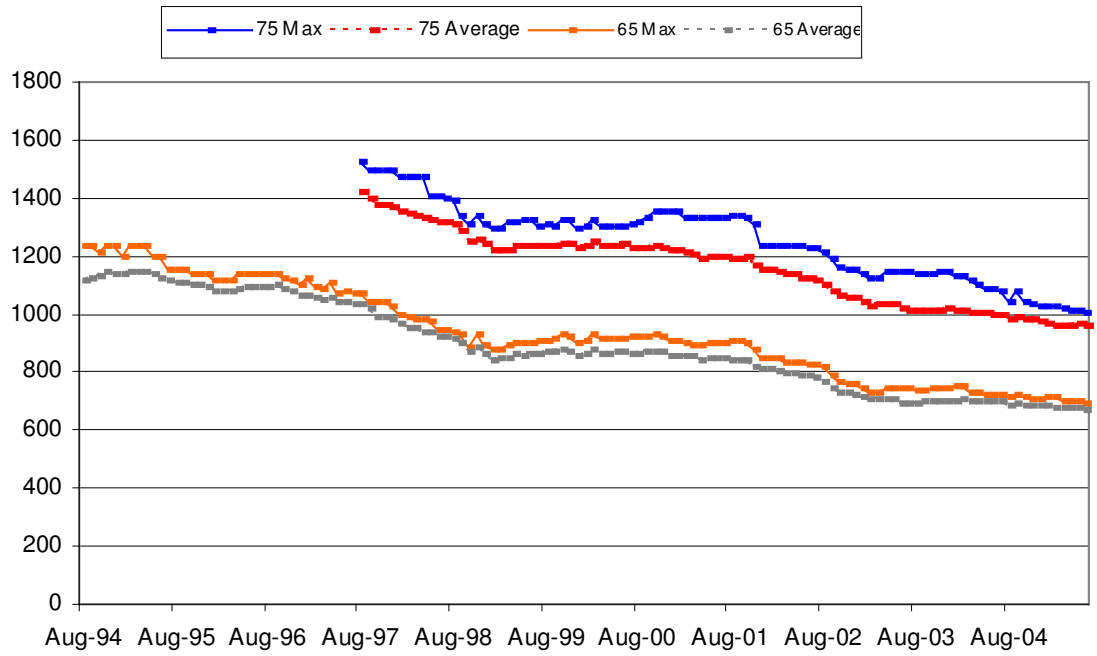
| | Level | | | | | ESCALATING 5% P.A. | | | | | RPI - LINKED | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Provider | Age | | | | | Age | | | | | Age | | | | |
| Number | 55 | 60 | 65 | 70 | 75 | 55 | 60 | 65 | 70 | 75 | 55 | 60 | 65 | 70 | 75 |
| 1 | 495 | 546 | 616 | 715 | 861 | 218 | 268 | 336 | 431 | 571 | 311 | 363 | 434 | 533 | 677 |
| 2 | | | | | | | | | | | | | | | |
| 3 | 542 | 600 | 681 | 795 | 965 | 262 | 319 | 398 | 509 | 675 | 335 | 394 | 475 | 589 | 758 |
| 4 | 518 | 580 | 669 | 798 | 998 | 232 | 291 | 374 | 496 | 683 | 319 | 382 | 469 | 595 | 789 |
| 5 | 517 | 592 | 691 | 823 | 997 | 246 | 310 | 396 | 513 | 671 | | | | | |
| | | | | | | | | | | | | | | | |
| 10 | 542 | 601 | 672 | 771 | 906 | 248 | 305 | 375 | 471 | 603 | 313 | 369 | 440 | 539 | 675 |
| 11 | 541 | 603 | 680 | 815 | 1003 | 239 | 293 | 363 | 493 | 672 | 336 | 382 | 452 | 597 | 790 |
| | | | | | | | | | | | | | | | |
| 13 | 542 | 615 | 682 | 794 | 997 | 265 | 336 | 400 | 507 | 697 | 338 | 451 | 482 | 611 | 807 |
| | | | | | | | | | | | | | | | |
| 15 | 540 | 606 | 685 | 798 | 996 | 254 | 314 | 395 | 508 | 673 | 331 | 392 | 468 | 591 | 784 |
| 16 | 540 | 606 | 679 | 783 | 945 | 242 | 309 | 382 | 487 | 644 | 328 | 397 | 471 | 576 | 733 |
| | | | | | | | | | | | | | | | |
| Statistical Analysis | | | | | | | | | | | | | | | |
| Average | 530 | 593 | 672 | 785 | 958 | 245 | 305 | 380 | 491 | 654 | 326 | 391 | 461 | 579 | 752 |
| Median | 540 | 601 | 680 | 795 | 981 | 246 | 309 | 382 | 496 | 672 | 330 | 387 | 469 | 590 | 771 |
| Max | 542 | 615 | 691 | 823 | 998 | 265 | 336 | 400 | 513 | 697 | 338 | 451 | 482 | 611 | 807 |
| 5th Large | 540 | 600 | 679 | 794 | 965 | 246 | 309 | 382 | 496 | 672 | 328 | 382 | 468 | 589 | 758 |
| Minimum | 495 | 546 | 616 | 715 | 861 | 218 | 268 | 336 | 431 | 571 | 311 | 363 | 434 | 533 | 675 |
| | | | | | | | | | | | | | | | |
| Std dev | 18 | 22 | 24 | 32 | 51 | 15 | 19 | 21 | 26 | 41 | 11 | 27 | 17 | 28 | 52 |
| Dispersion | 0.09 | 0.11 | 0.11 | 0.14 | 0.14 | 0.19 | 0.22 | 0.17 | 0.17 | 0.19 | 0.08 | 0.23 | 0.10 | 0.13 | 0.17 |

**Table 3.2 Male Nominal and real Annuity Payout Rates -£'s- 16 June 2005**

This shows a significant drop in the first year annuity payout from £998 to £807 (80.8%) if a RPI is purchased at 75 and to £697 (69.8%) for a 5%pa escalating annuity. The reduction in payout rate are more significant at 65 (69.8%and 57.9%) because of longer life expectation

In order to evaluate **the trend of rates** in recent years the most important and popular annuity products were plotted in Figure 3.1, showing the trend of maximum and average values of Level annuity payout rates for both for 65 and 75 year old male annuitants.

**Fig 3.1**
**Max and Average Male Level Annuity Payout Rates £'s for 65 and 75 yrs**




It clearly shows a downward trend since August 1994. However, it was not linear. For example, the 65 year average rate suffers an initial drop from £1,197 in August 1994 to £843 in January 1999 followed by a relatively constant payment rate period until October 2001 (£843) after which rates continue to drop to £673 in June 2005. . The maximum difference was £112in and occurred in August 1994.

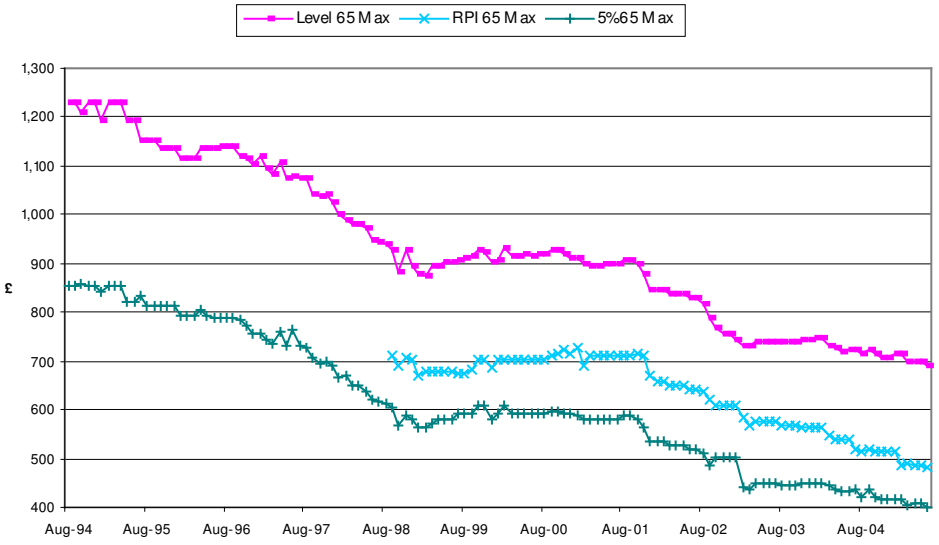
The market offered annuities to 75 year olds from August 1997 with an increased value / margin over the 65 year old rate of £452 (42%) to reflect reduced life expectancy. The average value followed the 65 year rate quite closely with the margin dropping to £430 in October 2001 and down again to £340 in June 2005 (49%).

The **maximum payout rate** is not as responsive to “market forces” as average rates. It remains constant for long periods and then makes some sharp adjustments e.g, the difference with respect to the average dropped from £136 in October 2001 to £80 in December 2001. By December 2003 a non-responsive maximum rate opened the gap

to £127. Over the subsequent 12 months the maximum followed the average but the excess dropped to only £40 by June 2005. Hence during most of the above period it was well worthwhile for the 75 year old to shop around for maximum rates. Accordingly we adapt the maximum payout rates as the basis for further analysis

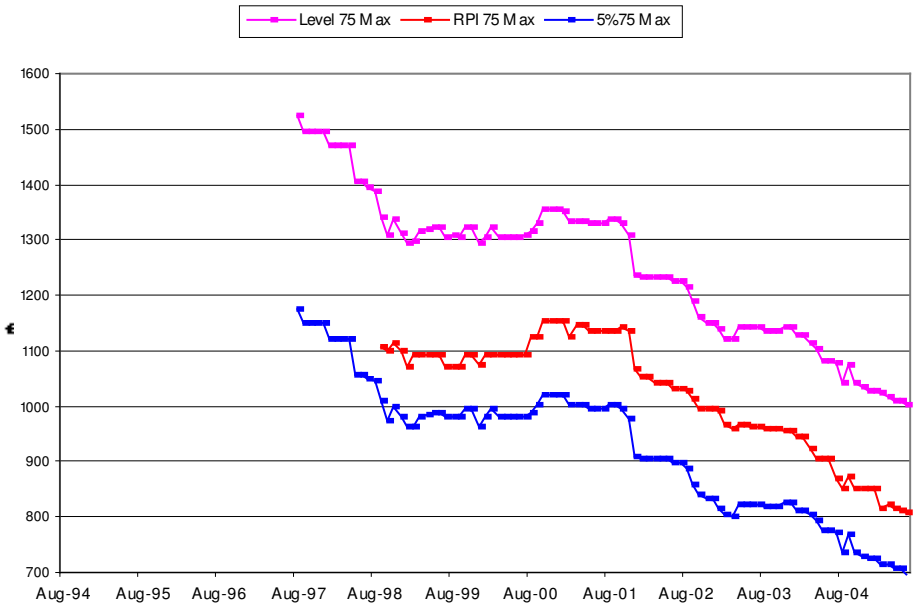
Fig 3.2 and 3.3 shows a similar pattern for the **history of real annuity rates** for both 65 and 75 year olds. Index linked annuities were introduced in 1998. They trend downwards until 1998. From 1998 to 2001 they were fairly static but have continued to declined since

**Fig 3.2 Annuity Payout Rate Trends Real v Nominal for 65 yr old Male**




The difference between the rates for the 3 types of annuity appears fairly constant throughout.

**Fig 3.3 Annuity Payout Rate Trends Real v Nominal for a 75 yr old Male**




As with max level rates, the maximum escalating and real rates also show a sluggish behaviour as they remain constant for months, followed by sudden changes / drops, e.g. Feb 03 for a 65 year old. It is particularly evident for 75 year olds.

One possible explanation is that some providers may use annuity funds as cash flow regulators and so offer high rates for prolonged periods until their cash balance needs are met. This then gives the trends their familiar “plateau” appearance. In any event their characteristic behaviour is somewhat at variance with the performance of an Efficient Market[1] and makes it doubly difficult for a would-be annuitant to optimise his position.

The Monies Worth implications are now addressed in order to determine which, if any, of the annuity products are value for money. This will also show whether the prevailing perceptions in 2002 remain valid

[1] Financial Theory and Corporate Policy by Copeland and Weston Addison Wesley 1992

# 4 Monies Worth of Annuities

## 4.1 Introduction

We now consider the value for money of an annuity as an investment. As stated earlier, the approach is identical to that carried out to support funding requests for investments and projects where the future cash flow streams, both positive and negative, are discounted back to the present value to give a net present value(NPV) Investors will naturally expect to see a positive NPV with a significant margin to cover risks. The annuity pv calculation includes the probability that the annuitant will survive to receive payout for each successive year

This work was first published by Mitchel (1999), and was focused on the USA market. She introduced the terminology of **EPDV (Expected Present Discount Value)** to be the discounted value of the future stream of annuity payouts.

Accordingly, NPV = Premium – EPDV.

The same notation was then followed by Finkelstein (2002) and Murthi (1999) and so is retained here.

Hence $$EPDV = \sum_{t=1}^{T} \frac{A_t * p_t}{\prod_{j=1}^{t}(1+i_j)}$$ equation 4.1.

Where $A_t$ is the annuity payout in year t, and $p_t$ is the probability of survival until year t, and $i_j$ is the discount factor for year j

Moneys Worth (MW), is defined as the EPDV/Premium ratio. As discussed earlier, this should be 1.0 if the annuity rates are actuarially fair (AFAR).

Since 1979, The Bank of England estimates yield curves for the UK on a daily basis. These include nominal and real yield curves and the implied inflation

structure for the UK. The nominal government spot interest rate is the appropriate **discount rate for future annuity payouts** when calculating their EPVD. The 20 year maturity values are used and their history since 1994 is shown in Table 4.1. Data is for July 1st each year. They are graphed in Fig 4.3

| **year** | **1994** | **1995** | **1996** | **1997** | **1998** |
|---|---|---|---|---|---|
| **Rate %** | 8.23 | 8.35 | 8.32 | 6.94 | 5.42 |
| **year** | **1999** | **2000** | **2001** | **2002** | **2003** |
| **Rate %** | 4.60 | 4.38 | 5.05 | 4.82 | 4.60 |
| **year** | **2004** | **2005** | **2006** | | |
| **Rate %** | 4.83 | 4.23 | 4.44 | | |

**Table 4.1 History of UK Nominal Spot Interest Rates 20 Year Maturity**

When considering index linked annuities the appropriate first year annuity rate was held constant but discounted at 2%, assuming **constant inflation of 3%** for the period.

## 4.2 Calculation of Probability of Survival

There are two groups of people to be considered when seeking information on survivor probabilities for annuity calculation purposes.

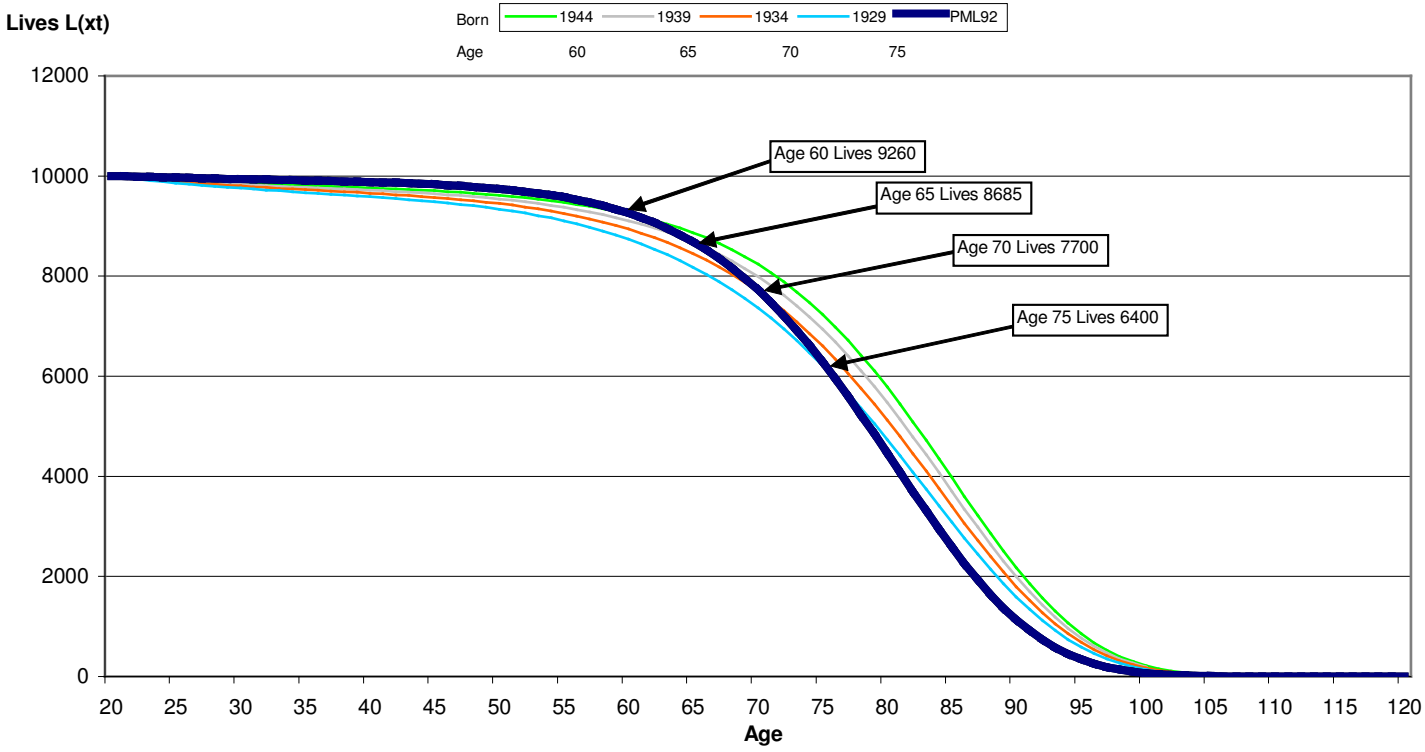
The first group relates to the expected mortality rates of the **population as a whole** and are published by GAD, Government Actuaries Department.

The second group relates to the expected mortality rates for **groups of individual annuitants** and are published by the Continuous Mortality Investigation Bureau (CMIR). CMIR reports 16 and 17 were used as these are for compulsory annuities. Its Table A5 for pensioners, which is designated PML 92B, is directly relevant. It tabulates mortality rates, $q_x$ for both Males and Females from age 20 to 120 in the base year 1992. There are two tables, “lives” and “amounts”.

The **“amounts” tables** are primarily for the use of the annuity provider as they represent a large group of annuitants. Hence, the **“lives” table**, was used as this best reflects the mortality rates for the individual pensioner.

However, life expectancy has been increasing dramatically and Institute of Actuaries (1999) CMIR 17 provides factors and equations to adjust for improvement in mortality over the course of time. It shows that the more accurate approach is to calculate an individual’s life expectation based on his or her year of birth. However, it is quite complex to compute. This is best illustrated in figure 4.1 which shows the cumulative survival profile as a function of age for 20 to 120 year olds based on PML92 Lives mortality rate data. The data is normalised at 10,000 “lives” at aged 20 and show how many “lives” remain at each subsequent year of age.

**Fig 4.1 Cumulative Survival Profile**



Probabilities of survival are built up from the mortality rate data in PML 92B table, starting at the age 20 as follows

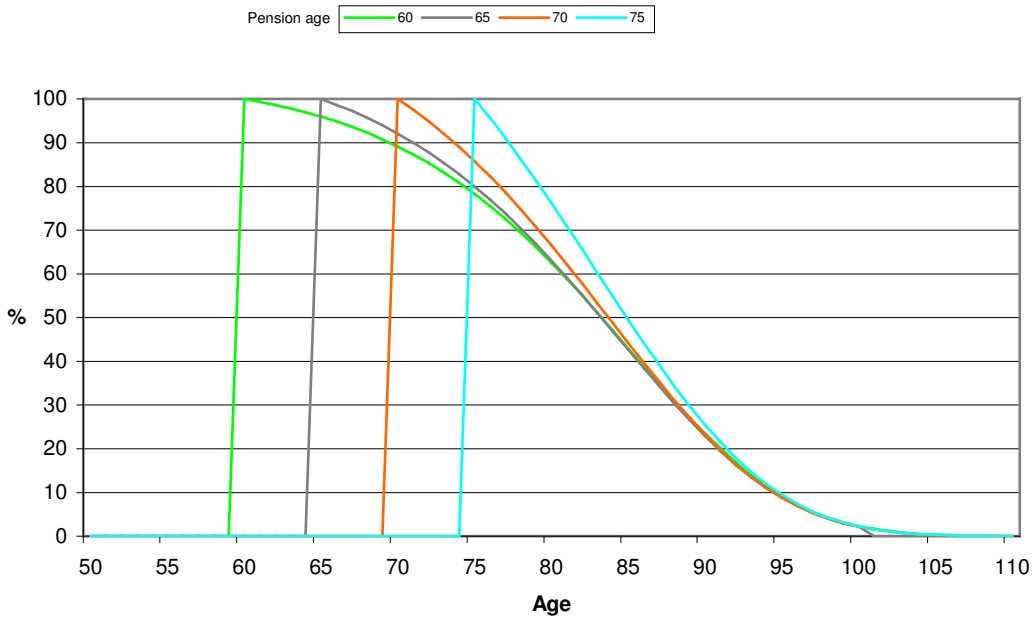
$$L_{21} = (1-q_{20}).L_{20}. \qquad \text{Eq 4.2}$$

The black curve in fig 5.1 is the base curve and the coloured ones reflect different age groups. For example, a 65 year old has 8,685 lives remaining but instead of following the black curve the grey curve is used which gives a clearly extended life profile. This is a life expectancy correction based on the 65 year old starting his pension last year (analysis year 2004) and so he belongs to the cohort who were born in 1939. Hence the **age and year a person purchases his annuity decides the precise survival probability curve he is subsequently expected to follow** for annuity evaluation/cost purposes.

At that point his probability of receiving his first payout is, naturally, 100%.

For example, a 75 year old would have 6,400 lives left and would then start to receive payment based on the blue curve profile. The actual probability of receiving an annuity in subsequent years is shown in Fig 4.2. Naturally, it is 100% on starting "retirement" regardless of age but falls rather more steeply for a 75 year old rather than a 65 year old. These curves are generated by normalizing the appropriate life curve of the Fig 4.1 to 100% on starting to draw the annuity payouts.

**Fig 4.2 Cumulative Probability of Reciept of Annuity (Survival)**




## 4.3 The EPDV Calculator

When the complexity of doing the calculations based on the year of birth was established and as it was planned to trend MW from 1994, the author endeavored, without success, to identify a software package to undertake the EPDV calculations. Therefore, it was necessary to develop an EPDV Calculator using Excel and do the necessary calculations to determine survival probabilities from mortality tables as part of the annuity payout discount cash flow computation. The EPD Calculator is set up to generate data for four age groups. 60, 65, 70, and 75 and so a separate spreadsheet similar to that in Fig 4.2 is needed for each age and year of birth.

| | A | B | C | D | E | G | J | K | L | M | N | O | S | U | X | AD | AG | AH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Initial Data** | | Birth Year | 1939 | | | | | | | | | | | | | | |
| 2 | | | Retirement Age | 65 | | | | | | | | | | | | | | |
| 3 | | | Analysis Year | 2004 | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | |
| 6 | **Base Data** | | | | | **Reduction Factor for Mortality Improvement** | | | | | | | | **EPDV Calculation** | | | | |
| 7 | **Age** | **Mortality rate** | | **Lives** | | **Years from base data date (1992)** | **mortality rate reduction factor** | **reduced mortality rate** | | **Revised Lives** | | **Probability of receiving annuity** | **Years Post Retirement Age** | **Annuity rate** | **Discount Factor** | **Cumulative Discount Factor** | | **Present Value** |
| 8 | | | | | | | | | | | | | | | | | | |
| 9 | **x** | **qx** | **sx** | **lx** | | **t** | **RF(x,t)** | **q(x,t)** | **s(x,t)** | **l(x,t)** | | **p(y)** | **y** | **Ay** | **i** | **((1+i)y)-1** | **p(y)** | **PV Ay** |
| 10 | | | | | | | | | | | | | | | | | | |
| 11 | 20 | 0.0006 | 0.9994 | 10000 | | -33 | 3.378767298 | 0.0021 | 0.9979 | 10000 | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | |
| 13 | 30 | 0.0006 | 0.9994 | 9942 | | -23 | 2.309339356 | 0.0013 | 0.9987 | 9834 | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | |
| 15 | 40 | 0.0008 | 0.9992 | 9881 | | -13 | 1.591945284 | 0.0013 | 0.9987 | 9717 | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | | |
| 17 | 53 | 0.0039 | 0.9961 | 9658 | | 0 | 1 | 0.0039 | 0.9961 | 9450 | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | | |
| 19 | 60 | 0.0098 | 0.9902 | 9261 | | 7 | 0.787875378 | 0.0077 | 0.9923 | 9104 | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | | |
| 21 | 65 | 0.0181 | 0.9819 | 8686 | | 12 | 0.718563511 | 0.0130 | 0.9870 | 8676 | | 1.000 | 0 | £702.00 | 0.05 | 1.0000 | 1.000 | £702.00 |
| 22 | | | | | | | | | | | | | | | | | | |
| 23 | 70 | 0.0321 | 0.9679 | 7724 | | 17 | 0.691442626 | 0.0222 | 0.9778 | 7991 | | 0.921 | 5 | £702.00 | 0.05 | 0.7835 | 0.921 | £506.60 |
| 24 | | | | | | | | | | | | | | | | | | |
| 25 | 75 | 0.0542 | 0.9458 | 6290 | | 22 | 0.692657833 | 0.0375 | 0.9625 | 6942 | | 0.800 | 10 | £702.00 | 0.05 | 0.6139 | 0.800 | £344.81 |
| 26 | | | | | | | | | | | | | | | | | | |
| 27 | 80 | 0.0866 | 0.9134 | 4464 | | 27 | 0.713184494 | 0.0618 | 0.9382 | 5473 | | 0.631 | 15 | £702.00 | 0.05 | 0.4810 | 0.631 | £213.01 |
| 28 | | | | | | | | | | | | | | | | | | |
| 29 | 85 | 0.1311 | 0.8689 | 2585 | | 32 | 0.746959212 | 0.0979 | 0.9021 | 3702 | | 0.427 | 20 | £702.00 | 0.05 | 0.3769 | 0.427 | £112.88 |
| 30 | | | | | | | | | | | | | | | | | | |
| 31 | 90 | 0.1875 | 0.8125 | 1128 | | 37 | 0.789769664 | 0.1481 | 0.8519 | 1988 | | 0.229 | 25 | £702.00 | 0.05 | 0.2953 | 0.229 | £47.50 |
| 32 | | | | | | | | | | | | | | | | | | |
| 33 | 100 | 0.3245 | 0.6755 | 65 | | 47 | 0.891069894 | 0.2892 | 0.7108 | 192 | | 0.022 | 35 | £702.00 | 0.05 | 0.1813 | 0.022 | £2.81 |
| 34 | | | | | | | | | | | | | | | | | | |
| 35 | 120 | 1.0000 | | 0 | | 67 | 1 | 1.0000 | 0.0000 | 0 | | 0.000 | 55 | £702.00 | 0.05 | 0.0683 | 0.000 | £0.00 |
| 36 | | | | | | | | | | | | | | | | | | |
| 37 | | | | | | | | | **Life expectancy** | | | **18.6** | | | | **EPDV** | | **£8,231.92** |

**Table 4.2 Principles of Annuity Evaluation using the "EPDV Calculator"**

Each holds the entire PML92 data from ages 20 to 120 i.e. 100 rows of data. This gives considerable accuracy. Table 5.4 illustrates the calculations for a male annuitant born in 1939 and so aged 64 in 2004. They are carried out for each year from age 64 to age 120 and their summation gives a probable life expectancy of 18.8 years and an EPDV of £8231

It is also possible to readily adapt it to cope with other mortality tables and to estimate

- Internal rate of return
- Retirement duration to achieve AFAR

The verification of the EPDV Calculator is a necessity and Lunnon M (2003) of GAD reviewed it, confirmed the actuarial approach methodology and found the results of the EPDV Calculator to be within 1% of their own. This is fully reported and comparisons with other published results by Murthi (1999) and Finkelstein (2002) are presented in Appendix A1

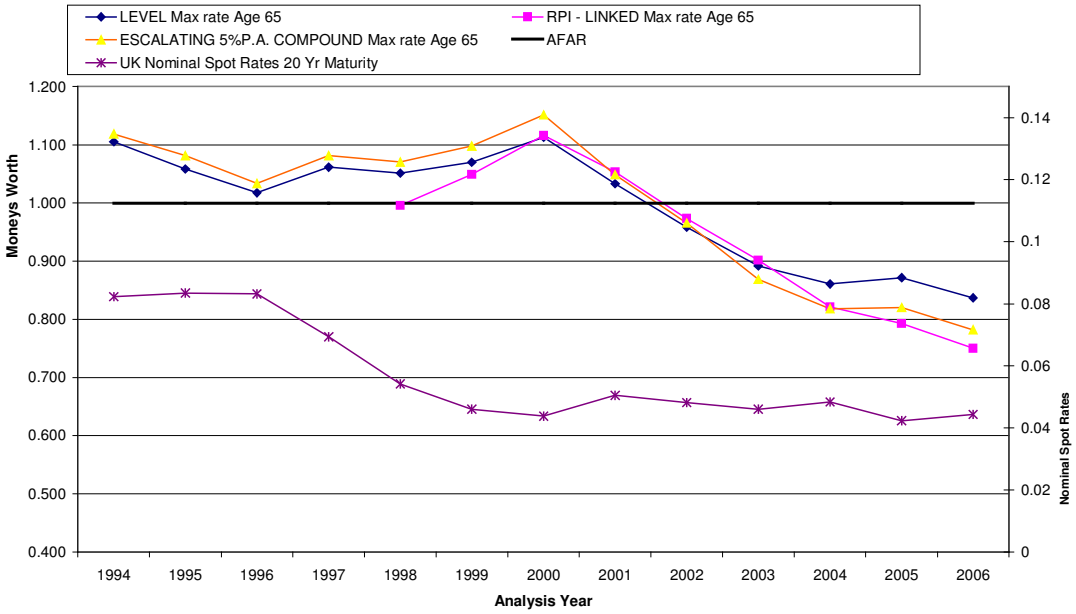
**In summary**, the data is sound, the analysis techniques adapted are proven and the MW calculations are verified. Hence one can have a high level of confidence in the analysis results

### 4.3 Monies Worth Values of Market Average Level Annuities

In June 2006 the MW value of the maximum annuity payment stream for a 65 year old is 0.843 and so the annuitant suffers a significant financial loss of 15.7 p in the premium £. The actuarially fair annuity rate is £813 cf market maximum payout of £686. (see table 5.1)

This was not always so. Fig 4.3 which shows the trend of Moneys Worth for Level, escalating at 5%, and RPI linked annuities for a 65 year old male. The UK nominal spot rates are also plotted as they are used as the discount factors in the MW computation

**Fig 4.3 Moneys Worth Trend using historic discount factors Real v Nominal for 65 yr old**




Up to 2001 the MW was in excess of 1.0 and so annuity payout rates were better than AFAR. In principle they were responsive to interest rate changes. They peaked in 2000, (at 1.12 for the Level annuity). Since then they have been in steady decline (Level annuity is down to 0.85 in June 2006), even though the discount factor remains

fairly constant . As MW did not drop below 0.95 until 2002, it has not been reported in any of the references considered in the literature review.

The real and escalating annuity rates follow a similar pattern except that since 2003 their MW values have dropped significantly below that offered by the Level product. Surprisingly, the MW of the real product (RPI 3% constant) is lower than an escalating one (5%). Finklestein (2000) discusses this inconsistency and suggests that it may be that insurance companies have to bear some inflation risk and "it is possible that risk averse individuals are willing to pay a higher risk premium for a real product" (p47)

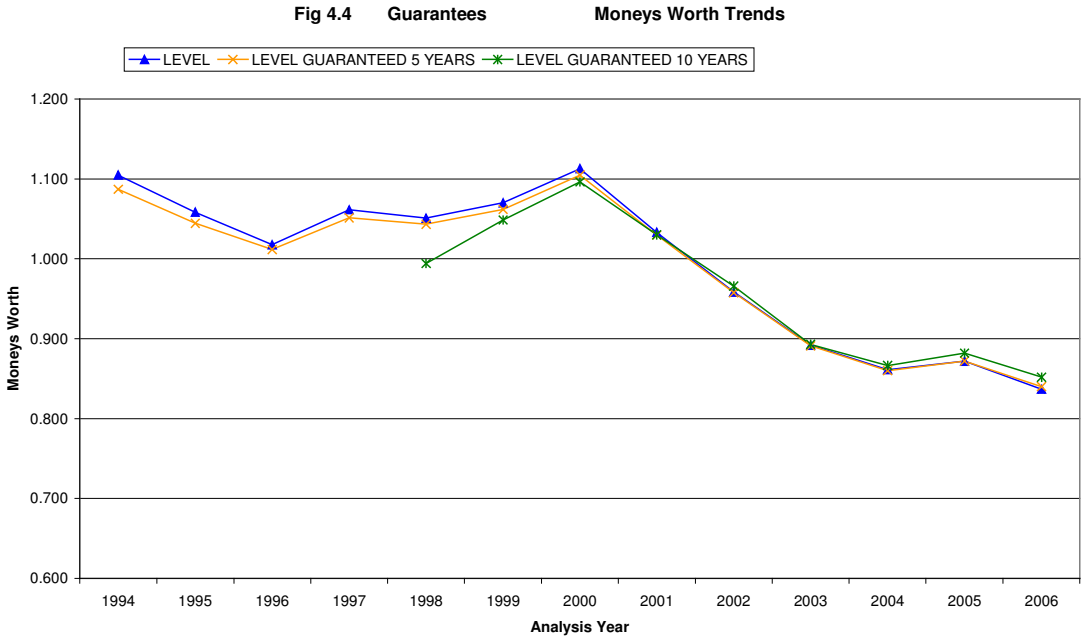



Fig 4.4 shows the same pattern for Level annuities with both 5 and 10 year guarantees. Indeed there is little difference in MW values for all 3 products since 2000

A key uncertainty in pricing annuities is life expectation and it is possible that annuity payout rates have been dropping to reflect concerns re the extent of this risk. In order to evaluate this theory, the EPDV calculator was re run to determine the number of **extra years** of life expectancy that would have to be added to the current life expectancy (18. 8 years for a 65 year old in June 2006), to make the EPDV equal to the premium of £10,000. This is done by incrementally reducing the age the annuity payout starts until the MW is 1.0. Using maximum annuity rates, this was found to be 5.8 extra years, bringing the actuarially fair **retirement life expectancy** up to 24.6 years. Although it is conceptually attractive to add these years on to the current life expectation, this is analytically incorrect and quite unrealistic with a significant reduced probability of surviving the extra years. The correct interpretation is that the pensioner should be offered **early retirement** with the same annuity rate paid accordingly ( eg from age 59.2). As this option is not offered, the present annuity payout rates give the annuity providers a generous margin for error in mortality predictions and tables.

Annuity payout rates are, naturally, expected to fall as forecasts of life expectancy rise at a given MW, ideally retaining AFAR. However, this cannot also justify the significant reductions in MW below its AFAR value of 1.0 as shown in Figs 4.3 and 4.4, and which leaves the pensioner with an ever reducing value for his annuity premium.

Further, as discussed earlier, the present major loss to the annuitant is difficult to explain in terms of costs to the providers which are minimal during the drawdown phase of a pension fund

# 5 Income Drawdown Strategies

## 5.1 The Pensioners Options and Dilemmas

In 2002 the Financial Services Authority (FSA) were concerned that consumer understanding of annuities was low and that people did not fully understand the risks of their decisions. The various options available on the market are discussed and analysed to develop strategies to guide pensioners when formulating their drawdown strategy. This is presented in section 5.2

Most people, especially those with small pensions, stay with their pension provider and do not shop around for the best annuity rates. Hence the **open market options** are rarely exercised. Shopping around is assessed in MW terms by comparing maximum and average rates for a range of products

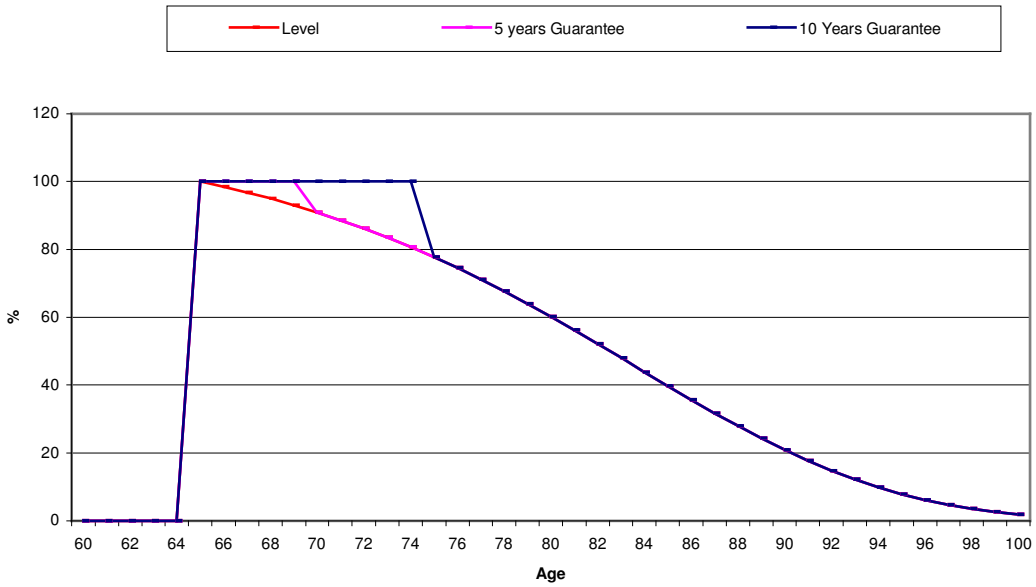
Many **delay the purchase of an annuity** as long as possible, risking a poor outcome. This is known as "longevity drag". As each type of annuity is available from age 55 onwards, the impact of delay is evaluated and quantified in MW terms

There is a common perception that the **highest initial income is best** and few people purchase either Index linked or escalating annuities. Further, people with longer than average life expectancies are naturally worried about the falling value in real terms of their fixed annuity income. This can be protected by purchasing index linked or escalating annuities. A MW analysis is carried out to see if they are value for money?

Guarantees were offered by the Industry in 1997 in response to the widespread criticism against compulsory annuities as confirmed by Lunnon (2003) **that when you die the money goes to the Insurance Company.** The guarantee is that should

the pensioner die payments will continue to be paid to the deceased estate for the remainder of the guarantee period.

**Fig 5.1 Impact of Guarantees on the Cumulative Probability of Survival and Receipt of an Annuity**




As shown in figure 5.1 they effectively amend the cumulative survival profile to be constant for the appropriate period after which it reverts to the basic Level profile. These are offered are for either 5 or 10 years with both nominal and real products but only to the age of 75.

In addition, individuals often buy **single life policies** leaving their partners exposed to significant risk, especially given that female life expectation is greater than males and many partners live 15 to 20 years on after the death of their husband. An MW analysis provides guidance on their value and possible use as an alternative to purchasing a joint life annuity

No analysis is undertaken for **impaired life annuities** for those with medical disabilities as they are ideal for those prepared to undergo the necessary medicals

## 5.2 Some Strategies for Income Drawdown

Table 5.1 shows all the options open to both 65 and 75 year old healthy Males using Moneyfacts data for annuity rates on 5th June 2006. Hence the **observations are current**.

**Table 5.1 Summary Analysis of Annuitants Options**

| | **Status 5th June 2006** | | | **Observations** | | |
|---|---|---|---|---|---|---|
| **Annuitants Options** Male only | AR Annuity rate (max) | MW Moneys Worth | IRR Internal rate of Return (Discount factor 4.5%) | AFAR Actuarially Fair Annuity Rate | Retirement Life expectation to achieve moneys worth of 1.0 (yrs) | Extra retirement years |
| **Shop around Age 65** | | | | | | |
| Min rate | £609 | 0.7486 | 1.3% | £813 | 30.8 | 12.5 |
| Average rate | £665 | 0.8175 | 2.2% | £813 | 26.3 | 7.5 |
| Max rate | £686 | 0.8433 | 2.5% | £813 | 24.6 | 5.8 |
| | | | | | | |
| **Options at 65** | | | | | | |
| L | £686 | 0.8433 | 2.5% | £813 | 24.6 | 5.8 |
| L +RPI | £462 | 0.7425 | 1.75% | £622 | 26.3 | 7.5 |
| L + 5% | £403 | 0.7978 | 2.5% | £505 | 23.7 | 4.9 |
| | | | | | | |
| L | £686 | 0.8433 | 2.5% | £813 | 24.6 | 5.8 |
| L + 5 years | £681 | 0.8452 | 2.5% | £806 | 24.6 | 5.8 |
| L + 10 years | £672 | 0.863 | 2.75% | £779 | 24.9 | 6.1 |
| | | | | | | |
| **Delay Purchase** | | | | | | |
| Age 65 | £686 | 0.8433 | 2.5% | £813 | 24.6 | 5.8 |
| 75 | £989 | 0.8362 | 1.5% | £1183 | 14.2 | 3.0 |
| | | | | | | |
| **Shop around Age75** | | | | | | |
| Min rate | £855 | 0.7229 | -ve 0.6% | £1171 | 17.7 | 6.5 |
| Average rate | £934 | 0.7897 | 0.7% | £1182 | 15.6 | 4.4 |
| Max rate | £989 | 0.8362 | 1.5% | £1183 | 14.2 | 3.0 |
| | | | | | | |
| **Options at 75** | | | | | | |
| L | £989 | 0.8362 | 1.5% | £1183 | 14.2 | 3.0 |
| L +RPI | £766 | 0.7762 | 1.0% | £987 | 14.9 | 3.7 |
| L + 5% | £688 | 0.7980 | 1.5% | £862 | 13.6 | 2.4 |
| | | | | | | |
| L | £989 | 0.8362 | 1.5% | £1183 | 14.2 | 3.0 |
| L + 5 years | £945 | 0.8356 | 1.5% | £1131 | 15.2 | 4.0 |
| L + 10 years | £865 | 0.8709 | 2.2% | £933 | 15 | 3.8 |

**Note**

Expected life expectation for 65 year old male is 18.8 years bringing expected survival to age 83.8
75 11.2 86.2

The extra years should be taken as early pension rather than additional to the expected survival age

The MW and IRR values are calculated and added. For completeness the observations show the AFAR and the "retirement life expectancy" the annuitant needs to achieve in order to get his money back ( ie achieve a MW of 1.0) under the present rates. The extra years over the mortality tables retirement life expectation are also shown for illustration of how many years the annuitant is expected to loose when purchasing under present market rates

The following strategies / observations should be noted

- In Moneys Worth terms all annuity products for both age groups offer very poor value for money. A comparison with AFAR clearly shows this. Hence the best strategy is to avoid purchasing an annuity by **opting for an ASP** at the appropriate time, particularly as the residual fund goes to ones estate. The remaining points are for those who intend to purchase an annuity perhaps as part of their drawdown strategy.
- **Shopping around** is common sense and in practical terms involves no risks since the size of the provider, his market share or his financial rating has little impact on annuity payout rates. This is clearly advantageous as it enables the annuitant to obtain the highest available payout rate without suffering any penalties and both the MW and IRR reflect this. However the annuitant should be aware of the anomalies of the market and the step nature of the movement of maximum rates.
- All further analysis are on the basis of maximum rates

- **Deferring purchase** from 65 to 75 provides an increase in annuity payout rate from £686 to £989 (+44%). However there is no significant change in MW, both being 0.84. Hence it is probably better to take the income, by transferring the fund to a SIPP, rather than let the fund build up. Under present rules 25% can be taken as a tax free lump sum and the remainder invested in a wide portfolio of assets. The amount of drawdown to take each year can also be decided by the pensioner up to a prescribed limit. Hence the pensioner retains control of his finances until he chooses to purchase an annuity - if ever. Throughout, the residual fund remains part of the pensioner's estate in the event of death.
- The need to **protect the standard of living** is a real concern if expected longevity is high or one is taking an early pension. The pensioner has to decide if it is better to purchase a product that gives a payout which escalates at a fixed rate or is inflation protected, even though the initial payout is low (£462 cf £686 for a 65 year old) However the MW is also reduced from 0.84 to 0.74 making it a poorer investment and one needs 7.5 extra retirement years to "get value"

  Hence there is no incentive in MW terms to purchase an indexed linked or escalating annuity as they both incur greater "losses" than the Level.

  Should a risk averse pensioner wish to protect income stream and wants 100% insurance then he is best investing in a SIPP, taking drawdown as needed, waiting until 75 and purchasing the most advantageous index linked annuity available. In June 2006 this was £766 from Prudential and incurred a "risk premium" of 23% in MW terms (MW=0.77) compared with an AFAR of £ 987. His investment will only payoff should he enjoy 3.7 extra retirement years.

- **Guarantees** are available at rates which offer similar MW returns as the level annuity. Indeed there is a small benefit accruing. . For example, a 75 year old male taking out a 10 year guarantee sees an increase in MW from 0.836 to 0.87 or 3.4p in the premium £. This is attractive especially if he has a partner of similar age as the alternative of buying a joint lives annuity is much more expensive. The savings could be invested as contingency for the partners pension should the partner outlive the annuity guarantee period, as is statistically likely.

In **summary**, at present the "compulsory "annuity is very poor value for money with MW values below 0.84 for the various products. In investment terms this is equal to a loss of 16% of the premium.

Fortunately, the recent A day legislation allows the pensioner to transfer his pension funds into a SIPP and manage his own investment and drawdown strategies - without having to purchase an annuity at 75. This should be considered as the most appropriate plan

## 6 Conclusions

The main conclusion is that annuities no longer provide value for money and hence a fair pension.

At present the maximum annuity payout rate available to healthy 65 year olds is £686 giving an MW of 0.84 equivalent to an Internal Rate of Return of 2.51%. The actuarially fair rate would be £813. This is an unacceptable "loss" / premium (16% minimum) to expect any investor to bear. The situation is worse for those either delaying to 75 (IRR = 1.5%) or wishing to buy an index linked product. (MW =0.74). There is a small benefit, in present value terms, for purchasing a Level annuity with a 10 year guarantee.

A suggested reason for these high costs was the underlying concern of annuity providers about increasing longevity. The analysis shows that it would be necessary to increase retirement life expectancy for a 65 year old with a maximum rate level annuity from 18.8 years by an extra 5.8 years to obtain actuarial fairness. These extra years should be earned by taking an earlier pension (at 55.5) at the same payout rate rather than hoping to live longer. As this option is not offered, current rates clearly provide the annuity providers with a very generous margin for error in mortality predictions and tables

Up to 2001 the MW was in excess of 1.0 . They peaked in 2000, at 1.12 for the Level annuity. Since then they have been in steady decline (Level annuity is down to 0.84 in June 2006), even though the discount factor remains fairly constant .Hence "compulsory" annuities provided reasonable value for money so long as the MW was

greater the 1.0. This threshold was crossed in 2002, and the "compulsory" annuity has become increasingly expensive and a poor investment. This observation applies to all annuity products that were analysed. Thus the wide perception that "annuities are poor value for money" has been confirmed to be correct since 2002. No rational explanation was found for their progressive devaluation over the last 5 years. While annuity rates can be expected to fall as life expectation rises there is no logical reason why this should also justify a reduction in its moneys worth value. As MW did not drop below 0.95 until 2002, their recent poor performance has not been reported in any of the references in the literature review

The sluggish response characteristic of some annuities rates is identified as applying to the maximum rate available to the annuitant rather than the average across the market. One explanation of this "phenomena" could be that some insurance companies may use the annuity sector to manage their cash flow. Therefore, in a period of shortage, higher annuity rates may be offered. These remain high until the primary objectives are achieved, after which these rates are revised. This is somewhat at variance with the characteristics on an efficient market and makes it doubly difficult for a would-be annuitant to optimise his position.

Hence, it is fortunate that compulsory annuitisation at the age of 75 was withdrawn as of April 2006. The use of personnel pension plans, such as a SIPP, leaves the investment and life long drawdown strategy with the pensioner. This offers many benefits as long as annuities continue to be such poor value for money.

The impact on the future of the annuity market remains to be seen.

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## Appendices

### Appendix A1 EPDV Accuracy checks

It was considered, with the complexity of the calculations, that it was important to check on its accuracy by comparing with other reliable sources. A 10% margin is considered satisfactory given the range of assumptions that are possible.

Only two references contained detailed data on both the annuity rates and their corresponding MW calculation.

a. Murthi (1999) Table 3 (p40) included industry average annuity payout rates for males aged 65, 70 and 75 as of April 1999. They are for a premium of £10,000. The corresponding MW values are included in its Table 4 (p41). They are based on mortality data from the PML92 Base tables and arewere not corrected against year of birth. They use zero coupon yield curves (ZCYC) for discounting.
b. Finkelstein (2002) Table 1 provided "compulsory" annuity payout rates from November 1998 and its Table 2 the corresponding MW results. References are made to a "compulsory" annuity lives weighted mortality tables – presumably PML92B. No information is provided about the nominal interest rates used.

As mentioned earlier M.Lunnon of GAD provided advice on actuarial matters. calculated the corresponding MW using PML92B mortality tables adjusted for year of birth and a constant 5% discount factor.

The results are compared with corresponding EPDV calculations in Table A1.

| | Age | Analysis Year | Year of Birth | 1st Year Annuity | Discount Factor | Moneys Worth MW | Differences |
|---|---|---|---|---|---|---|---|
| EPDV Calculator | 60 | 2004 | 1944 | 617.18 | 0.05 | 0.830 | |
| GAD | | | | 617.80 | | 0.820 | 1.20% |
| EPDV Calculator | 65 | 2004 | 1939 | 702.00 | 0.05 | 0.823 | |
| GAD | | | | 702.00 | | 0.823 | 0.00% |
| EPDV Calculator | | 1999 | 1934 | 850.00 | 0.05 | 0.976 | |
| Murthi,M (1999) | | | | 850.00 | ZCYC | 0.965 | 1.17% |
| EPDV Calculator | | 1998 | 1933 | 897.00 | 0.05 | 1.026 | |
| Finklestein, A | | | | 897.00 | | 0.962 | 6.24% |
| EPDV Calculator | 70 | 2004 | 1934 | 818.09 | 0.05 | 0.811 | |
| GAD | | | | 818.09 | | 0.811 | 0.01% |
| EPDV Calculator | | 1999 | 1929 | 1,003.00 | 0.05 | 0.971 | |
| Murthi,M (1999) | | | | 1,003.00 | ZCYC | 0.946 | 2.57% |
| EPDV Calculator | | 1998 | 1928 | 1,036.00 | 0.05 | 0.998 | |
| Finklestein, A | | | | 1,036.00 | | 0.945 | 5.31% |
| EPDV Calculator | 75 | 2004 | 1929 | 996.09 | 0.05 | 0.812 | |
| GAD | | | | 996.09 | | 0.812 | 0.00% |
| EPDV Calculator | | 1999 | 1924 | 1,221.00 | 0.05 | 0.970 | |
| Murthi,M (1999) | | | | 1,221.00 | ZCYC | 0.928 | 4.33% |
| EPDV Calculator | | 1998 | 1923 | 1,252.00 | 0.05 | 0.99 | |
| Finklestein, A | | | | 1,252.00 | | 0.921 | 7.11% |

**Table A1 Accuracy of EPDV Calculator - Moneys Worth Values**

The table is divided into age groups. For each age group, the annuity payout rates and MW data from external source is entered and the same annuity rates used in the EPDV Calculator to estimate an MW and the MW's are compared. For example taking the 65 year old data from Murthi the stated AR of £850 and is entered into the EPDV Calculator which estimated a MW of 0.976 . This

compares with Murthi's MW of 0.965 and the normalised difference of 1.17 % is shown in the differences column.

It can be seen from GAD comparisons where assumptions and actuarial results are the same that the results are virtually identical. With the Murthi published data agreement is in the range of 1 to 4.5% and Finkelstein a bit wider at 5% to 7½%.

Hence, the GAD comparison shows EPDV Calculator is sound and can be relied on to produce accurate results. The other comparisons confirm this as the results are consistent and well within the margins of error from the differing sets of assumptions. In all cases the EPDV Calculator generated higher MW values which are consistent with the longer life expectancy arising from the use of date of birth adjusted mortality tables.