B.A.J. **6**, I, 55–141 (2000)

PENSION FUND VALUATIONS AND MARKET VALUES

BY S. J. HEAD, D. R. ADKINS, A. J. G. CAIRNS, A. J. CORVESOR, D. O. CULE, C. J. EXLEY, I. S. JOHNSON, J. G. SPAIN AND A. J. WISE

[Presented to the Institute of Actuaries, 25 October 1999]

ABSTRACT

The traditional approach to United Kingdom pension fund valuations is to use an off-market approach to valuing assets and liabilities. This approach has been called into question for a number of reasons, such as changes to the taxation of U.K. share dividends and a growing understanding and appreciation of the key principles of financial economics. This paper looks at the history of the traditional approach and focuses on the drivers for change. We compare the properties of various methods that take assets into the balance sheet at market value against the traditional valuation method. Our principal aim throughout has been to produce a paper that is practical and helpful to pension scheme actuaries.

KEYWORDS

Pension Schemes; Valuation Methods; Market Values; Funding; Pricing

CONTACT ADDRESS

S. J. Head, F.I.A., Aon Consulting, Carnegie House, 21 Peterborough Road, Harrow, Middlesex HA1 2AJ, U.K. Tel: +44(0)181-864-9966; Fax: +44(0)181-970-4798;
E-mail: simon.head@aonconsulting.co.uk

1. INTRODUCTION

1.1 In the United Kingdom, the traditional approach to the actuarial valuation of a defined benefit pension scheme has been to take assets into account at a value other than market value. This has generally been determined as the present value of the expected future income stream, predominantly dividends from equities.

1.2 In 1997 the Chancellor of the Exchequer decided to withdraw U.K. pension schemes' ability to reclaim the Advanced Corporation Tax (ACT) credit on U.K. company dividends. U.K. pension schemes, thereafter, were only entitled to receive dividends net of tax, a difference worth up to 20 pence per £1 of gross dividend. This substantial change in the taxation of U.K. dividends implied, in the absence of remedy, a reduction of up to 20% in the value placed by actuaries on the assets of a pension scheme, with knock-on effects for disclosed funding levels and contribution rates. In the face of such a significant impact from taxation and a number of other factors driving changes to the U.K. pension scheme environment, actuaries began to question the merits of traditional asset valuation methodologies.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

1.3 In response to this, the Technical Support and Research Committee of the Pensions Board established a Working Party to consider the use of market values for actuarial valuations. This is the report of that Working Party.

1.4 The terms of reference set by the Technical Support and Research Committee were as follows:

(1) to consider the merits of various valuation methodologies for U.K. pension funds following the ACT change; in particular, to consider how the assets should be brought into the actuarial valuation balance sheet;
(2) to assist the MFR Change of Conditions Working Party in formulating any changes to MFR methodology; and
(3) to have regard to:
   — work being carried out by the International Accounting Standards Board;
   — current practice;
   — the needs of users of valuations; and
   — the importance of effective communication by the profession.

1.5 In interpreting these terms of reference, the Working Party believes that the needs of the profession are best served by the following:

— to describe the different methods of producing a valuation where assets are taken into account at market value;
— to compare these methods against a suitable set of criteria;
— to compare these methods against the traditional assessed value methodology;
— to produce a paper that is practical and helpful to pension scheme actuaries; and
— to produce a paper written in a language familiar to pension scheme actuaries.

1.6 The main body of the paper is laid out as follows. In Section 2 we examine the purposes for which actuarial calculations may be required. Section 3 looks at the history of how we got to where we are today. Section 4 describes the drivers for change from current practice, with Section 5 expanding on the key principles of financial economics as they relate to pension liabilities. In Section 6 we describe alternative methods of conducting a valuation, and Section 7 introduces a common set of criteria, or properties, for comparing those methods. Section 8 shows the results of modelling the behaviour of the different methods on the funding level and contribution rate of an example scheme. In Section 9 we compare these methods against the properties described in Section 7, and in Section 10 we draw our conclusions.

2. The Purpose of an Actuarial Valuation

2.1 Before comparing different valuation methods, it is worthwhile to have a clear view of their purpose.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

2.2 There are four principal subsets of purposes underlying actuarial valuations: funding; commercial transactions; accounting and regulatory.

2.2.1 *Funding*

In general terms, a client may wish to know one of four things:

(a) the future contribution rate;
(b) how far the assets cover accrued liabilities, allowing for future pay increases;
(c) how far the assets cover accrued liabilities, were the scheme to be wound up and the benefits secured with an appropriate pension provider; and
(d) how a disclosed surplus (or deficiency) should be allocated between different classes of member or employer.

2.2.2 *Commercial transactions*

In this context a transaction is taken as a cash payment in respect of retirement benefits. These situations cover individual or grouped (bulk) payments, e.g. transfer payments. Individual cases might also include, say, special retirement options or augmentation payments. Setting up or changing pension arrangements also represents, in principle, a transaction between employer and employees.

2.2.3 *Accounting*

Sponsoring employers require pension expense calculations for their company accounts. More than one set of calculations may be required because of different accounting principles in the U.K. (SSAP 24) and elsewhere internationally (e.g. FAS 87 for United States reporting).

2.2.4 *Regulatory*

Valuations are required to comply with regulatory standards, most notably the Minimum Funding Requirement (MFR), demonstrating the ability to contract out of SERPS and testing for excess surplus.

2.3 The traditional actuarial valuation of a pension fund is primarily concerned with setting a contribution rate, namely under ¶2.2.1(a). This is part of a procedure for controlling the pace at which a fund is built up to meet the liabilities, and involves a number of assumptions. In many ways it can be considered as an algorithm for setting a contribution rate, but with the assumptions used determining the pace of funding.

2.4 In a traditional valuation, it is conventional to work with present values rather than rolling all payments up to a terminal date. The use of a constant interest rate for all time periods is not essential for accumulation or discounting, but, conveniently, does allow the use of standard actuarial commutation functions to switch back and forth. It is when we work with present values that confusion can, however, emerge in terms of the meaning of the resulting numbers. Although they may appear superficially similar, these present values are not 'values' in the sense typically used for commercial transactions or corporate finance.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

2.5 The historical development of traditional actuarial valuation techniques is described in Section 3. In the analysis of different methods which follows it is termed Method 0 (but Method 1 is very closely related to it).

2.6 As the other purposes of actuarial valuations have appeared, generally it has been the traditional method which has been adapted and used (with the exception of FAS 87, which prescribes a different approach).

2.7 In more recent years, a different approach to considering pension scheme liabilities has developed, based on the concept of market pricing. This is based on the wide body of literature and theory associated with financial economics and corporate finance, a potted history of which is given in Section 5.

2.8 In this paper this market pricing approach of financial economics is termed Method 3, or the 'economic valuation'.

2.9 Neither the income from the assets held nor an assumed return on net inflows or outflows enter an economic valuation. In fact, the discount rates used to value the liabilities have a subtly different role. It is misleading to think of the discount rates used to value liabilities for a transaction in terms of an assumed future return on assets, it is far clearer to think in terms of forward rates and their direct link with today's asset prices.

2.10 Understanding this difference between a traditional valuation and an economic valuation is fundamental to the sections which follow.

2.11 It is sometimes suggested that these two valuation approaches can be used interchangeably. In reality they perform distinctly separate roles, and some basic financial parameters require subtly different interpretation. For example, since expected returns on new money have no real role in valuations within financial economics (as described below), a modification of the financial economic approach for setting a contribution rate, by allowing for anticipated returns on a 'fund', requires care in presentation. Equally, the returns in a traditional valuation are supposed to reflect returns on actual assets held, so use of expected returns on notional matching portfolios can also be somewhat confusing. The main difficulties which lie ahead in any discussion of pension fund valuations and market values are thus largely concerned with disentangling attempts to merge the distinct approach of the traditional valuation and the financial economics approach of market pricing. We defer discussion of various merged approaches to later sections.

3. The Historical Development of the Traditional Valuation Method

3.1 In this section we examine the background to, and historical development of, the traditional methods used in pension fund valuations. The purpose of this is to explain how and why current practice developed, before moving on, in Section 4, to look at the factors which are now causing many actuaries to consider departing from the traditional approach.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

3.2 *Actuarial Valuation of Pension Fund Liabilities*

3.2.1 Up until the 1970s pension fund valuations were primarily concerned with setting a contribution rate. This was frequently determined by the aggregate funding method, as the value of all future liabilities less the value of assets spread over the future lifetime of the fund. The entry age method was also in common usage, though the recommended contribution rate also involved quantification of both the above values.

3.2.2 As discussed in the previous section, in order to establish a contribution rate some assumption is required as to the return on investments, and this is traditionally dealt with by accumulating or discounting liabilities expected at future times to a single date, using an assumed return on assets. This naturally led to the publishing of a figure representing the 'present value' of scheme liabilities. Whilst this was actually only a mechanical calculation on a subjective set of assumptions, it did come to be viewed as the actuary's estimate of the value of the scheme's liabilities in its widest sense.

3.2.3 The textbook by Lee (1986) showed that, in order for the result to be the same regardless of the chosen date for discounting values, it was necessary that the valuation rate of interest should be equal to the average rate of interest at which existing assets and future contributions were assumed to be invested in future. If a different discount rate was chosen, then, even if experience was exactly as expected, the derived contributions would accumulate over time to an amount that was different to that of benefits paid. The long-term rate of interest was, therefore, an amalgam of *current* investment returns available in the market and *future* unknown investment returns. The crucial point is again that, in order to derive a contribution rate, the actuary was required to make an assumption about future long-term investment returns.

3.2.4 Lee's work was by no means original in this respect. Earlier textbooks by Porteus (1946) and Crabbe & Poyser (1953) reached the same conclusion. The contemporary practice for combining the *current* and *future* investment return assumptions into one valuation rate of interest was to weight the two components respectively by the size of the existing fund versus the annual sums to be invested in the future. As most schemes were immature, most attention was focused on the latter rather than on the former.

3.2.5 Earlier, Puckridge (1947) had advocated a simpler approach for the valuation rate of interest, i.e. to consider only the long-term rate of interest that could be earned on *future* investments. The key proviso for this simplification is that assets have to be brought into the balance sheet by discounting *future* income, regardless of whether this is derived from existing assets or new assets held in the future, at the same rate of interest. Since the concept of discounting income from assets had not been developed, Puckridge initially received little support for his work. Only when more attention was focused on the actuarial valuation of pension fund assets did his work receive wider acceptance.

3.2.6 The process of determining the numerical value for the long-term valuation rate of interest developed by observing stable historic differences

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

between investment returns and price inflation. In the early twentieth century it was not necessary to fix an assumption for price inflation, since this was assumed to be neatly offset by the growth in liabilities through pay escalation and pension increases. As Lee said, even as U.K. economic conditions became less stable in the second half on the twentieth century, the financial stability of pension schemes showed some resilience. Taking one year with another, investment performance in excess of the assumed real return of 3% or 4% helped to cover the additional liabilities arising from pay increases greater than expected and to provide resources from which discretionary pension increases could be granted.

3.3 *Actuarial Valuation of Pension Fund Assets*

3.3.1 The assessment of pension fund liabilities using a long-term return on assets to discount the expected cash flows, therefore, received a good deal of attention in earlier literature. Until the 1960s, however, the assessment of the value of assets to input into the contribution rate calculation had not. At that time it was still conventional to value assets at book value (or market value if less). Book values are merely an accounting measure to value individual investments according to the date of their purchase. This produces the odd result that identical investments are attributed different values in the same scheme depending on when they were purchased.

3.3.2 It was this fact that led Day & McKelvey (1964), following the earlier work of Heywood & Lander (1961), to develop their dividend discount model for valuing equity assets. This is confirmed by K. J. McKelvey, the author's son, who recalled why his father developed an off-market valuation basis for assets:

> ".. the sole objective of that 1964 paper was to find a consistent basis for valuing assets, given an existing methodology for valuing liabilities. The liability valuation basis was off-market, by convention, at that time. Therefore, the asset valuation inevitably became off- market. The main aim of the authors was to move away from the valuation of assets by book value, which was still common. They simply did not think about market values since most pension schemes were new and immature and there were no formal discontinuance tests and the like".

3.3.3 Indeed, references in the paper to market values were generally limited to explaining their inappropriateness when compared with an actuarially assessed value of liabilities. In the ensuing discussion of the paper, only one person, Mr J. Plymen, considered the idea of a consistent market-related valuation of both assets and liabilities. In today's context, his comments are most interesting. To quote from the *Journal*:

> "Mr J. Plymen felt that the impression was getting around that there was something quite immoral in valuing assets at market values, whereas an elaborate valuation process...that produced a figure [of assets] 20% higher than the market value was perfectly respectable! He felt that that was tackling the problem from the wrong end. It was traditional that with a life office valuation a decision was taken on the rate of interest for the valuation of the liabilities and that was that. The authors were taking the same line with a pension fund valuation. They were assuming a certain figure for the rate of interest for valuing the liabilities, and twisting the valuation of the assets round to be consistent with that basis. Why not start off with the

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

market value of the assets and try to deduce from that basis a consistent system for valuing the liabilities?"

3.3.4 Nevertheless, Day & McKelvey's work was such an improvement on what had existed before that it became the widely accepted funding methodology by nearly all U.K. pension fund actuaries. Perhaps its worth was most appreciated following the 1974/75 Stock Market collapse. The fact that assessed values were being used to measure assets meant that plan sponsors were not suddenly required to increase the contribution rate into their pension schemes. It was this implicit smoothing mechanism that helped to make the methodology so popular.

3.4 *Consistency*

3.4.1 The historical development of valuing U.K. pension fund assets and liabilities led to the concept of 'consistency' within actuarial pension fund work. What most actuaries mean by this is that the unit of currency is the same on both sides of the balance sheet. The concept arises because our historical development provides us with a choice in presenting valuation results: either

(a) an actuarially assessed value of assets compared with an actuarially assessed value of liabilities; or
(b) market value of assets compared with a market-related value of liabilities.

3.4.2 The U.K. actuarial approach has developed along the lines of (a), with significant interest only being placed on (b) within recent years. Had we not developed the off-market valuation approach in (a), then this consistent currency concept would not have risen to such axiomatic prominence.

3.5 *Adoption of Accrued Benefits Funding Methods*

3.5.1 The funding methods widely used in Day & McKelvey's era are examples of prospective benefits funding methods. These methods generate a contribution rate, firstly by evaluating total service benefits, rather than a deliberate separation of past and future service liabilities. In the case of the aggregate method, past service surpluses or deficits are implicitly spread over the average remaining working lifetime of active members.

3.5.2 In the last thirty years the rising maturity of pension schemes has increased the importance of past service values. Today the projected unit method dominates pension scheme funding, and, as an example of an accrued benefits funding method, specifically focuses on the quantification of past service liabilities. The reason for this is that, prior to the introduction of the Minimum Funding Requirement, the ongoing funding level became known as the prime measure of the financial security of members' accrued benefit expectations.

3.5.3 The shift towards accrued benefit funding methods is one example of how pension fund valuations have changed over the last thirty years. Further drivers for change are considered in Section 4.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

4. DRIVERS FOR CHANGE

4.1 *Success to Date*

4.1.1 The traditional approach (i.e. whereby an assessed value of assets is compared against a value of liabilities determined using a long-term rate of return) has succeeded in meeting the following objectives over the last thirty years or so:

— acceptably smooth past service funding levels, reducing the volatility in the market value of U.K. equity assets;
— acceptably smooth and stable future service contribution rates; and
— presentational credibility, with general acceptance of the underlying theory by the various parties traditionally involved.

4.1.2 However, the conditions during which these objectives have been met are characterised by:

— stable dividend policy by U.K. companies;
— two major periods of market volatility (a sharp dip in 1974 and a sharp spike in 1987), which enhanced the credibility of the approach;
— the success of a U.K. equity biased investment strategy;
— high levels of discontinuance solvency arising from greater pre-funding of discretionary benefits and lower early leaver entitlements than is the case today;
— a relatively low level of concern about the risks inherent in different investment strategies among trustees and company representatives traditionally involved in pensions management;
— even after the introduction of SSAP 24, significant flexibility in the way valuation results are presented by company management in financial statements; and
— a requirement for trustees to monitor the funding position of their scheme only once every three years.

4.1.3 In this section we first consider, in turn, the three features of the traditional method which have, in our opinion, defined its past success, and discuss the forces which are currently casting doubt on its future. Finally, we address some of the key external forces for change.

4.2 *Smoothness of Funding Levels*

4.2.1 As noted above, one of the major features of the traditional approach is that it smoothes out short-term fluctuations in market values. This effect can be seen in Figure 4.1.

4.2.2 This smoothness arises from the historic stability of U.K. dividends. This historic effect is not in question. If a smooth series is divided by a constant yield, then the result is an equally smooth series of actuarial values, provided that the assets are invested in the U.K. equities which underlie this calculation.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

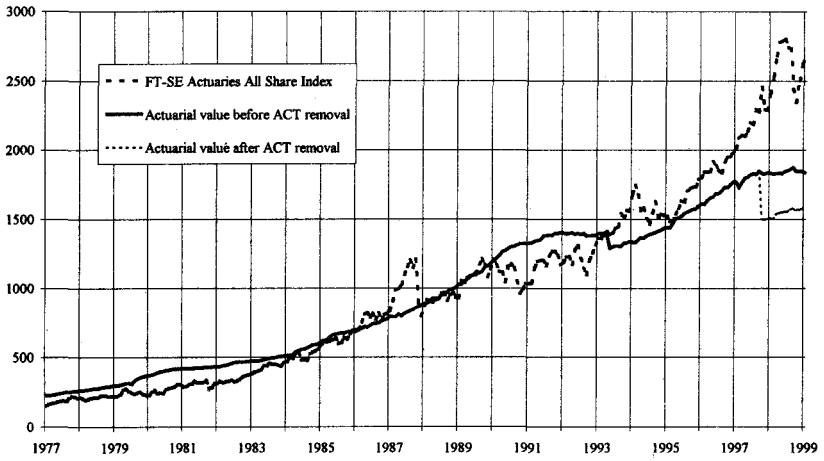

Figure 4.1. Market value vs actuarial value

4.2.3 The long-term smoothness of the method applied in this way to U.K. equity investment will only be threatened if dividend payments become more volatile in the U.K. Step changes in taxation aside, the main driver here would be a change in the attitude of U.K. company management towards dividends.

4.2.4 It has been common, historically in the U.K., for company management to see dividend stability (and growth) as a business objective. Thus, dividends may have been paid even when capital was being raised, and shareholder funds may have been retained even when no immediate investment opportunities presented themselves. This has been an important factor in the historic stability of U.K. dividends, and hence the smoothness of asset values under the traditional method. In the U.S.A., by contrast, it is more commonplace for companies to distribute funds to shareholders only when all the investment opportunities have been utilised, and, on the other hand, to make large repayments (typically through share buy backs) rather than retain shareholder funds. Under this U.S. model, which is more consistent with the modern business objective of enhancing shareholder value, dividend series are, therefore, far less stable. There is some evidence emerging for changes in U.K. payment patterns.

4.2.5 Another feature, particularly relevant to the MFR, is the dependence of this smoothing process upon the choice of notional portfolio. The traditional approach gives smoothness only if the notional asset portfolio is closely linked to the actual assets held. In reality, most schemes have historically used a notional portfolio which assumed a relatively high U.K. equity content, whilst the scheme has, perhaps, only held around 60% of its assets in U.K. equities. The effect of this is to create more volatile past service funding ratios than would be anticipated if the notional and actual portfolios coincided. The best example of

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

Figure 4.2. Market value vs smoothed market value

this is to consider a major correction in U.K. equities (e.g. October 1987) when, instead of protecting the scheme's funding position, the effect of using the typical traditional valuation basis assuming 100% investment in U.K. equities would have been to increase the funding ratio. More recently, divergence between U.K. and overseas equity returns has led to some instability in MFR calculations based on U.K. equity notional funds. One solution is to move the notional portfolio closer to the actual assets being held by the scheme. However, as schemes invest more in overseas asset classes, where yields are perhaps more volatile and reliable statistics are harder to find, this notional portfolio problem becomes harder to solve, and attempts to apply the traditional method to such assets appear to have been unsuccessful.

4.3 *Smoothness of Future Service Contribution Rates*

4.3.1 Future service contribution rates under the traditional method appear to be smooth, since the same long-term investment assumptions are applied at each valuation, therefore contribution rates change only with changes in demographics and benefits. By contrast, significant volatility would be introduced by any changes to long-term investment assumptions, due to the long duration of new accrual.

4.3.2 However, even if long-term investment assumptions are kept constant over time (and, in practice, this may be unlikely), this stability actually arises from an inconsistency in the traditional method. This inconsistency is revealed, for example, if we consider an immature scheme when actuarial values are above market values, and where the employer pays the contributions recommended by the actuary. We find that surplus emerges even if all the actuary's assumptions

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

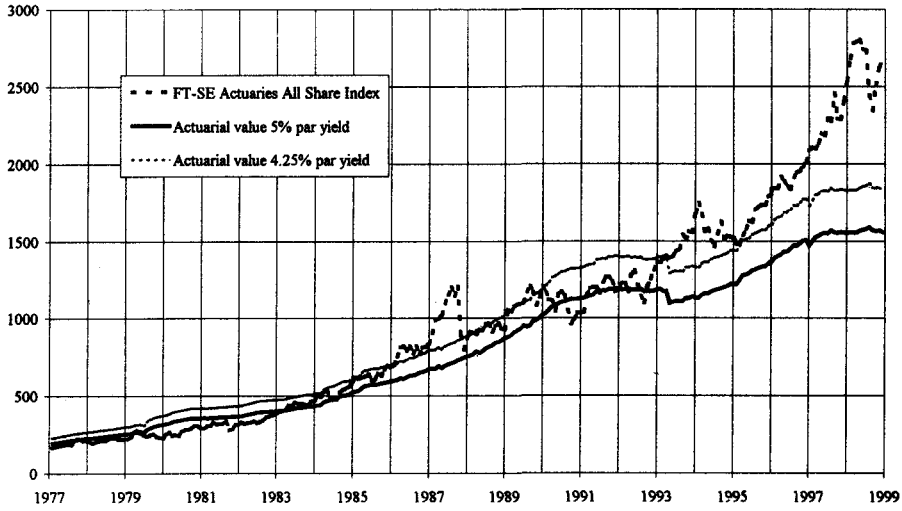

Figure 4.3. Market value vs actuarial value; impact of changing par yield

were borne out in practice. This effect arises, of course, because consistent application of the traditional method would also apply the asset adjustment to the derived contribution rate — thus producing lower contributions in this case. Ironically though, applying the traditional method consistently in this way can result in a highly volatile overall contribution rate, which negates the efforts made to smooth the other components in the calculation.

4.4 *Credibility*

4.4.1 If we return to Figure 4.1, we note that, although the historic smoothness of U.K. dividends (step changes in tax aside) is not in doubt, the vertical positioning of the dashed line is entirely dependent on the choice of divisor. If the constant average yield is increased by 25% (from 4% to 5%, say), then all values reduce by 20%.

4.4.2 Dyson & Exley (1995) pointed out that an equally smooth (or smoother or less smooth, if required) series of values could be obtained by any explicit smoothing technique. The solid line in Figure 4.2 shows one particular method, their geometric method. The credibility underlying the explanation of the traditional approach, when compared with an arbitrary choice of smoothing method, hinges on a supposition that dividend yields will revert to a single long-term average yield over time.

4.4.3 There have been historical events which appear to support this 'mean reversion' effect, most notably in 1974 and 1987. However, there also appear to be secular trends in dividend yields, which make the long-term average itself difficult to establish going forward (although easy to establish with hindsight).

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

4.4.4 A secular change in dividend yields can leave the traditional method generating values constantly well below (or well above) market values. Figure 4.3 illustrates this. This shows the traditional method based on the long-term yield of 5% which was prevalent in the early 1980s. Arbitrary step changes are required in the assumed long-term yield to address this, and experience of such changes has been one factor undermining the traditional approach used for the MFR.

4.4.5 The choice of long-term dividend yield is therefore important to the presentational credibility of the traditional method. This explains why the removal of the ACT tax credit enjoyed by pension schemes on U.K. equity dividends acted as such a catalyst for reappraisal. As a consequence of the change, it is expected that companies will follow the U.S. example of using other more tax efficient means (such as share buy backs) to return funds to shareholders (this trend was, in fact, already under way before the 1997 Budget). This makes the appropriate long run average equity yield difficult to predict with credibility. Without credibility in this number, assessed asset values could be placed in a wide range, depending on how future investment returns are assumed to be divided between income yields and dividend growth.

4.4.6 It has often been argued that there is a stable relationship between dividend growth and salary inflation. If a strong and stable link existed between these two factors, then, for example, errors in the assumed rate of dividend growth would be offset by errors in the assumed rate of salary growth. Without this link, valuation results are highly sensitive to the assumed division between equity income yield and growth. A number of papers (for example, Dyson & Exley, 1995; Exley, Mehta & Smith, 1997; Smith, 1998) have directly challenged the existence of this link between equities and salary-related liabilities, and argued that the statistical evidence for any such link is very weak.

4.5 *External Forces*

4.5.1 Finally, there have been three main external forces challenging the use of traditional actuarial valuation methods in recent years.

4.5.2 There is a growing understanding and appreciation within the actuarial and accounting profession of the key principles of financial economics. Furthermore, these principles are increasingly taught in management schools, thereby increasing potential client exposure to the concepts. This theme is advanced in Exley, Mehta & Smith (1997), which goes on to explain how, in many applications, market values are the right measure to use from the shareholder's perspective, even if markets themselves are inefficient and market values do not reflect rational expectations. However, this approach can lead to conflict between the desires of shareholders for transparent and objective valuation methods and the interests of other stakeholders. Management of this conflict represents a challenge for any valuation method.

4.5.3 Some of the key principles of financial economics are explained in Section 5. This goes on to discuss some of the practical issues surrounding their application to pension liabilities.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

4.5.4 Secondly, the Government imposed a Minimum Funding Requirement (MFR), with effect from April 1997 (subject to transitional arrangements). The existence of an MFR introduces short-term funding considerations, since a drop in a scheme's MFR funding level can result in the employer having to pay in significant contributions at short notice. This has led to a desire by trustees and employers to gain a greater understanding of the factors affecting a scheme's financial position. Since the majority of active and deferred pensioner liabilities are effectively valued using the traditional method (linked to U.K. equity yields), this has focused clients' attention on many of the issues described above.

4.5.5 Finally, the new international accounting standard, IAS 19, uses market-based methods, and this has prompted the U.K.'s Accounting Standards Board (ASB) to consider market related methods for the revision of SSAP 24. This move again appears to be motivated by the desire for transparency, conflicting with the smoothing sought from the traditional method, which potentially removes a lot of information regarding short-term effects on the financial position of the scheme. This may be an important consideration in the disclosure of information gained from a valuation, since smoothing is a one-way process. Armed with an unsmoothed series of results, it is possible for the recipient to create a smoothed series, but the reverse does not necessarily apply.

5. Financial Economics

5.1 *Market Price*

5.1.1 Financial economics is the study of the market pricing of Stock Exchange securities and other financial instruments. It is a body of theories which seek to explain the market price of financial instruments, the interrelationships between market prices and the development of market prices over time. The subject has mostly developed during the last 30 years; it underpins the modern business approach to shareholder value and the explosive development of the derivatives markets.

5.1.2 Only a few years ago the legislative framework of U.K. pension funds was such that market pricing of pension fund assets was of relatively minor importance. Trustees, sponsoring company and Scheme Actuary were all looking primarily at funding issues, particularly the setting and reviewing of contribution rates. Market price fluctuations were not regarded as important, except for the (usually undemanding) solvency checks. Now, the framework has changed and the market value of the assets is a much more important consideration, via annuity buyout costs, MFR, etc. It has, therefore, become more relevant to understand the principles of market pricing, insofar as these may affect the liabilities as well as the assets.

5.1.3 The relevance of market price, as distinct from any other assessment of value, is that it provides a common agreed measurement of value irrespective of the views and positions of market participants. In principle, the market price of a

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

traded asset is settled on the basis of the maximum information about that asset which is available to all market participants.

5.1.4 Market pricing of financial assets has continued to develop in both breadth and depth. We now have index-linked bonds, gilt strips and highly liquid markets in stock options and futures, none of which existed 30 years ago.

5.1.5 Like any other body of science, the theories of financial economics are an attempt to explain relevant aspects of what we observe in the real world. As with any theory, the starting point is a collection of basic axioms which are deemed to be self-evident and true. The theory is deduced by logical reasoning on the basis of the stated axioms, and the theory is then tested against real life observations. If the fit is good, the theory is good. If the fit between theory and reality is less good, sometimes it is necessary to go back to fundamentals and adjust one or more of the axioms. The axioms of financial economics have been exposed to scrutiny from academics and practitioners over the last thirty years, and the basic principles have gained wide, though not universal, acceptance.

5.2 *The No Arbitrage Principle*

5.2.1 To illustrate the economic foundations, let us hypothecate that those people determining prices through their trading activities are financially rational and wish not to give up or to lose money in the absence of any compensating advantage to themselves. Assume, also, that these market participants are competing for the same stock of assets at any point in time. Then nobody is going to be able to get something for no risk or effort, because that can only be achieved at someone else's expense. This is the principle of 'no free lunch' or, in financial parlance, the principle of 'no arbitrage'. This principle can immediately be applied to the valuation of a pension, the future instalments of which can be exactly cash flow matched by an appropriate bond portfolio. According to the principle of no arbitrage, the market value of the pension must be exactly the same as the market value of the matching bond portfolio. To see this in elementary steps, let the market value of the asset portfolio be denoted by A and the corresponding value of the pension liability be L. If both the asset and the liability are tradeable, then we can apply the following reasoning.

5.2.2 Suppose first that L is greater than A. Any participant in the market can then acquire the liability, for which they will be paid a cash sum L, and can acquire the matching portfolio, for which they must pay the market price A. The cash flows from the asset portfolio will exactly match the payments due on the pension, so the net financial position of the participant is unaffected, apart from making a guaranteed 'free lunch' gain of L minus A. This is contrary to our axiom that other market participants are willing to lose money in order to allow this free lunch, so it cannot be true that L is greater than A.

5.2.3 Conversely, suppose that L is less than A. Consider an institution which has the liability to pay this pension, and suppose that, within its total asset portfolio, it arranges that a sub-portfolio with a value A is invested in the matching bond portfolio. Then the financial position of the institution is

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

unchanged if it buys out the pension at price L and sells the asset at price A, and yet it gains a 'free lunch' profit of A minus L from the deal. Consequently L cannot be less than A either. The only logical conclusion is that L and A must be equal.

5.2.4 The principle of no arbitrage is the most powerful principle of financial economics. The simple and inescapable logic of the argument means that, even if the bonds are considered by some to be overpriced by reference to a subjective long-term criterion of value, then the market price of the corresponding pension must be correspondingly high. There is no room for subjective judgement where market pricing holds sway.

5.3 *Valuation of Liabilities*

5.3.1 Inspection of finance theory textbooks would suggest that finance theory is mostly concerned with market valuation of assets, not liabilities, but the emphasis in the textbooks on asset pricing is merely a reflection of the fact that many assets are widely traded, whilst most liabilities, other than financial instruments, are not. It should not be concluded that finance theory has little or nothing to say about liability valuation. The same principles which apply to asset pricing can be applied to liabilities as well, but with some differences to bear in mind.

5.3.2 We have already noted the fundamental principle of no arbitrage, and have shown how this assigns a market price to liabilities which can be cash flow matched by a portfolio of assets. Exley, Mehta & Smith (1997) pointed out that this principle can be extended to further classes of liability by using the principle of dynamic hedging. This is the principle which has been successfully applied in option pricing (via the Black Scholes option pricing formula), and which is based on the idea that the matching (or hedging) portfolio is varied in time, so that, at any instant of time, the asset/liability net position is immunised against changes in financial conditions during an arbitrarily short time interval. However, any such attempt to price liabilities is dependent on the model which is used for the pattern of short-term financial behaviour of the markets. The Black Scholes formula has been modified for practical use in option pricing over the years, because short-term stock market price movements do not behave exactly like the investment model which underlies the original formula. It is, therefore, necessary to design models which are appropriate to value liabilities, to test the predictions of the models against observed market prices (where such prices can be observed in a market) and to refine the underlying model as appropriate. For example, in the case of final salary pensions, the simplest model for future salary increases is price inflation plus a fixed margin of, say, 1.5% p.a. This would enable a suitably chosen index-linked bond portfolio to provide reasonably good cash flow matching to expected future salary increases, thus enabling the no-arbitrage principle to assign a market price to those liabilities; but is it reasonable to assume a fixed margin over price inflation, or should the model be refined? What happens to the margin when GDP growth accelerates or declines, or when interest

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

rates rise or fall? More sophisticated models can be devised to tackle such questions; an example of this, in relation to future salary increases, is given by Smith (1998).

5.4 *Liability Risk*

5.4.1 Another principle of financial economics is based on the distinction between systematic and diversifiable risk. The textbooks usually explain the difference in terms of share prices, but we can do so in terms of mortality. In relation to any single person, there is usually much uncertainty about the year in which that person will die; but, to a large extent, the risk is diversifiable, because the uncertainty can be greatly reduced by looking at a large cohort of individuals in similar circumstances of age, sex, etc. That fundamental principle of life assurance is equivalent to the more general principle of financial economics, that the price to be associated with diversifiable risk is nil. This is easily demonstrated in the case of mortality. Suppose we are looking at £20,000 whole life assurance contracts for males aged 40. Suppose that a fair market price for a pure single premium payment to meet the liability is £3,300, and that this includes £300 for the price of the mortality risk. Then, leaving aside the separate matter of the costs of doing insurance business, an insurer can gather together a large cohort of similar contracts for 40-year-old males, can charge the pure net premium of £3,300 and can then pocket the 'free lunch' profit of £300 per policy, on the grounds that the mortality risk mostly disappears for a large enough group of policies. This is a breach of the no-arbitrage principle, which shows that there cannot be a material price attaching to the diversifiable mortality risk.

5.4.2 On the other hand, there is a systematic risk in mortality as well, because nobody knows whether, in future years, people will live shorter or longer lives than are predicted on the basis of current observed mortality rates. This longevity risk is the systematic or non-diversifiable risk, for which there is a price to be paid. In financial economics asset prices are effectively marked down by the price of systematic risk within the asset. The parallel for liability valuation is that values must be marked up by the price of systematic risk.

5.4.3 It is often observed that the cost of buying out pensions with insured annuities is more expensive than the reserving basis which is used by pension Scheme Actuaries. Part of the difference can be traced to differences in mortality rates, where insurance companies typically make a larger allowance for future mortality improvement than is normal in actuarial valuations. At least part of the difference in mortality assumptions may be attributable to an appropriate allowance being made by the insurance company for systematic longevity risk.

5.4.4 Another potentially important area of uncertainty is credit risk — or the degree of security attaching to a pension promise. The issue here (which comes up in discussion of reviewing the MFR) is whether a promise of a company pension should be regarded as providing the same degree of security as an insured pension, or whether a lesser degree of security is appropriate, and, if so,

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

how much. In financial economics credit risk has a price, and so the value to be assigned to a pension must depend on the degree of security which is assigned to it. Thus, the degree of security needs to be defined before it is possible to place an economic value on the pension.

5.5 *Actuarial Values versus Market Prices*

5.5.1 The traditional actuarial valuation is based on a single deterministic set of assumption parameters which are designed to apply both to asset and liability valuations. Projected cash flows are discounted at a suitably chosen discount rate. In the traditional presentation of a pension fund valuation, assets do not appear at market value and the liability value is not adjusted to market either.

5.5.2 In complete contrast to this, the market value of a portfolio of assets is the result of the balance between supply and demand for the relevant assets at a point in time. Whilst individual market participants may make their own assumptions and judgements about the assets, the market price represents a 'democratic financial decision', which, actually, is not driven by any particular set of assumptions at all. Of course, it is usually possible to derive a model and assumptions which justify that market price, which leads to language about the market taking a view on something. Whether the market really does have a view is, perhaps, a matter of opinion and semantics.

5.5.3 In principle, a pure application of financial economics to the valuation of liabilities would lead to a 'market price' of the liabilities which is similarly derived from market price information, without any individual or subjective assumptions or judgements. In practice, matters are not so clear-cut, because of the nature of typical U.K. pension schemes. There are aspects of systematic risk within pension schemes which cannot be priced from the market very well, if at all. Examples of this are the extent to which future real salary growth net of price inflation will vary according to changing economic conditions, and demographic factors such as unknown future rates of withdrawal from service, early retirement, etc. The market does not readily supply prices for all these risk factors.

5.5.4 In the absence of a true traded market in final salary pensions, or in their various risk factors, it cannot be said that there is a uniquely correct market price to be associated with any given pension liability. Instead, financial economics offers a methodology for establishing an economic valuation, or a 'market consistent' valuation, as termed by Gordon (1999). This denotes a valuation which is consistent with the feasible range of market prices, if a true market were actually to exist.

5.5.5 The concept of a price range is entirely normal within asset pricing generally. The same concept must be applied to some types of liability. In the absence of trading, and without any matching assets, there is scope for judgement to be applied in certain liability valuation models and parameters within the market consistent framework. This notion is consistent with the degree of uncertainty that exists in some of the parameters underlying the pension promise.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

5.6 *Summary*

In conclusion, financial economics is a body of theoretical analysis with application to the valuation of pension liabilities. In the absence of a market in pension liabilities, the application of financial economics principles leads, not to a uniquely correct market price, but to a range of reasonable possibilities. However, the opportunity is provided for a more explicit and transparent approach to setting assumptions and applying judgement when required.

6. Valuation Methods Considered

6.1 *Introduction*

6.1.1 The Working Party took the view that valuation methods which take assets at market value can be broadly grouped under four headings, although there could be variants within each one. In this section we describe each of these methods, numbering them 1 to 4. We then move on to analyse their properties in Sections 8 and 9. Appendix A sets out the methods algebraically, together with a practical example of the application of each method using market information as at 31 December 1998.

6.1.2 In each case we have described how the economic elements of the valuation basis are determined. These are used to calculate the past service value of liabilities, which is compared with the market value of assets. There is also the question of the future contribution rate. Throughout this paper we have adopted the approach that the future contribution rate is calculated using the same assumptions as the past service value of liabilities, giving a contribution rate in market value terms. It would be possible to adopt a hybrid approach of employing different methods for past and future service.

6.1.3 For comparison, we have also analysed the behaviour of what we call the traditional approach to an actuarial valuation, which we have termed Method 0.

6.2 *Method 0 (Traditional Method)*

6.2.1 This values both assets and liabilities using a discounted cash flow approach. The assessed value of assets represents the discounted present value of the expected income and capital proceeds from the scheme's assets, usually expressed in the form of a market value adjustment (MVA) to those assets.

6.2.2 The MVA can be based on the proportions of assets actually held in each asset class, or alternatively based on a notional distribution of assets. Furthermore, it is common for most asset classes to be notionally invested in a representative index (e.g. U.K. equities valued as if invested in the FTSE Actuaries All-Share Index).

6.3 *Method 1 (Market Value Adjustment (MVA) Approach)*

6.3.1 This method is the most closely related to the traditional discounted

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

cash flow approach, and provides a common way of arriving at individual or bulk transfer payments, for which a market value of liabilities is required at a relevant date.

6.3.2 The method takes the MVA (traditionally applied to the assets), and applies the inverse to the discounted value of the liabilities to give a market-adjusted value.

6.3.3 In this paper we have examined what we term Method 1, where the MVA is based on the actual proportion held in each asset class, and Method 1a, where the MVA is based on a notional portfolio which is intended to match the liability profile to some extent.

6.4 *Method 2 (Asset-Based Discount Rate)*

6.4.1 Under this method the market reference is made directly via the discount rate. We first derive an implied market discount rate for each asset class. For example, for gilt investments this is simply the gross redemption yield. For equity investments this involves determining the discount rate implied by the current market price and expected dividend and/or sale proceeds.

6.4.2 The overall valuation discount rate is then determined as a weighted average of these individual discount rates, based on the proportions invested in each asset class.

6.4.3 Different investment portfolios can be used to derive the discount rate applicable to the liabilities. Thus, this method could be based on the actual investment portfolio (say Method 2) or on a notional portfolio intended to match the liabilities (say Method 2a).

6.5 *Method 3 (Economic Valuation using Bond Yields)*

6.5.1 This is the method derived from financial economics. The inflation rate, discount rate and related assumptions are derived directly from market information.

6.5.2 At its simplest, the discount rate is taken as the gross redemption yield on a portfolio of conventional gilts with appropriate duration and convexity. The market inflation rate is derived by taking the difference between the yields on suitable portfolios of fixed-interest and index-linked gilts. The discount rate so derived is then used to value the liabilities.

6.5.3 The method described above makes use of a portfolio of assets, which leaves the minimum amount of risk with the fund sponsor as the liabilities are run off. Risks for which there is no obvious matching asset include salary growth in excess of price inflation, interest rates for very-long-term liabilities and demographic risks. For current pensioners with fixed pension increases the portfolio is made up of a suitable range of conventional gilts which match, precisely, the expected future pension payments. The only non-hedgeable risk is then systematic mortality risk. At the other end of the spectrum we have active members. Here the minimum risk portfolio is less clear.

6.5.4 Greater sophistication can be achieved in an economic valuation by consideration of the following:

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

— replacing the constant interest rate assumption with rates which vary according to the term to each liability payment. (for example, see Feldman *et al.*, 1998);
— use of discount rates based on yields on corporate debt, which therefore makes allowance for credit risk;
— valuation of caps and collars on pension escalation (e.g. Smith, 1998); and
— valuation of salary increases (e.g. Smith, 1998).

6.6 *Method 4 (Bond Yields plus Risk Premium)*

6.6.1 This method starts with the Method 3 discount rate (based on bond yields), but then adjusts it to take account of returns expected from other asset classes (e.g. equities).

6.6.2 This is done by adjusting (usually increasing) the discount rate by the addition of either a constant or a variable risk premium.

6.6.3 If a constant risk premium is used, the properties of this method are the same as Method 3, except that, effectively, the funding target is (usually) lower.

6.6.4 The more common approach is to introduce a variable risk premium. In reality this would be derived by a combination of market information and actuarial judgement. However, actuarial judgement is impossible to model accurately. We have, therefore, derived a formula which, by adjusting the discount rate to take account of market conditions, aims to maximise short-term stability in funding levels. This gives us an indication of how discount rates might be set if the aim is to achieve this stability. The derivation of this formula is set out in Appendix B. It must be emphasised that this is essentially a smoothing method. It is not possible to say what an actuary would advise under particular future market conditions, so the formula is a simplification.

6.7 *Smoothing*

Any method may be modified through use of a smoothing mechanism, either smoothing asset and liability values themselves or, for example, the resulting contribution rate. There are numerous methods of smoothing, and we do not propose to review these here. With any method of smoothing, care needs to be taken to ensure that the assumptions used for valuing the liabilities are consistent with the value placed on assets.

6.8 *Other Issues*

6.8.1 It is common for U.K. pension schemes to have a higher weighting in equity investment than might be deemed the matching portfolio. The use of prudent assumptions for future returns on equities would introduce, in effect, an implicit mismatching reserve under any of Methods 0, 1, 2 or 4, and this has often been the case where these methods have been used. It would, of course, be possible to allow for a mismatching reserve explicitly in conjunction with Method 3.

6.8.2 Many schemes have benefits which are not always fully defined

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

(typically if there is an element of employer's discretion). These uncertainties could be modelled directly into the calculation process, or allowed for by an adjustment to the discount rate. Given the wide range of possibilities, we have not addressed this point further in this paper.

6.8.3 We have not reviewed international methods, such as FAS 87 or the German book reserve model, though the principles underlying the liability valuation in FAS 87 could be regarded as Method 3.

6.8.4 The above methods are analysed further in Section 8.

7. Criteria for Comparing Valuation Methods

7.1 *Introduction*

7.1.1 We now have five valuation methods to compare, i.e. the traditional assessed value approach, referred to as Method 0, and four other approaches detailed in the previous section, which take assets at market value.

7.1.2 In order to compare these methods, it is necessary to construct a common set of criteria against which these methods may be judged. Rather than refer to them as criteria, however, the Working Party settled on the word 'properties'. This enabled the Working Party to refer to a particular method as either featuring, or not featuring, a specified property, without necessarily commenting on whether that property was a desirable or undesirable outcome.

7.1.3 These properties are explained individually in Section 7.3. The various purposes for which actuarial valuations are carried out were described in Section 2. Below we also cover the various types of users of those actuarial valuations.

7.2 *Users of Actuarial Valuations*

7.2.1 The following users have a legitimate interest in one or more of the above valuation types.

7.2.1.1 *Trustees*

In general their objective is to protect the members' interests. To this end, they certainly seek sufficiency of assets and will monitor the various measures of funding described in Section 2. In addition, they will be conscious of the MFR requirements governed by Opra, implying a floor to funding. On the other hand, a ceiling is imposed by the excessive surplus legislation controlled by the Inland Revenue. Finally, they will also be interested in the effect of transactions, whether transfer values or other special payments.

7.2.1.2 *Sponsoring employers*

Traditionally, their normal objective has been to ensure that the pension fund is adequately, but not excessively, funded. Generally, they wish to use capital for their business rather than 'park' assets in pension funds over which they do not have control. For this reason they will normally wish to minimise contribution

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

inputs to the scheme. In some cases an additional objective would be to make sure that any bulk transfer of pension liabilities, agreed as part of a corporate transaction, is likely to be covered by the assets received. Finally, the employer's financial results will depend on the pension expenses determined by the accounting provisions.

7.2.1.3 *Members*

Historically, members have relied upon the trustees to safeguard their interests. In general, members who are not trustees will not be as well informed as the trustees in terms of monitoring particular measures. However, it may reasonably be assumed that the members' objectives are, or should be, the same as those of the trustees.

7.2.1.4 *Opra*

Since April 1997 Opra have been charged with ensuring compliance with the requirements introduced by the Pensions Act 1995, including the MFR. The MFR sets a 'line in the sand', below which the asset values should not fall, having regard to the liability profile of each scheme.

7.2.1.5 *Inland Revenue*

Via the Pension Schemes Office (PSO), the Inland Revenue monitors tax relief on scheme contributions and investment proceeds. In order that the provision of tax relief is not abused, an excessive surplus test is carried out as part of each triennial valuation. This test is carried out using a conservative set of assumptions (set out in regulations) in order to be confident that any surplus assets revealed really are surplus to requirements.

7.2.1.6 *Accounting bodies*

They will wish to ensure that company accounts contain a true and fair reflection of the cost of accruing pension liabilities in accordance with the relevant accounting standard (currently undergoing some revision in the U.K.).

7.2.1.7 *Investors (and related parties)*

Active and prospective shareholders will normally rely on the accountants to check that pension expenses have been reported fairly. Other related parties include sponsors (e.g. merchant banks) of corporate new issues and the Stock Exchange. The latter has been active in the area of reporting on directors' pension arrangements following the Greenbury Report.

7.3 *Properties used to compare Valuation Methods*

7.3.1 In this section we describe the properties, or criteria, used to compare the different valuation methods referred to in Section 6.

7.3.1.1 *Consistency*

The relevance of consistency has already been discussed in Section 3.4. Here

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

we consider consistency at two levels. Firstly, we consider whether assets and liabilities are included in the balance sheet at the same 'currency': either market values or assessed values. At the second level, we consider whether past service values are consistent with future service contribution payments.

7.3.1.2 *Simplicity*

This refers to the simplicity of determining the valuation assumptions and performing the necessary calculations.

7.3.1.3 *Durability*

Durability represents the ability of a valuation method to withstand sudden 'shocks'. Two examples of a sudden shock are changes to U.K. taxation policy and changes in the way shareholder value is rewarded.

7.3.1.4 *Objectivity*

This refers to the degree to which a valuation method requires subjective assumption setting from an actuary. We would expect regulators and investors to be keen on objectivity, since such a feature permits a fair comparison between different schemes or between companies' financial results.

7.3.1.5 *Targeting security of defined benefit*

A valuation method features this property if it aims to meet the defined benefit, both in the event of scheme wind-up and in the ongoing state.

7.3.1.6 *Stability of values*

We look at stability at two levels: stability of past service funding levels; and stability of contribution rates. These are tested, using an example scheme, in Section 8.

7.3.1.7 *Applicability to other valuation purposes*

Under this heading we discuss the extent to which different valuation methods could be used for all of the valuation purposes described in Section 2.

7.3.1.8 *Potential for impact on current U.K. pension scheme investment policy*

Even in a post-MFR environment, U.K. pension scheme investment is still biased towards equities. A valuation method which features this property has the potential for shifting current U.K. pension scheme investment policy towards greater bond investment. Whether this is desirable or undesirable we leave for the reader to decide.

7.3.1.9 *Potential for impact on current U.K. pension scheme funding policy*

Likewise, some valuation methods hold potential impact for changing the pace at which U.K. pension schemes are currently funded. Again, we do not comment on the desirability or otherwise, though, clearly, different interest groups would take different views on this.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

8. NUMERICAL TESTING OF METHODS

8.1 *Introduction*

8.1.1 In this section we apply the various valuation methods described in Section 6, first using past data from 1985 to the end of 1998 (back testing), and second using simulated data generated by stochastic investment models proposed by Wilkie (1995) and Cairns (1999a) (forward testing).

8.1.2 The purpose of these studies is to investigate how each method performs over time for a typical (but simplified) pension scheme. Thus, we look at the stability and mean of the funding level and of the contribution rate over time under each proposed method, and compare the results with the traditional discounted cash flow method.

8.1.3 Back testing will give us some comfort (or otherwise) that a proposed method would have given sensible answers in the past. The period for back testing has been chosen as that in which there have been sufficient quantities of index-linked gilts in issue for meaningful statistics to be available. Forward testing allows us to investigate how the methods perform in a much wider range of scenarios, enabling us to check for problems which could arise in the future, but which have not happened in the recent past.

8.1.4 In this section, for both back and forward testing, we have considered a simple pension scheme which has a stable membership distribution. The benefits provided are a single life pension from age 60, with pension increases in line with full price inflation. Full details of the scheme are given in Appendix C.

8.2 *Back Testing*

8.2.1 In this section the notional scheme has been modelled over the period from 31 December 1985 to 31 December 1998. Assets have been projected using actual returns on relevant indices over the period, with allowance for any income not used to pay benefits to be reinvested on a monthly basis. Assets were rebalanced to a particular target portfolio on a monthly basis.

8.2.2 The pension scheme was assumed to have reached the point where it has a stable membership distribution by 31 December 1985. From that point on, the liabilities were projected based on actual price and salary inflation. Salary increases were assumed to be in line with national average earnings increases.

8.2.3 In each case the same initial market value of assets has been used to aid comparability. Thereafter, employer contributions were assumed to be made in accordance with the valuation method chosen, based on annual actuarial valuations. Any surplus or deficit was amortised by adjusting the employer's future contribution rates to amortise surplus as a level percentage of salaries over 12 years (which is roughly the future working lifetime of the active membership).

8.2.4 In the back testing we have considered the following funding methods, as defined in Section 6.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

8.2.4.1 *Method 0 (traditional)*

This is the traditional discounted value approach, where the market-value adjustment (MVA) is applied to the assets. The MVA is based on the proportions of assets actually held (but with overseas equities notionally valued as U.K. equities). Using the notation (i_v, e_v, r_v, d_v) for the valuation nominal rate of interest, rate of salary growth, rate of price inflation and gross dividend yield, respectively, we have used the following valuation basis:

$$i_v = 0.08,\ e_v = 0.06,\ r_v = 0.04,\ d_v = 0.04.$$

8.2.4.2 *Method 1 (MVA approach)*

This is as Method 0, but with the inverse of the MVA applied to the liabilities. The MVA is also applied to the contribution rate.

8.2.4.3 *Method 1a*

This is as Method 1, but with the MVA based on a notional portfolio which might traditionally be considered a closer match to the liabilities. As the liabilities are broadly evenly divided between active members and pensioners, this matching portfolio has been selected as 50% U.K. equities and 50% index-linked gilts.

8.2.4.4 *Method 2 (asset-based discount rate)*

The discount rate is set by reference to expected market returns on the asset classes held.

8.2.4.5 *Method 3 (economic valuation using bond yields)*

Here we define i_v as the yield on 15-year medium-coupon gilts (y_f), r_v is the difference between y_f and y_r, the real yield on 15-year index-linked gilts, and e_v is chosen such that the real salary assumption remains the same as above. d_v is not required.

8.2.4.6 *Method 4 (bond yields plus risk premium)*

As described in Section 6.6, for the purpose of modelling we have taken the approach of adding a variable risk premium to the discount rate derived for Method 3. The formula used to derive this premium is set out in Appendix B, and aims to maximise short-term stability in the funding level and contribution rate. It depends on the proportions invested in each asset class (long-dated fixed-interest, index-linked gilts and equities), and the durations of assets and liabilities. It represents a smoothing mechanism, and is not intended as a statement about the expected outperformance of equities relative to gilts. The constant term in the formula was chosen so as to give the same initial value of liabilities as at 31 December 1985 as Method 1.

8.2.5 In order to compare different methods, and in particular the volatility or

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

otherwise, in their outcomes, we have determined certain summary statistics which are defined in Appendix D. Those calculated for the back testing are:

— *MF*1 — mean funding level;
— *MC* — mean contribution rate;
— *VF*1 — variance of funding level; and
— *VC*1 — variance of contribution rate.

8.2.6 However, a relatively smooth series of funding levels or contribution rates may demonstrate a high variance if they trend in a single direction over the entire period. Thus, we have also determined short-term volatility measures, which look at the average change year on year. These are:

— *VF*3 — short-term variance of funding level; and
— *VC*5 — short-term variance of contribution rate.

8.3 *Back Testing Experiments*

8.3.1 *Test 0: typical U.K. pension fund asset distribution*

8.3.1.1 This test assumed assets were invested 60% in U.K. equities, 20% in overseas equities, 5% in cash, 10% in fixed-interest gilts and 5% in index-linked gilts. This reflects a typical pension scheme investment portfolio over the period.

8.3.1.2 We have examined the funding position of our example scheme on the statutory bases currently in existence. This shows that neither the MFR (as set out in Actuarial Guidance Note 27, version 1.2), nor the statutory surplus test (as defined in the Income and Corporation Taxes Act 1988 and Statutory Instrument 1987/412) would have had any major impact on contribution rates in any of the tests.

8.3.1.3 The resulting funding levels and balancing contribution rates are shown in Figures 8.1 to 8.4. Summary statistics from this and all other tests are set out in Appendix E.

8.3.1.4 The main points to be noted from the figures, together with the statistics in Appendix E, are as follows:

— Funding levels under Methods 0 and 1 track, to a large degree, the behaviour of U.K. equity dividend payments over the period, with strong real dividend growth resulting in an improving funding position, and vice versa.
— In contrast, Method 3, in particular, tracks the behaviour of equity markets (in which the scheme is predominantly invested) against the index-linked gilt market (on which liability values are based).
— Methods 0 and 1 produce, as expected, very similar results. The difference between these methods is that under Method 1, both standard contribution rate and surplus to be amortised are subject to a market level adjustment, which they are not under the traditional approach (Method 0). However, Method 1 barely shows any increase in volatility of results from Method 0. The reason is primarily because there is a surplus, and the conditions under which surplus is 'written up' to market value also result in the standard contribution rate being written up, and the two effects cancel out to some

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

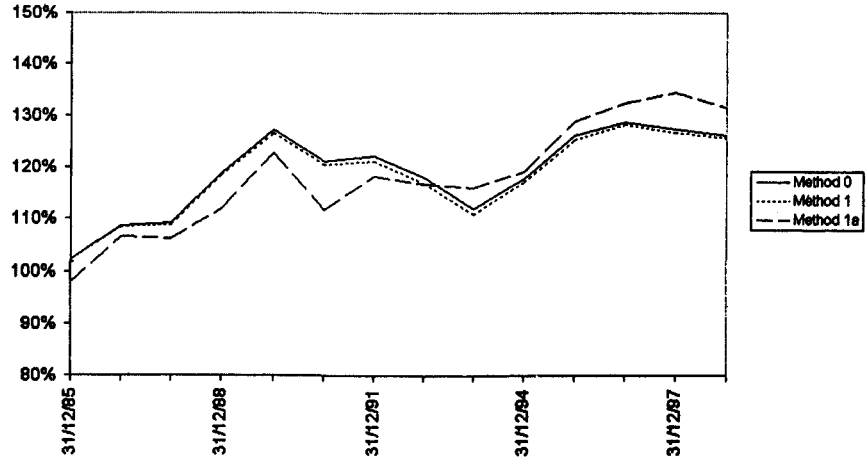

Figure 8.1. Funding levels; typical U.K. pension fund asset distribution; Methods 0, 1 and 1a

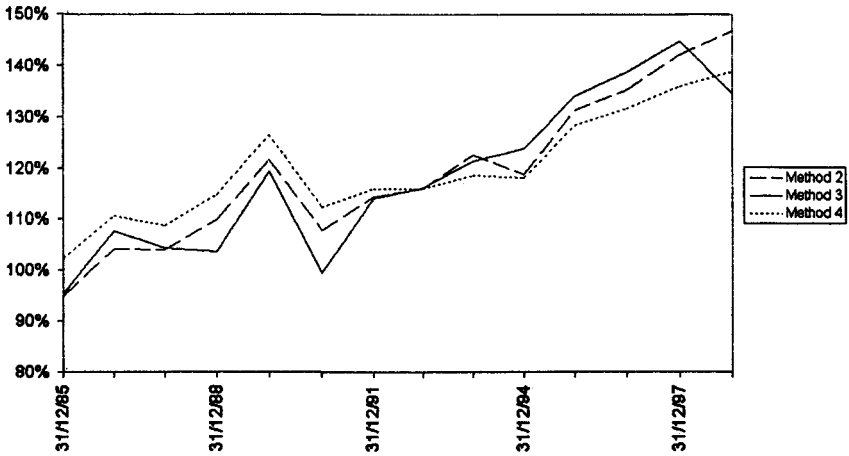

Figure 8.2. Funding levels; typical U.K. pension fund asset distribution; Methods 2, 3 and 4

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

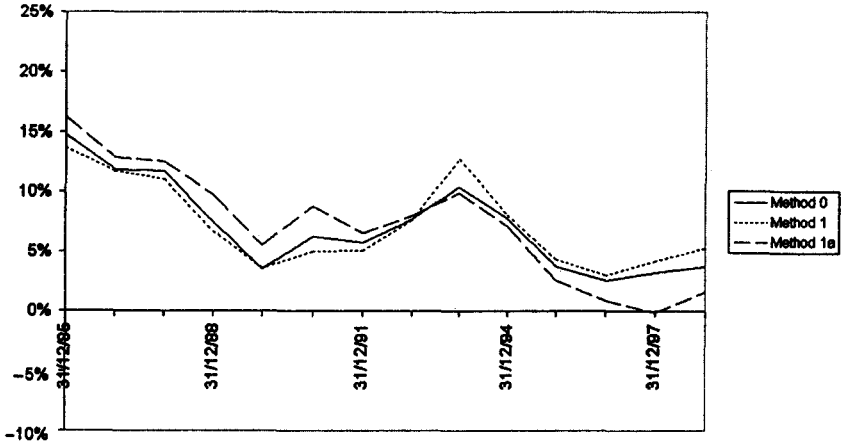

Figure 8.3. Contribution rates; typical U.K. pension fund asset distribution; Methods 0, 1 and 1a

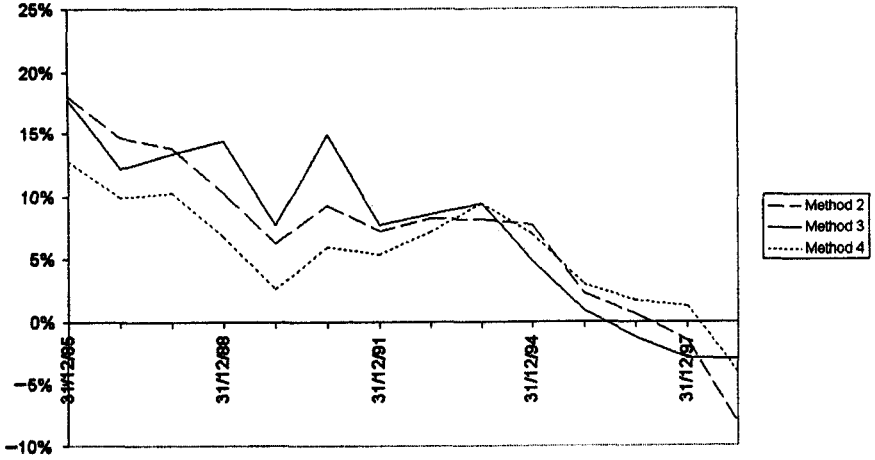

Figure 8.4. Contribution rates; typical U.K. pension fund asset distribution; Methods 2, 3 and 4

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

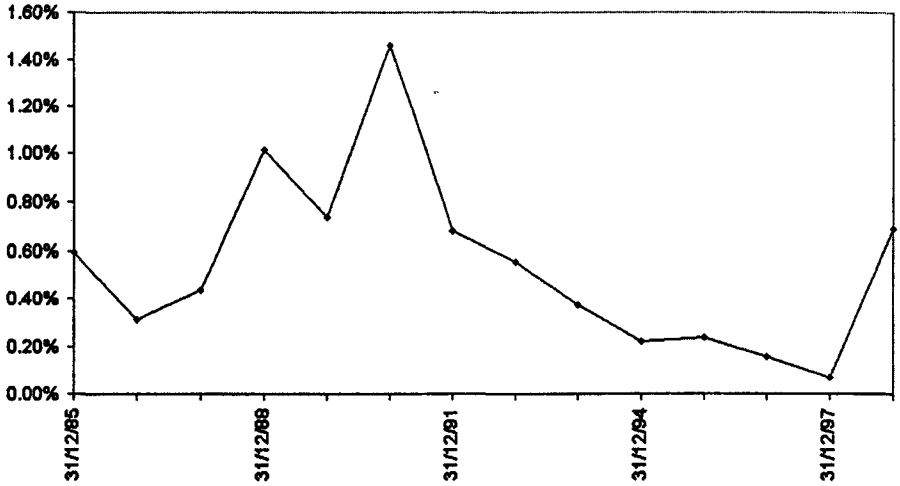

Figure 8.5. Risk premium under Method 4 in Test 0

degree. In the event of a deficit arising, the opposite would be true and volatility would increase.

— Once the notional portfolio moves further from the actual portfolio (Method 1a), the volatility of funding level increases.
— Method 2 appears more volatile than Methods 0 and 1, but less than Method 3.
— Method 3 exhibits the greatest volatility in results, as expected, due to the mismatch between assets and liabilities on this basis. This is particularly apparent in the late 1980s and early 1990s.
— Method 4 (by design) appears effective in reducing the volatility of results closer to that under Methods 0 and 1.
— Method 4 produces a risk premium varying between 0.07%p.a. and 1.46%p.a. on this asset distribution. The progression of the risk premium over time is shown in Figure 8.5.

8.3.2 *Test 1: effect of fixing the amortisation factor*

8.3.2.1 Previous studies (for example, Dufresne, 1988; Cairns & Parker, 1997) have indicated that varying the amortisation factor used to spread surpluses or deficits affects the stability of funding levels and contribution rates. To examine whether this is having an effect on the results of Test 0, we repeat Test 0, but using a constant factor of 0.1 for amortising surplus or deficit in the following year (that is, the employer's contribution is reduced by one tenth of the

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

surplus). The results, which are only investigated for Methods 3 and 4, are set out in Appendix E.

8.3.2.2 The impact is that a marginal reduction in funding level volatility is achieved at the expense of greater volatility in contribution rates. Over the period in question, and on the assumptions used, this is due to a shorter average amortisation period with a fixed factor.

8.3.3 *Tests 2 and 3: effect of changing the asset distribution*

8.3.3.1 The substantial volatility, in particular of Method 3, is a result of the mismatch between assets, predominately invested in equities, and liabilities, denominated entirely in terms of index-linked gilt yields.

8.3.3.2 Tests 2 and 3 consider the impact of assuming a different asset distribution. They compare the results assuming investment in the 'typical' portfolio described in ¶8.3.1.1 with those assuming investment of 50/50 (U.K. equities/index-linked gilts) and 100% index-linked gilts respectively. The results for Methods 0, 1 and 3 are shown in Figures 8.6 to 8.11, and statistics are set out in Appendix E.

8.3.3.3 The shift towards index-linked gilts in the asset distribution serves to reduce volatility under all methods, but the reduction is clearly more marked in Method 3. Over the period examined, however, the outperformance of equities relative to index-linked gilts does produce dramatically differing mean contribution rates, with these being much higher as the asset distribution shifts towards index-linked gilts.

8.3.3.4 When the asset distribution is 100% index-linked gilts, there is least difference in behaviour between the various methods. Differences do remain, however, due to the imperfect match of assets and liabilities by term, and the 'currency' of Method 0 (i.e. assessed value rather than market value).

8.4 *Forward Testing*

8.4.1 Let us now consider how the different methods compare under a much longer, randomly-generated scenario. It was considered important to use more than one stochastic investment model. This reduces the risk that we make conclusions that are model dependent. The models we have used here are those of Wilkie (1995) and Cairns (1999a), which will be referred to hereafter as Models 1 and 2 respectively. A comparison of these models is given in Appendix F. We have not considered here the effect of different parameter values in the two models, although this clearly is an important issue besides model variation.

8.4.2 In all, we show the results of a central experiment (experiment 0), and 9 others, in order to vary upper and lower funding level barriers, the amortisation factor for surpluses or deficits, and the asset distribution.

8.5 *Forward Testing Experiments*

8.5.1 The simulations used the same approach to determining the valuation assumptions for each method, as described in Section 8.2.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

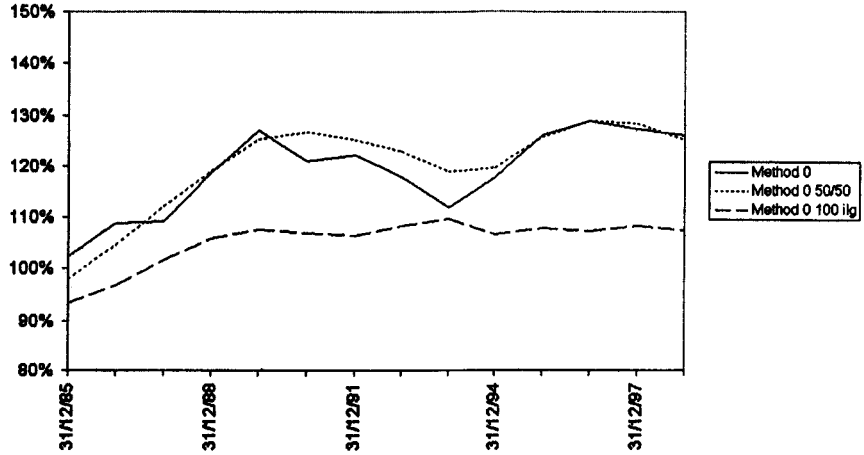

Figure 8.6. Funding level for Method 0 under different asset distributions

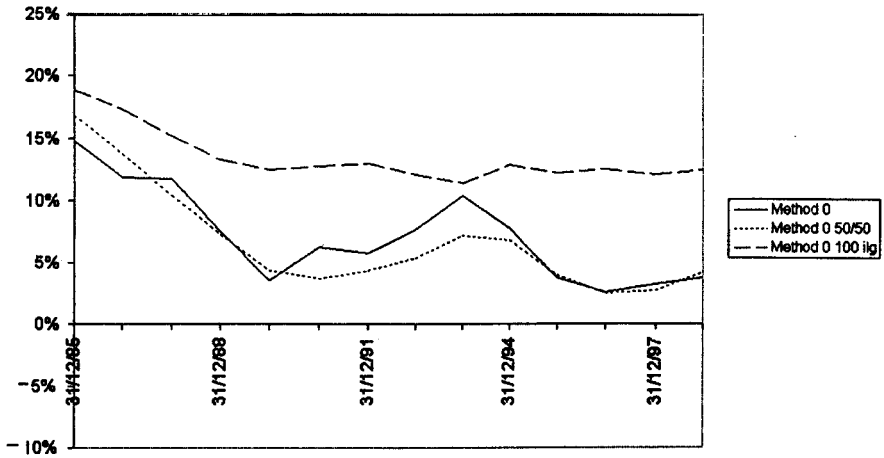

Figure 8.7. Contribution rate for Method 0 under different asset distributions

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

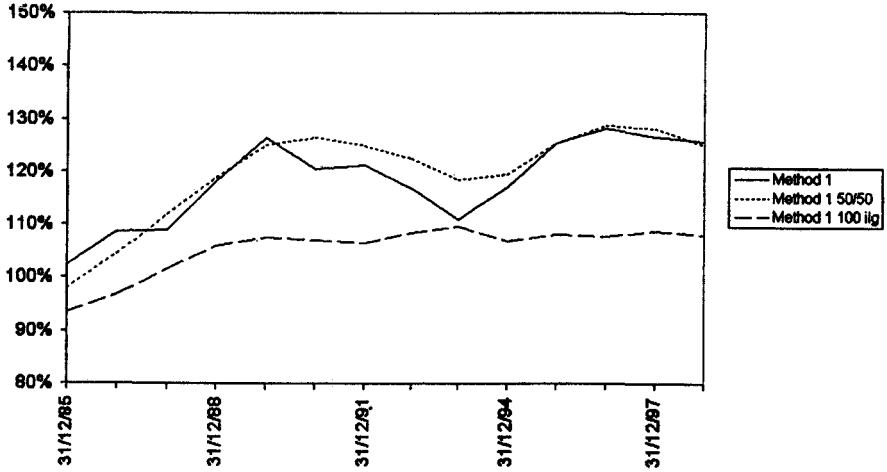

Figure 8.8. Funding level for Method 1 under different investment strategies

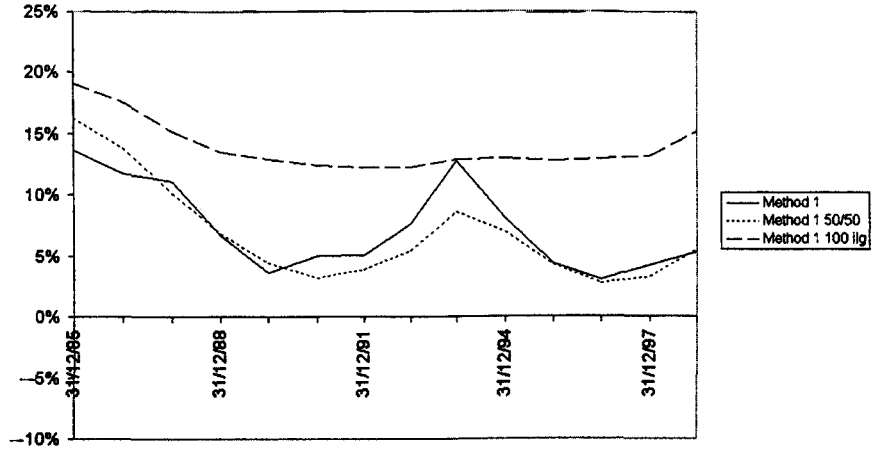

Figure 8.9. Contribution rate for Method 1 under different investment strategies

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

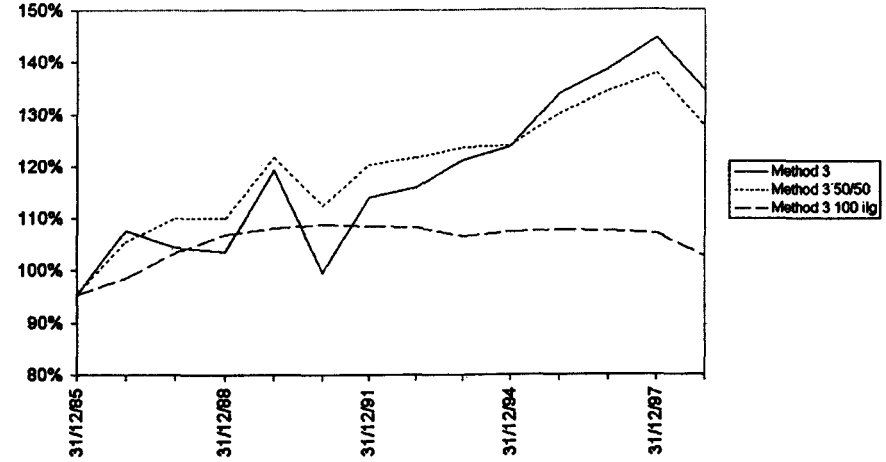

Figure 8.10. Funding level for Method 3 under different investment strategies

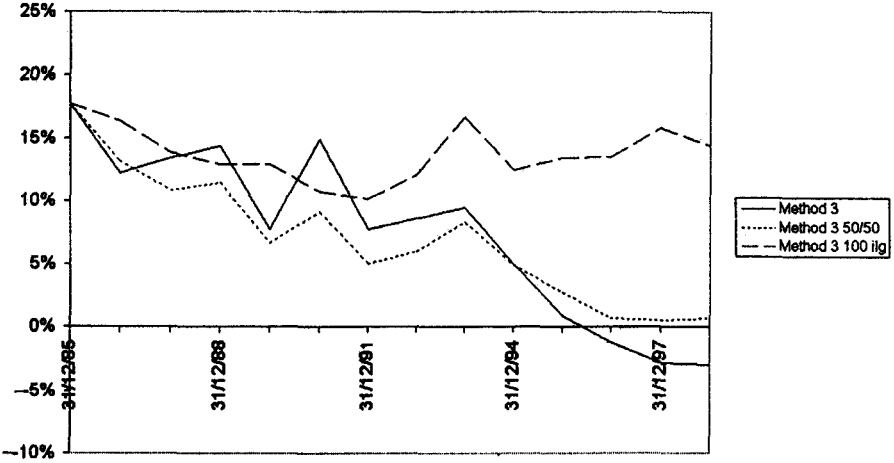

Figure 8.11. Contribution rate for Method 3 under different investment strategies

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

8.5.2 The asset distribution for the central experiment was taken to be 60% in U.K. equities, 5% in cash, 10% in fixed-interest gilts and 25% in index-linked gilts.

8.5.3 Upper and lower barriers were imposed as a simple means of mimicking a minimum funding requirement and statutory surplus regulations. Thus, any excess surplus over 25% of the liability on the regular valuation basis was required to be repaid immediately to the sponsor, while any deficit in excess of 25% of the liability was to be made up immediately.

8.5.4 The amortisation factor used in the central experiment was fixed at $k = 1/\ddot{a}_{\overline{m}|} = 0.1$ (this is higher than that using the average future working lifetime, but reflects the need to keep the funding level away from its boundaries). As referred to in Section 8.3.2, the reason for fixing k rather than fixing m is that the factor would vary as we change between valuation methods and valuation bases. Varying k, in addition to the valuation method, valuation basis and asset strategy, can cause some variation in the stability of funding levels and contribution rates (for example, see Dufresne, 1988; Cairns & Parker, 1997; and the comparisons in Experiments 1, 2 and 3). However, in later experiments we note that a change in the asset distribution can have a much more significant effect on stability than a change in k. Since we are aiming, here, to concentrate on the effect of the valuation method, it makes sense to remove this source of variation by fixing k.

8.5.5 In each experiment we considered the same 1000-year economic scenario generated by one of the two stochastic investment models (that is, Models 1 and 2). This ensured that differences between experiments using the same stochastic investment model could not be attributed to differences in sampling errors (differences between the two models will be subject to a small extent to sampling errors, since we are using two independent simulations).

8.5.6 A number of measures of stability are provided. For funding levels we give two basic values: $VF1$ is the long-term variance of the funding level; while $VF3$ is the short-term variance. A basic source of variability is the absolute size of the fund, that is, one fund, which is twice the size of another, will appear to be twice as volatile. Different funding methods can give rise to quite different fund sizes. Under such circumstances, comparison of absolute variances might give rise to misleading conclusions. Instead, we consider standardised variances $VF2$ and $VF4$, which remove the effect of fund size. Precise definitions of these measures can be found in Appendix D.

8.5.7 For contribution rates we give three principle measures of stability, depending upon the time horizon one wishes to consider. All are standardised to remove the effect of fund size. Measure $VC2$ gives the long-term variability of the contribution rate. Measure $VC3$ gives the average variance of the contribution over any 5-year period (perhaps a reasonable measure from the sponsor's point of view). Measure $VC4$ gives the 1-year volatility in contribution rates (a measure of local smoothness). Measure $VC1$ is the long-term variance before standardisation.

8.5.8 Numerical results for the various experiments are given in Appendix G.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

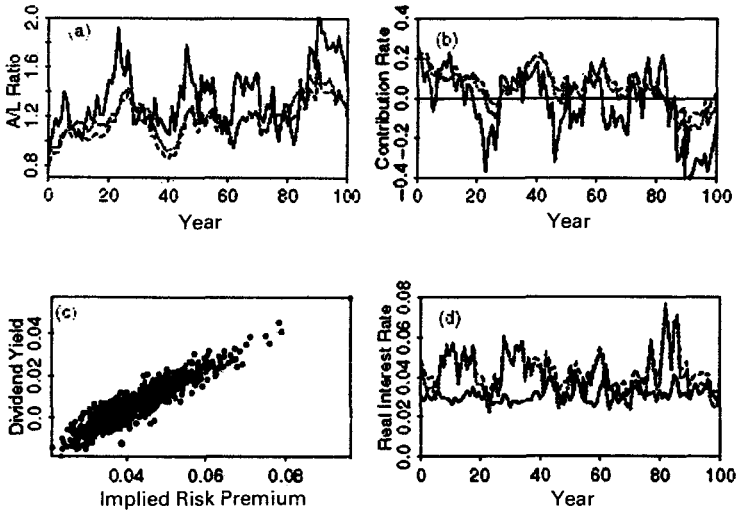

Figure 8.12. Results arising from a single, 100-year simulation using the Wilkie model; comparison of Methods 1, 3 and 4; in (a), (b) and (d): Method 3 – solid line; Method 1 – dotted line; Method 4 – dashed line; (a) variation of $A(t)/L(t)$ over 100 years; (b) variation of $CR(t)$; (c) dividend yield versus implied risk premium under Method 1. (d) variation of the real rates of interest

8.5.9 *Experiment 0*

8.5.9.1 This was the only experiment in which the barriers were set at 0.1 and 10 instead of 0.75 and 1.25. We consider results for both stochastic investment models.

8.5.9.2 Selected results are plotted in Figure 8.12. In Figure 8.12(a) we can see how the funding levels evolve over a 100-year period under Methods 1, 3 and 4. Clearly Methods 1 and 4 produce similar results, while Method 3 produces much more volatility. The latter observation is not entirely surprising, as it was not designed to produce stability. Contribution rates are plotted in Figure 8.12(b), with essentially the inverse of the patterns in Figure 8.12(a). Note that all methods produce regular periods of contribution refunds. This reflects the difference between average experienced real investment returns against the assumptions in the valuation basis. Figure 8.12(c) plots the dividend yield against the risk-premium implied within Method 1. The high degree of correlation led to the development of Method 4. Figure 8.12(d) plots the development of the valuation real rates of interest for the three methods.

8.5.9.3 Numerical results for this experiment are given in Tables W0 and C0 of Appendix G. We can make the following points:

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

— Methods 0, 1 and 4 produce similar levels of volatility over the short, medium and long terms. Method 3 produces much higher volatility in funding levels in the short term, but with similar levels of variability over longer periods to the other methods (comparing the statistics *VF*4 and *VF*2 respectively). Method 3 produces greater volatility in the contribution rate over all ranges.
— Although one-year unconditional means and variances in the two models are similar, the Cairns model produces returns which are more highly correlated from one year to the next. Cairns & Parker (1997) showed that this leads to higher variability in the funding level, and this is what we observe here: similar levels of short-term volatility and higher levels of long-term variance in Table C0.
— The strength of some valuation bases led, in some cases, to negative mean contribution rates. In reality, persistent surplus would probably result in benefit improvements such as discretionary pension increases rather than solely rebates to the sponsor.
— From Figure 8.12(d), we can see that the relative stability achieved under Methods 1 and 4 is achieved at the expense of rather volatile valuation rates of interest compared to Method 3.

8.5.10 *Experiment 1*

8.5.10.1 In this experiment we used the central assumptions described above. The only difference from Experiment 0 was the introduction of much more severe barriers at 0.75 and 1.25. These are intended to be reasonable approximations to the current minimum and maximum regulations in the U.K. The effect of the introduction of the narrower band can be seen graphically in Figure 8.13 (using a simulation generated by Model 1). Broadly the two funds progress in the same way over time, with deviations only when the funding level breaks through the upper barrier. The process rarely hits the lower barrier because of the high expected returns relative to the valuation basis.

8.5.10.2 Numerical results are detailed in Table W1.

8.5.10.3 Inevitably the funding level becomes more stable because of the constraints. Mean funding levels are lower, because the relative strength of the valuation basis means that the upper barrier comes into play much more frequently than the lower barrier. In contrast, the contribution rates become very much more variable. Primarily this is because of a small number of very large contribution refunds or deficit payments as a result of a breach of one of the barriers. Mean contribution rates are a little bit higher in this experiment because the mean funding level is lower. This means that there is less investment return to support contributions in the future.

8.5.10.4 This experiment also included a look at the effect of using a notional fund different from the actual structure of the portfolio (Method 1a). It can be seen from Table W1 that the notional fund results in a more stable funding level, but no obvious change in the stability of contributions. This is perhaps

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

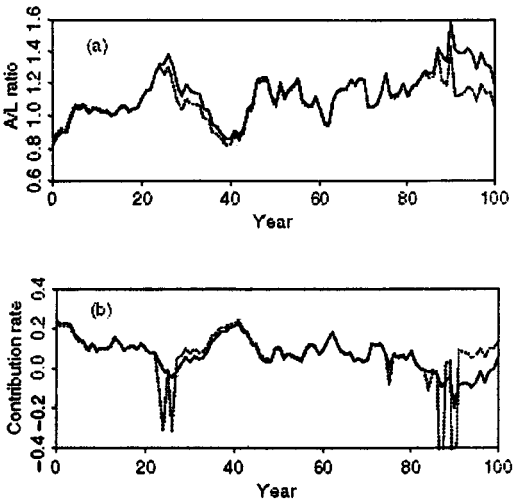

Figure 8.13. Method 4; comparison of (a) $A(t)/L(t)$ and $CR(t)$ with barriers at 0.1 and 10 (solid lines), or at 0.75 and 1.25 (dotted lines)

counterintuitive. However, we can note that Method 3 is an extreme version of the notional fund, as is the case where we assume a notional fund with 100% in U.K. equities, and both are significantly more volatile than the actual fund approach. We can infer from this that, as we work our way through the range of notional funds, there is a U-shape with a minimum variance close to, but not equal to, the actual fund.

8.5.10.5 We would stress that we are interested in qualitative results. Modelling more exactly the barriers and the way in which regulations require action if a barrier is breached could refine the model. However, this would not substantially alter the observations made below from a qualitative point of view.

8.5.11 *Experiments 1, 2, and 3*

8.5.11.1 We noted, in Experiment 1, that the barriers create additional variability. In these experiments we considered the effect of the amortisation rate k. If the barriers are considered to be a problem, then we should try to avoid hitting them. This means increasing k.

8.5.11.2 These three experiments took $k=0.1$, 0.15 and 0.06 respectively. Numerical results are detailed in Tables W1, W2 and W3. A look at the variances shows that increasing k does, indeed, reduce volatility. This is because increasing k reduces the frequency at which the fund size breaches one of the barriers. However, this does not reveal the full picture. It is informative to look at the distribution of contribution rates. This is plotted in Figure 8.14. Where k is small the distribution is, in fact, quite closely packed around the mean, except for a fat

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

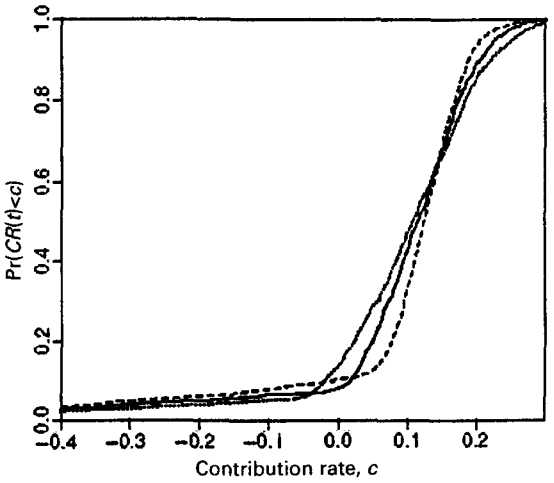

Figure 8.14. Experiments 1, 2 and 3; Method 4; cumulative distribution functions of the contribution rates for $k = 0.15$ (dotted line), $k = 0.1$ (solid line) and $k = 0.06$ (dashed line)

left-hand tail (caused by the number of refunds). This fat tail increases the variance noted in Table W3. However, a look at the shape of the distribution makes $k=0.06$ look quite favourable. On the other hand, if we were to use a less conservative valuation basis, then we would be equally likely to hit either barrier. Under such circumstances, $k=0.06$ would give rise to equally fat left and right-hand tails. In particular, the right hand represents additional contributions required under the MFR regulations, and may come at a bad time for the sponsoring employer.

8.5.12 *Experiments 4, 5 and 6*

8.5.12.1 Here we considered the effect of changing the investment strategy. The three experiments concentrate investments in equities and long-dated index-linked bonds in the ratio 80/20, 40/60 and 0/100 respectively. Numerical results, using stochastic investment Model 2, are given in Tables C4, C5 and C6. Funding levels and contribution rates for Experiments 4 and 6 are plotted in Figure 8.15.

8.5.12.2 From the tables and from Figures 8.15(a) and 8.15(b), we can see that switching into index-linked bonds has a very significant effect. This effect is much stronger than changing the amortisation factor k, noted in Experiments 1, 2 and 3. The residual variability where we are invested 100% in bonds is due both to the imperfect match between salaries and inflation and to the imperfect match from year to year between index-linked returns and inflation. The smoothing in Method 4 reduces the latter effect, and we can see this by comparing variances under Methods 3 and 4.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

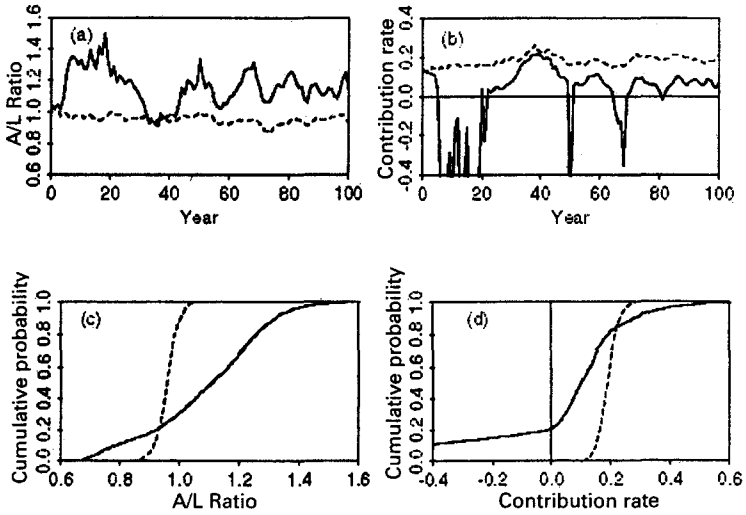

Figure 8.15. Method 4; dynamics of the fund under different investment strategies; (a) $A(t)/L(t)$; (b) $CR(t)$; (c) Cumulative distribution function of $A(t)/L(t)$; (d) cumulative distribution function of $CR(t)$; Experiment 4; 80% in equities and 20% in index-linked bonds (solid lines); Experiment 6; 100% index-linked bonds (dashed lines)

8.5.12.3 Over the one hundred years plotted, the equity strategy appears to perform rather better, with very few occasions when contribution rates are higher than the 100% bonds strategy. However, over the full 1000-year period (Figures 8.15(c) and 8.15(d)) we can see that the additional risks attached to equities do mean that there are a significant number of occasions (around 1 in 5) when the fund will appear to be in a much worse state, with higher contributions.

8.5.12.4 We can also see that mean contribution rates are higher as we put more into bonds. This is the counter balance to the lower variability. This is a reflection of two things. First, the average rate of return on the fund is lower. Second, the average fund size (amounts) is lower. This creates less investment return to offset contributions everything else being equal.

8.5.13 *Experiments 7, 8 and 9*

8.5.13.1 In Tables W7, W8 and W9 we give numerical results for three experiments in which we considered the effect of overseas equities using Model 1. We considered the following possibilities:

8.5.13.2 Experiment 7 has 20% in U.S. equities (used as a proxy for overseas equities), with the use of 1-year currency forwards to remove the exchange rate risk from 1-year returns.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

8.5.13.3 Experiment 8 has 20% in U.S. equities, without the use of 1-year currency forwards.

8.5.13.4 In Experiment 9 the 20% is moved into U.K. equities.

8.5.13.5 It was assumed that overseas equities were treated as U.K. equities for the purpose of the valuations. It appears from the numerical results that the introduction of overseas equities marginally increases volatility under all methods, but this is more marked under Methods 0 and 1.

9. Results of Comparing Valuation Methods

9.1 *Introduction*

In this section we look at how the alternative valuation methods previously described compare against each of the properties introduced in Section 7.3, drawing, where necessary, on the simulated results from Section 8.

9.2 *Results of Comparison*

9.2.1 *Consistency*

9.2.1.1 All the methods investigated, including the traditional assessed value approach, show assets and liabilities in a consistent 'currency'.

9.2.1.2 However, when we consider consistency between past service values and future service payments, the traditional assessed value approach does not feature this second aspect. This is because the contribution rate over a particular time period is calculated in assessed value terms, but paid at the prevailing market conditions without adjustment. Once contributions have been paid, the following actuarial valuation will apply a market value adjustment (MVA), thereby altering the assessed value attached to those contributions. This produces the peculiar capacity to create actuarial surplus or deficit, even if the inter-valuation experience has been exactly in line with the valuation assumptions. All of Methods 1 to 4 avoid this problem, because market conditions are taken into account when setting the contribution rate, though, of course, these market conditions may have changed by the time a particular contribution payment is actually paid.

9.2.2 *Simplicity*

9.2.2.1 Actuaries are used to performing assessed value calculations and setting the appropriate long-term valuation assumptions. Most actuaries would, therefore, regard the traditional approach as relatively straightforward to perform. Similarly, Methods 1 and 1a, which apply an MVA to liabilities determined using long-term assessed value assumptions, also feature this property.

9.2.2.2 We also regard Method 3 (economic valuation using bond yields) as simple to perform, since the appropriate yields are published daily in the *Financial Times.*

9.2.2.3 Method 2 (asset based discount rate) and Method 4 (bond yields plus risk premium), however, require an opinion on either current market expectations

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

of equity dividend growth or the appropriate risk premium from other asset classes such as equities. At any one moment such views are likely to be highly contentious, and therefore we do not regard these methods as straightforward to operate.

9.2.3 *Durability*

9.2.3.1 The traditional assessed value approach focuses significantly on the dividend yield for the purpose of calculating the assessed value of assets. It is, therefore, exposed to 'shocks' that undermine the focus on dividends as the prime source of rewarding shareholders. We have seen two such shocks in recent years, firstly the taxation of U.K. company dividends to pension scheme investors, and secondly the growing use of share buy-backs and special dividends as an alternative means of rewarding shareholders. Given that these were prime reasons for the establishment of this Working Party, we conclude that the traditional approach no longer retains the property of durability.

9.2.3.2 Similarly, Methods 1 and 1a, which also rely on the dividend-based MVA approach, and Method 2, which uses expected dividend cash flows from the actual investment policy to determine a discount rate, fail to satisfy the durability test.

9.2.3.3 Method 3, however, is driven from bond yields at source. The durability of these methods is, therefore, dependent on the supply of government and corporate bonds. We expect that there will always be a need for government or for companies to borrow, hence the existence of a supply of debt is not really in doubt (though the adequacy of this supply may be called into question from time to time). Taxation is unlikely to be an issue, because any change will be immediately reflected in the redemption yield. Unlike equities, where companies can change habits to offset tax changes, there is no doubt as to the impact of tax on the investment return from bonds. We can think of no other possible shocks that would compromise the durability of Method 3.

9.2.3.4 The durability of Method 4 depends on the construction of the risk premium. A constant addition to bond yields is just as durable as Method 3, because the matching asset class is still bonds. On the other hand, a variable risk premium calculated using dividend yield data, such as the method shown in Appendix B, is exposed to uncertainty from the 'shocks' referred to in ¶9.2.3.1.

9.2.4 *Objectivity*

9.2.4.1 To the extent that any valuation method is prescribed by legislation (e.g. the current MFR), it can be considered objective. Here we focus on the objectivity, or otherwise, of non-prescribed valuations.

9.2.4.2 The traditional assessed value approach is not an objective valuation method, because the long-term investment return assumption is a subjective decision of the Scheme Actuary.

9.2.4.3 Likewise, Methods 1 and 2 are dependent on the actual investment portfolio of a scheme, and therefore cannot be considered as objective measures.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

9.2.4.4 On the other hand, Method 3 (economic valuation using bond yields) is entirely objective, since it could be applied consistently across all pension schemes and avoids subjective judgement.

9.2.4.5 Method 1a (MVA approach with notional asset distribution) falls somewhere in the middle on the objectivity scale. It defines an asset distribution intended to match the liabilities in some way (although this still involves some subjectivity). It also involves a subjective assumption about implied dividend growth from equities. Method 4 (bond yields plus risk premium) again depends on the construction of the appropriate risk premium to add to bond yields. We have assessed these two valuation methods as 'mixed' for this property.

9.2.5 *Targeting security of defined benefit*

Method 3 (economic valuation using bond yields) most satisfies this property, since it targets the defined benefit in the event of scheme wind-up as well as at projected retirement age. All other methods target security of defined benefit at projected retirement age only.

9.2.6 *Stability of values*

9.2.6.1 Using the standardised volatility results from Appendix G (*VF*2 and *VF*4 — funding level, *VC*2, *VC*3 and *VC*4 — contribution rate), Methods 1 and 1a (MVA approach, using actual and notional asset distributions respectively) show volatility similar to the traditional method, the yardstick for measuring this property. It should be stressed that this assumes a typical U.K. pension fund asset distribution (i.e. with a heavy equity content).

9.2.6.2 Method 2 (asset based discount rate) is marginally more volatile, but still similar to the traditional approach.

9.2.6.3 Method 3 (economic valuation using bond yields) shows significantly greater volatility in funding level and contribution rate.

9.2.6.4 Method 4 (bond yields plus risk premium) shows stability of both funding levels and contribution rates. This is not surprising, since the construction of the risk premium in our example is specifically designed for this purpose. Indeed, any arbitrary smoothing rule can be applied separately to each of these methods.

9.2.7 *Applicability to other valuation purposes*

9.2.7.1 The force behind the International Accounting Standards Board's drive towards the use of market values for pension expense calculations means that the traditional assessed valuation approach is unlikely to be retained by the U.K. Accounting Standards Board. Thus, the traditional approach is unlikely to be applicable for all valuation purposes identified in Section 2.

9.2.7.2 Methods 1 and 2 would not be suitable for regulatory valuations, since the use of the actual investment policy would imply a discount rate that was scheme-specific.

9.2.7.3 We consider that the other methods could be used for all valuation purposes identified in Section 2.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

Table 9.1. Comparison of alternative valuation methods

Property	Method 0 (traditional)	Method 1 (MVA, actual inv)	Method 1a (MVA, notional inv)	Method 2 (asset based d.r.)	Method 3 (economic – bond yields)	Method 4 (bond yields plus risk premium)
Consistency						
Same 'currency' for assets and liabilities	✔	✔	✔	✔	✔	✔
Treatment of past service values and contribution payments	x	✔	✔	✔	✔	✔
Simplicity of calculations	✔	✔	✔	x	✔	x
Durability e.g. to changes in taxation or reward of shareholder value	x	x	x	x	✔	–
Objectivity	x	x	–	x	✔	–
Targeting security of defined benefit	x	x	x	x	✔	x
Stability of values						
Past service funding levels	✔	✔	✔	✔	x	✔
Contribution rates	✔	✔	✔	✔	x	✔
Applicability to other valuation purposes	x	x	✔	x	✔	✔
Potential for impact on current U.K. pension scheme *investment* policy	x	x	✔	x	✔	✔
Potential for impact on current U.K. pension scheme *funding* policy	x	x	✔	x	✔	✔

Key: x = this method *does not* feature this property; – = mixed; ✔ = this method *does* feature this property

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

9.2.8 *Potential for impact on current U.K. pension scheme investment policy*

Method 1a (MVA approach using notional asset distribution), Method 3 (economic valuation using bond yields), and (depending on construction) Method 4 (bond yields plus risk premium) have the potential for altering U.K. pension scheme investment policy, principally the re-allocation of equities into bonds. Such re-allocation would inevitably arise as pension schemes moved to reduce mis-matching against the new liability benchmark. Method 3 is potentially very severe in this respect. A material reduction in expected investment returns, resulting from use of these methods, might be an extremely sensitive issue with many trustees and sponsoring employers.

9.2.9 *Potential for impact on current U.K. pension scheme funding policy*

9.2.9.1 The same methods referred to in ¶9.2.8 have the potential for altering U.K. pension scheme funding policy. Using Method 3 (economic valuation using bond yields) as an example, introducing a funding target of 100% of liabilities under this method would currently require a significant increase in contributions to most schemes, at least over the short to medium term, as sponsors try to rectify funding deficits against this target. Obviously, such a requirement would be very sensitive amongst scheme sponsors.

9.2.9.2 A possible solution to this problem would be to target a percentage of liabilities lower than 100%. Whether trustees and members could accept the psychology of targeting less than 100% funding is arguable. In addition, any government looking to use such an approach for a minimum funding standard will meet political objection if the new standard is interpreted, rightly or wrongly, as 'weak'.

9.3 *Summary of Results*

A summary of these results is shown in Table 9.1.

10. CONCLUSIONS

10.1 Actuarial science is a developing process. From the history described in the other sections, it can be seen how techniques change to reflect advances in thinking and technology. We have no reason to presume that this process will not continue into the future and believe that this review of valuation methods is simply another step along that road.

10.2 We have identified the following general points.

10.2.1 Depending on the purpose of the valuation, there is a wide range of techniques that can be adopted to calculate a value of liabilities to be compared with a set of assets taken at market value.

10.2.2 All of these methods allow for subjective input (both demographic and economic), to a greater or lesser extent, and so all can be called methods that allow for actuarial judgement, although some methods require less judgement than others.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

10.2.3 It is not impossible, therefore, to arrive at similar (or even identical) liability calculations using different methods with appropriate actuarial judgement. It is also possible to have very different answers using some particular methods or differing judgement.

10.2.4 This shows us, once again, the power and professional responsibility that lies with actuarial judgement, and hence the requirement to apply this judgement correctly in terms of both the choice of method and any subjective assumptions used.

10.2.5 Inherent with this responsibility is a prerequisite to understand the purpose of the valuation and implications of the application of actuarial judgement. We therefore conclude that the profession should extend its education process to cover the understanding of methods of determining liabilities on a basis consistent with market values.

10.3 *Uses of the Valuation*

10.3.1 As a profession, we are unusual in that our advice is often used by several parties for several different purposes. The Working Party has recognised (as have many others in the profession) that often one 'answer' cannot suffice for several 'questions'.

10.3.2 The Working Party believes that it is possible to classify the purposes of valuation calculations into those requiring no judgement (e.g. MFR), limited judgement (e.g. an accounting standard), or full judgement (e.g. setting contribution rates or sale or purchase calculations).

10.3.3 With such a classification, we believe that it is possible to identify methods which allow for greater or less control of the actuarial judgement referred to in ¶10.2.4.

10.4 *Observations*

10.4.1 Our conclusions from the specific testing we carried out were not altogether surprising. The adoption of a market value for assets must mean a volatile value for any comparable calculation of liabilities. This leads to volatile funding levels (unless assets and liabilities are closely 'matched') and volatile contribution requirements (unless long-term assumptions are used or smoothing is applied). It would appear to us that the holy grail of an objective methodology and smooth results is unattainable. Some compromise (or actuarial judgement) will still be required.

10.4.2 Our terms of reference requested us to assist in the MFR process now being undertaken by the profession. The Working Party's conclusions are dependent on how the purpose of the MFR itself is defined. We believe that, if the current terms of reference are accepted, then a variation on Method 4 (bond yields plus risk premium) is appropriate. However, if the MFR is required to value near certainty of provision of the accrued benefit promise, only Method 3 (economic valuation using bond yields) would appear satisfactory.

10.4.3 Finally, it should be remembered that pension provision by employers

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

is essentially a voluntary act. We would caution against dogma and overly prescriptive sets of actuarial assumptions and methods for setting contribution rates or as a basis for legislation. Not only does this potentially stifle the future application and development of more advanced techniques, but a prescriptive approach could also have wider economic and market implications, which may not serve the wider community.

ACKNOWLEDGEMENTS

The authors would like to thank the following: the Institute of Actuaries, for the provision of a research grant to assist in some aspects of this research; Sarah Cornwall, for all her skill and effort in typing and formatting much of the paper; Sandra Bell, for carrying out the back testing in Section 8; and numerous colleagues, together with the Technical Support and Research Committee, for their input and comments on the paper as it took shape.

REFERENCES

CAIRNS, A.J.G. (1999a). A multifactor, equilibrium model for the term structure and inflation. *Proceedings of the 9th AFIR Colloquium*, Tokyo.

CAIRNS, A.J.G. (1999b). *A multifactor model for the term structure and inflation for long-term risk management with an extension to the equities market.* Institute and Faculty Libraries.

CAIRNS, A.J.G. & PARKER, G. (1997). Stochastic pension fund modelling. *Insurance Mathematics and Economics* **21**, 43-79.

CRABBE, R.J.W. & POYSER, C.A. (1953). *Pension and widows' and orphans' funds.* Cambridge University Press.

DAY, J.G. & MCKELVEY, K.M. (1964). The treatment of assets in the actuarial valuation of a pension fund. *J.I.A.* **90**, 104-147.

DUFRESNE, D. (1998). Moments of pension contributions and fund levels when rates of return are random. *J.I.A.* **115**, 535-544.

DYSON, A.C.L. & EXLEY, C.J. (1995). Pension fund asset valuation and investment. *B.A.J.* **1**, 471-557.

EXLEY, C.J., MEHTA, S.J.B. & SMITH, A. D. (1997). The financial theory of defined benefit pension schemes. *B.A.J.* **3**, 835-966.

FELDMAN, K. S., BERGMAN, B., CAIRNS, A. J. G., CHAPLIN, G. B., GWILT, G. D., LOCKYER, P. R. & TURLEY, F. B. (1998). Report of the fixed-interest working group. *B.A.J.* **4**, 213-383.

FLESAKER, B. & HUGHSTON, L.P. (1996). Positive interest. *Risk* **9**(1), 46-49.

GORDON, T. (1999). The price of actuarial values. Paper presented to the Staple Inn Actuarial Society.

HEYWOOD, G. & LANDER, M. (1961). Pension fund valuations in modern conditions. *J.I.A.* **87**, 314-370.

LEE, E.M. (1986). *An introduction to pension schemes.* Institute of Actuaries.

PORTEUS, D.A. (1946). *Pension and widows' and orphans' funds.* Cambridge University Press.

PUCKRIDGE, C.E. (1947). The rate of interest which should be employed in the valuation of a pension fund and the values which should be placed on existing investments. *J.I.A.* **74**, 1.

ROGERS, L. C. G. (1997). The potential approach to the term-structure of interest rates and foreign exchange rates. *Mathematical Finance*, **7**, 157-164.

RUTKOWSKI, M. (1997). A note on the Flesaker & Hughston model of the term structure of interest rates. *Applied Mathematical Finance*, **4**, 151-163.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

SMITH, A. D. (1998). Salary related cash flows: market based valuation. Institute of Mathematics and its Applications Conference on Actuarial Valuations, Accounting Standards and Financial Economics, 20 January.

WILKIE, A.D. (1995). More on a stochastic asset model for actuarial use (with discussion). *B.A.J.* **1**, 777-964.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

APPENDIX A

VALUATION METHODS CONSIDERED

A.1 In this appendix we set out the various methods algebraically, and practical examples of how assumptions could have been set as at 31 December 1998, for each of Methods 0 to 4.

A.1.1 At 31 December 1998, the key financial index figures were as follows:

FT-Actuaries All-Share Index gross dividend yield	2.92% p.a.
FT-Actuaries Fixed-Interest 15-year medium coupon yield	4.43% p.a.
FT-Actuaries over-5-year index-linked gilt yield (5% inflation)	1.94% p.a.

A.1.2 The long-term valuation assumptions, where used, are:

Investment return	8% p.a.
Salary growth	6% p.a.
Price inflation (pension increases)	4% p.a.
Equity dividend growth	3.765% p.a.

A.1.3 Combining the investment return and dividend growth assumptions above, using a traditional approach, gives a normal 'par' gross dividend yield on U.K. equities of:

$$\text{Ln}((1.08)/(1.03765)) = 0.04 \qquad \text{i.e. a } 4\% \text{ par yield.}$$

A.2 *Method 0 (traditional)*

A.2.1 Algebraically the method is expressed as follows:

Liability cash flows	l_t at future time t
Discount factor	v based on the long-term rate of return on assets
Market value of assets	F
Asset model	A proportion P_i is invested in asset class i; this yields expected cash flows a_{it} at time t per unit of market value

Thus:

Value of liabilities	$L = \sum l_t v^t$
Market value adjustment (MVA)	$\sum\sum P_i \, a_{it} \, v^t$
Value of assets	$F \times MVA$

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

A.2.2 *Example*

A.2.2.1 Liabilities are valued using the long-term assumptions:

Investment return	8% p.a.
Salary growth	6% p.a.
Pension increases	4% p.a.

A.2.2.2 The equity MVA, MVA_e is calculated as:

$$MVA_e = 0.0292/0.04 = 0.730.$$

A.2.2.3 The fixed interest MVA, MVA_f is calculated as:

$$MVA_f = 0.0443 \times a^{(2)}_{\overline{15}|} + (1/1.08)^{15} = 0.702$$

where $a^{(2)}_{\overline{15}|}$ is calculated at 8% p.a. interest.

A.2.2.4 The index-linked MVA, MVA_r is calculated as:

$$MVA_r = 0.0194 \times a^{(2)}_{\overline{15}|} + (1.04/1.08)^{15} = 0.788$$

where $a^{(2)}_{\overline{15}|}$ is calculated at $(1.08/1.04)-1 = 3.85\%$ p.a. interest.

A.2.2.5 Based on an asset distribution of 80% equities, 10% fixed-interest, 5% index-linked and 5% cash, this gives:

$$MVA = 0.8 \times 0.730 + 0.10 \times 0.702 + 0.05 \times 0.788 + 0.05 \times 1 = 0.744.$$

A.3 *Method 1 (MVA approach using actual asset distribution)*

A.3.1 Algebraically the method is the same as Method 0, except that assets are taken at market value and liabilities are adjusted to a market value, as follows:

$$\text{Market adjusted liability value} = L/MVA.$$

A.3.2 *Example*

As at 31 December 1998, values of liabilities are determined using the long-term valuation assumptions, and then multiplied by 1/0.744.

A.4 *Method 1a (MVA approach using notional asset distribution)*

A.4.1 Algebraically the method is expressed as above.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

A.4.2 *Example*

Assume a matching portfolio is taken to be 50% equities, 50% index-linked gilts, then the MVA as at 31 December 1998 would be:

$$MVA = 0.5 \times 0.730 + 0.5 \times 0.788 = 0.759.$$

A.5 *Method 2 (asset-based discount rate)*

A.5.1 Algebraically the method is expressed as follows.

A.5.1.1 An appropriate asset model is used to derive an implied discount rate for each asset class i by solving the equation $\sum a_{it}\, v_i^t = 1$ for each i, since a_{it} are per unit of market value.

A.5.1.2 Under certain circumstances this can mean that the return on equities held for 15 years, say, is less then the return on a 15-year gilt.

A.5.1.3 A composite discount rate w is obtained by weighting the implied expected rates of asset return by asset model proportion $w^{-1} = \sum P_i\, v_i^{-1}$.

A.5.1.4 Alternatively, w can be determined by solving the equation $\sum w^t \sum P_i\, a_{it} = 1$.

A.5.1.5 The liability value is then obtained by discounting at w. $L = \sum l_t\, w^t$.

A.5.2 *Example*

A.5.2.1 First determine the market perception of price inflation r, based on fixed-interest and index-linked gilt yields, as follows:

$$r = 1.0443/1.0194 - 1 = 0.0244 \qquad \text{i.e. } 2.44\% \text{ p.a.}$$

A.5.2.2 Determine the rate of dividend growth relative to this price inflation figure, using the real dividend growth assumption implicit in the long-term assumptions:

$$d_r = (1.03765/1.04) - 1 = 0.998 \qquad \text{i.e. } -0.2\% \text{ p.a.}$$

A.5.2.3 So, the dividend growth d is:

$$d = 1.0244 \times 0.998 - 1 = 0.0224 \qquad \text{i.e. } 2.24\% \text{ p.a.}$$

A.5.2.4 Then determine the return on equities i_e by solving the equation $\bar{a}_\infty \times 0.0292 = 1$, where $\bar{a}_\infty$ is calculated at a net rate of interest of $(1+i_e)/1.0224 - 1$.

A.5.2.5 This gives $i_e = e^{0.0292} \times 1.0224 - 1 = 0.0527$ i.e. 5.27% p.a.

A.5.2.6 Returns on fixed interest and index-linked gilts are the relevant yields.

A.5.2.7 Based on a portfolio of 80% equity, 10% fixed-interest, 5% index-

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

linked and 5% cash (say 5% p.a. expected return), the interest rate for valuation is:

$$i = 0.8 \times 0.0527 + 0.1 \times 0.0443 + 0.05 \times 0.0443 + 0.05 \times 0.05 = 0.0513$$
i.e. 5.13% p.a.

A.5.2.8 Pension increases are taken at market price inflation, namely 2.44% p.a.

A.5.2.9 Salary increases are taken at price inflation plus a margin, say 2%, giving 4.44% p.a.

A.6 *Method 3 (economic valuation using bond yields)*

A.6.1 Algebraically the liability valuation is the same as Method 0, except that the discount factor for the liabilities is taken from appropriate matching assets of appropriate term and the asset value is taken at market value.

A.6.2 *Example*

Assuming market pricing is taken from the gilt market, economic elements are taken directly from gilt market information, namely:

Investment return	4.43% p.a. (fixed-interest yield)
Salary growth	4.44% p.a. (market price inflation plus 2%)
Pension increases	2.44% p.a. (market price inflation).

A.7 *Method 4 (bond yields plus risk premium)*

A.7.1 Algebraically this method is identical to Method 3, except that the discount rate is adjusted according to (amongst other things) market conditions and investment policy.

A.7.2 *Example*

Assumptions are set as per Method 3. The discount rate is then adjusted by a risk premium. Using the approach adopted for the back and forward testing of Method 4 (the formula for which is set out in Appendix B), the addition to the discount rate as at 31 December 1998 is 0.69% p.a. giving:

Investment return	5.12% p.a. (fixed-interest yield)
Salary growth	4.44% p.a. (market price inflation plus 2%)
Pension increases	2.44% p.a. (market price inflation).

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

APPENDIX B

DERIVATION OF THE RISK PREMIUM EMPLOYED IN METHOD 4

B.1 In this appendix we justify the particular form of the adjustment given in Method 4 of Section 6. The key point is that, by suitable duration matching, we can justify Method 4 described below using a *model-free* argument. Thus, the method should sit equally well with any stochastic asset model.

B.2 *Notation*

y_f = yield on 15-year medium coupon fixed-interest gilts (*)
y_r = real yield on long-dated index-linked gilts (*)
d = gross dividend yield on equities
π = risk adjustment
= function of d, y_f and y_r
r = implied inflation
= $y_f - y_r$
δ = valuation force of interest
= $y_f + \pi$
M = current market statistics
= $\{d, y_f, y_r\}$.

(*) Yields are assumed to be continuously compounding rates.

B.3 The liability can be written as:

$$L = \sum_t c_t e^{rt} e^{-\delta t} = \sum_t c_t e^{-(y_r+\pi)t}$$

where c_t is the expected cash flow at t expressed in real terms relative to RPI (and includes allowance for the valuation real rate of salary growth over RPI).

B.4 Let the total assets be equal to A with a proportion p_i invested in assets i = 1 (equities), 2 (15-year 8% fixed-interest gilt) and 3 (long-dated 3.75% index-linked gilt).

B.5 Let $A_i = Ap_i$ be the amount held in asset i.

B.6 Suppose that the market conditions M change to:

$$M' = \{d', y_f', y_r'\} = \{d+\Delta d, y_f+\Delta y_f, y_r+\Delta y_r\}$$

where each of the changes, Δd, Δy_f and Δy_r are small. Then:

Equities	$A_1 \to A_1' = A_1\, d/d' \approx A_1(1-\tau_1 \Delta d)$
Fixed interest	$A_2 \to A_2' \approx A_2\,(1-\tau_2 \Delta y_f)$
Index-linked	$A_3 \to A_3' \approx A_3\,(1-\tau_3 \Delta y_r)$

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

where $\tau_1 = 1/d$ is the equities duration, and τ_2 and τ_3 are the durations of the fixed-interest and index-linked assets.
Thus $A \to A' \approx A(1 - p_1\tau_1\Delta d - p_2\tau_2\Delta y_f - p_3\tau_3\Delta y_r)$.
Similarly $L \to L' \approx L\,(1-\tau_L\,(\Delta y_r + \Delta\pi))$, where τ_L is the duration of the liabilities and $\Delta\pi$ is the change we choose to make to π in response to changes in the other economic variables.

B.7 When we consider stability we are concerned (amongst other things) with the asset-liability ratio. Here:

$$\frac{A}{L} \to \frac{A'}{L'} \approx \frac{A}{L}(1 - p_1\tau_1\Delta d - p_2\tau_2\Delta y_f - p_3\tau_3\Delta y_r + \tau_L(\Delta y_r + \Delta\pi)).$$

B.8 For the greatest degree of short-term stability we therefore aim to have:

$$1 - p_1\tau_1\Delta d - p_2\tau_2\Delta y_f - p_3\tau_3\Delta y_r + \tau_L(\Delta y_r + \Delta\pi)) = 1$$

that is:

$$\Delta\pi = \frac{p_1\tau_1\Delta d + p_2\tau_2\Delta y_f + (p_3\tau_3 - \tau_L)\Delta y_r}{\tau_L}.$$

B.9 We should, therefore, define the equity smoothing adjustment (as a function of time) to be:

$$\pi(t) = \pi_0(t) + \frac{p_1\tau_1}{\tau_L}d(t) + \frac{p_2\tau_2}{\tau_L}y_f(t) + \frac{(p_3\tau_3 - \tau_L)}{\tau_L}y_r(t)$$

where $\pi_0(t)$ is a smooth function (possibly deterministic and possibly constant).

B.10 The same method can be applied to the contribution rate. This is more complex, since the interest rate adjustment needs to depend upon the factors above plus pensioners' liabilities, the asset-liability ratio and the current funding level.

B.11 *Example*

All of the durations used in the calculation above vary over time with economic conditions. In practice, we use approximations to the durations based upon central assumptions. Thus, in the simulations, we took the fixed values $\tau_1 = 25$, $\tau_2 = 12$, $\tau_3 = 15$ and $\tau_L = 20$, and each year calculate directly the equity smoothing adjustment:

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

$$\pi(t) = \pi_0 + \frac{p_1\tau_1}{\tau_L} d(t) + \frac{p_2\tau_2}{\tau_L} y_f(t) + \frac{(p_3\tau_3 - \tau_L)}{\tau_L} y_r(t)$$

using the appropriate proportions in each asset class.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

APPENDIX C

MODEL PENSION SCHEME

C.1 The model scheme used in the back testing and forward simulations is as follows.

C.1.1 Benefits are 1/60 of salary at the date of retirement for each year of service.

C.1.2 Pensions are payable annually in advance and increase in line with full RPI.

C.1.3 There are no other benefits.

C.1.4 There are no member contributions.

C.1.5 The demographic elements of the valuation basis used were as follows:

Mortality	Pre-retirement	Zero
	Post-retirement	PA(90) minus 2 years
Other decrements	None	
New entrants	For forward modelling 10 p.a. at each of ages 20 to 29 inclusive. For back testing, 4 p.a. at each of ages 20 to 39, 2 at ages 40 to 49 and nil above this age	
Salary structure	All members receive the same salary p.a.	
Salary increases	In line with national average earnings, determined using a stochastically generated salary index for forward simulations	

C.1.6 The membership is assumed to have been in a stable state for many years.

C.1.7 On the traditional valuation basis used in Section 8 (Method 0), actives make up approximately 50% of the liabilities on the above valuation basis.

C.1.8 Liabilities are always valued as past service benefits only, and make full allowance for future expected salary increases.

C.1.9 Valuations are conducted using the projected unit method.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

APPENDIX D

NUMERICAL RESULTS OF SIMULATIONS

In the tables that follow, we use the following notation:

n = number of years in simulation
$F(t)$ = 100 $A(t)/L(t)$ = funding level at t
$CR(t)$ = $100C(t)/TSR(t)$ = percentage contribution rate
$F_e(t)$ = $A(t)/L_e(t)$ = funding level as a percentage of the Method 3 liability

$$CB5(t) = \frac{1}{5}(CR(t-2)+CR(t-1)+\cdots+CR(t+2)) = \text{5-year sample mean}$$

$$SVC5(t) = \frac{1}{5}\sum_{s=t-2}^{t+2}(CR(s)-CB5(t))^2 = \text{5-year sample variance}$$

$\Delta CR(t) = CR(t)-CR(t-1)$
$\Delta F(t) = F(t)-F(t-1)$

$$MF1 = \frac{1}{n}\sum_{t} F(t) = \text{mean funding level}$$

$$MF2 = \frac{1}{n}\sum_{t} F_e(t) = \text{standardised mean}$$

$$VF1 = \frac{1}{n}\sum_{t}(F(t)-MF1)^2 = \text{long-term variance of } F(t)$$

$VF2 = VF1 \times 10000/MF2^2$ = standardised variance of $F(t)$

$VF3$ = = short-term volatility

$VF4 = VF3 \times 10000/MF2^2$ = standardised short-term volatility

MC = = mean CR

$VC1$ = = long-term variance of $CR(t)$

$VC2 = VC1 \times 10000/MF2^2$ = standardised long-term variance

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

$$VC3 = \left(\frac{1}{n-4}\sum_{t} SVC5(t)\right) \times 10000 / MF2^2 = \text{standardised mean 5-year variance}$$

$$VC4 = \left(\frac{1}{n-1}\sum_{t} \{\Delta CR(t)\}^2\right) \times 10000 / MF2^2 = \text{standardised short-term volatility}$$

$$VC5 = \frac{1}{n-1}\sum_{t} (\Delta CR(t))^2 = \text{short-term volatility.}$$

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

APPENDIX E

NUMERICAL RESULTS OF BACK TESTING

Test 0 Typical U.K. pension fund asset distribution

	*MF*1	√*VF*1	√*VF*3	*MC*	√*VC*1	√*VC*5
Method 0	118.95	8.21	5.61	7.15	3.81	2.57
Method 1	118.34	8.08	5.57	7.27	3.61	2.87
Method 1a	118.16	10.94	6.30	7.29	4.87	2.69
Method 2	119.20	15.14	7.75	6.91	6.84	3.25
Method 3	118.33	15.38	10.05	7.47	6.85	4.16
Method 4	119.84	10.73	6.82	5.65	4.42	2.88

Test 1 Effect of fixing amortisation factor

	*MF*1	√*VF*1	√*VF*3	*MC*	√*VC*1	√*VC*5
Method 3	117.86	14.91	10.04	6.72	7.59	4.45
Method 4	119.48	10.39	6.79	5.09	4.97	3.09

Test 2 Investment strategy 50% U.K. equities, 50% index-linked gilts

	*MF*1	√*VF*1	√*VF*3	*MC*	√*VC*1	√*VC*5
Method 0	120.05	9.24	4.57	6.65	4.27	2.10
Method 1	119.82	9.17	4.55	6.79	4.11	2.29
Method 3	119.62	11.75	6.65	6.96	5.14	2.76

Test 3 Investment strategy 100% index-linked gilts

	*MF*1	√*VF*1	√*VF*3	*MC*	√*VC*1	√*VC*5
Method 0	105.25	4.70	2.40	13.44	2.16	1.10
Method 1	105.50	4.81	2.38	13.91	2.10	1.12
Method 3	105.50	4.11	2.34	13.75	2.24	2.26

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

APPENDIX F

STOCHASTIC INVESTMENT MODELS

F.1 Here we give a brief comparison of the two stochastic investment models used in the simulations in Section 8. The first model considered was the Wilkie model. This is well documented in the paper by Wilkie (1995).

F.2 The second model has been developed by one member of the Working Party. Details of the term-structure part of this model can be found in the paper by Cairns (1999b). The model can be considered in the form of a cascade model, although the model is Markov, meaning that all market variables in fact have equal status. Key features of this second model are:

— At the top layer the model considers nominal and real rates of interest.
— Retail price inflation is driven by the difference between short-term nominal and real rates of interest. This ensures that expected returns on index-linked bonds are consistent with the risk-free (nominal) rate of interest.
— All rates of interest evolve within an arbitrage-free framework (see, for example, Flesaker & Hughston, 1996; Rogers, 1997; Rutkowski, 1997).
— All nominal rates of interest are positive.
— Total returns on equities are driven by the risk-free rate of interest plus a risk premium plus a random error.
— Equity price changes are positively correlated with price changes on fixed-interest bonds.
— The model is constructed within a continuous-time framework, but is simple to operate (as it is here) in discrete time.
— The arbitrage-free nature of the model gives it a coherent short-term structure. In addition, the model is designed to give realistic long-term properties such as autoregression.
— The model incorporates factors which fluctuate in long cycles, so that, for example, prices can go through long periods of low, stable inflation and other long periods of high, unstable inflation. This feature produces results which can appear to be non-stationary over periods of, say, 100 years while, in fact, being genuinely stationary over much longer periods.

F.3 For the purpose of this paper, the Cairns model has been calibrated to give comparable real returns on each asset class when compared to the Wilkie model. Nominal returns in the Cairns model are on average 3% lower than the Wilkie model. This is partly dictated by the fixed-interest model under which long-term par yields must span the range 2.5% to 15% with reasonable probability. This calibration reduces the risk that differences between the two sets of results are the result of parameter risk rather than due to differences between the structures of the two models. Note that the existence of long cycles means

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

that the model is entirely consistent with, say, the last 50 or 100 years of U.K. data, even though, in the long run, mean returns are quite different.

F.4 Selected statistics relating to the two models are given in Tables F.1 and F.2.

F.5 Note that the qualitative conclusions drawn from the results of forward testing using these two models are not particularly sensitive to the parameter values used. For example, our observations would not change substantially if equities yielded 1% more or 1% less than assumed in our calculations.

Table F.1. Sample mean real returns on different assets on the two models (that is, the mean of the $TRI(t) \times RPI(t-1)/(TRI(t-1) \times RPI(t))$, where $TRI(t)$ is the total return index for the given index and $RPI(t)$ is the retail prices index, and not the mean of the log-returns); the Wilkie model uses irredeemable fixed-interest and index-linked bonds while the Cairns model uses 25-year par bonds; under the Wilkie model the cash account was constructed using a rolling portfolio in 1-year zero-coupon bonds; under the Cairns model a rolling portfolio in 1-month Treasury bills was used; U.S. equities were considered with and without the use of one-year currency forward contracts; in contrast to the Wilkie model, price inflation under the Cairns model is heavily skewed to the right, making periods of negative inflation (when nominal rates of interest are low) less severe than they would otherwise be

Class	Asset	Wilkie mean %	S.D. %	Cairns mean %	S.D. %
1	U.K. equities (net)	7.6	21.2	7.5	20.6
2	U.K. cash	2.2	4.7	2.5	1.4
3	U.K. consols (W)/ 25-year fixed-interest par (C)	4.3	12.3	4.0	11.4
4	U.K. 25-year index-linked par	3.7	12.2	3.6	4.1
5	U.S. equities (with currency forward)	8.3	26.0	–	–
6	U.S. equities (without currency forward)	9.4	28.6	–	–
Real salary growth		2.0	2.6	1.9	2.5
Annual price inflation		5.1	3.8	2.1	5.0

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

Table F.2. Sample correlation matrices for real returns on the Wilkie model (ρ_W) and on the Cairns model (ρ_C)

$$\rho_W = \begin{pmatrix} 1.00 & 0.21 & 0.26 & 0.05 & 0.61 & 0.54 \\ 0.21 & 1.00 & 0.54 & 0.09 & 0.18 & 0.05 \\ 0.26 & 0.54 & 1.00 & 0.40 & 0.19 & 0.11 \\ 0.05 & 0.09 & 0.40 & 1.00 & 0.01 & 0.00 \\ 0.61 & 0.18 & 0.19 & 0.01 & 1.00 & 0.87 \\ 0.54 & 0.05 & 0.11 & 0.00 & 0.87 & 1.00 \end{pmatrix}$$

$$\rho_C = \begin{pmatrix} 1.00 & 0.10 & 0.58 & 0.03 & - & - \\ 0.10 & 1.00 & 0.26 & 0.27 & - & - \\ 0.58 & 0.26 & 1.00 & 0.07 & - & - \\ 0.03 & 0.27 & 0.07 & 1.00 & - & - \\ - & - & - & - & - & - \\ - & - & - & - & - & - \end{pmatrix}$$

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

APPENDIX G

FORWARD SIMULATION RESULTS

G.1 In the tables below the quoted statistics are the sample means and variances calculated from a single 1000-year scenario generated by either the Wilkie (1995) or the Cairns (1999) stochastic investment model. Apart from the choice of model, we always use the same scenario in each set of calculations to eliminate differences due to sampling errors.

G.2 The various statistics are defined in Appendix D. *VF*1, *VF*2, *VC*1 and *VC*2 are all long-term variances; *VC*3 measures 5-year volatility; *VF*4 and *VC*4 measure short-term volatility.

Table W0. Experiment 0; Model W; central basis, but with barriers at 0.1 and 10

	*MF*1	*MF*2	√*VF*1	√*VF*2	√*VF*4	*MC*	√*VC*1	√*VC*2	√*VC*3	√*VC*4
Method 0	119.4	108.7	21.1	19.4	6.4	4.9	12.3	11.3	3.7	3.8
Method 1	119.0	108.4	20.8	19.2	6.5	5.0	12.6	11.6	4.1	4.3
Method 2	127.9	126.6	23.9	18.9	6.3	1.8	16.1	12.7	5.5	5.9
Method 3	132.4	132.4	29.5	22.3	13.2	–1.2	19.6	14.8	7.8	8.8
Method 4	113.5	97.0	20.2	20.8	7.5	7.3	11.1	11.4	4.0	4.2

Table C0. Experiment 0; Model C; central basis, but with barriers at 0.1 and 10

	*MF*1	*MF*2	√*VF*1	√*VF*2	√*VF*4	*MC*	√*VC*1	√*VC*2	√*VC*3	√*VC*4
Method 0	134.4	146.3	46.8	32.0	4.3	–4.0	27.6	18.9	3.3	2.6
Method 1	130.6	142.0	38.4	27.0	4.1	–3.1	25.8	18.2	4.1	3.6
Method 3	135.1	135.1	41.4	30.6	13.3	–2.4	26.6	19.7	8.5	8.6
Method 4	125.8	123.7	37.3	30.2	5.9	0.7	22.2	17.9	4.3	4.1

Table W1. Experiment 1; Model W; central basis, Method 1(a) uses a notional portfolio of 50% equities and 50% index-linked gilts; all other methods (other than Method 3) use the actual portfolio

	*MF*1	*MF*2	√*VF*1	√*VF*2	√*VF*4	*MC*	√*VC*1	√*VC*2	√*VC*3	√*VC*4
Method 0	110.2	100.3	12.9	12.9	6.8	6.5	18.8	18.8	14.6	19.3
Method 1	110.1	100.2	13.0	12.9	6.9	6.6	20.1	20.1	16.4	21.8
Method 1(a)	113.8	117.0	11.8	10.1	5.9	3.0	24.5	20.9	16.9	22.4
Method 2	113.6	112.4	12.4	11.1	6.9	4.8	25.2	22.4	18.8	24.8
Method 3	109.9	109.9	16.6	15.1	14.6	2.6	42.1	38.3	36.1	49.1
Method 4	106.6	91.1	13.7	15.0	8.0	8.2	18.7	20.6	16.8	22.4

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

Table W2. Experiment 2; Model W; central basis, but with an amortisation factor of $k = 0.15$

	*MF*1	*MF*2	√*VF*1	√*VF*2	√*VF*4	*MC*	√*VC*1	√*VC*2	√*VC*3	√*VC*4
Method 0	108.3	98.6	11.7	11.8	6.8	6.8	17.3	17.5	12.7	16.4
Method 1	108.2	98.5	11.7	11.9	6.8	6.9	18.3	18.6	14.1	18.5
Method 3	108.9	108.9	15.9	14.6	14.6	2.7	40.9	37.6	35.2	47.2
Method 4	105.4	90.1	12.0	13.3	8.0	8.4	17.3	19.2	14.8	19.6

Table W3. Experiment 3; Model W; central basis, but with an amortisation factor of $k = 0.06$

	*MF*1	*MF*2	√*VF*1	√*VF*2	√*VF*4	*MC*	√*VC*1	√*VC*2	√*VC*3	√*VC*4
Method 0	112.0	101.9	14.0	13.7	7.0	6.2	20.9	20.5	17.0	22.9
Method 1	111.8	101.7	14.1	13.9	7.1	6.3	22.2	21.8	18.7	25.2
Method 3	110.8	110.8	17.2	15.5	14.7	2.5	43.4	39.2	37.3	51.2
Method 4	107.6	92.0	15.2	16.5	8.1	8.0	20.1	21.9	18.6	25.1

Table C4. Experiment 4; Model C; central basis, but with 80% equities and 20% index-linked

	*MF*1	*MF*2	√*VF*1	√*VF*2	√*VF*4	*MC*	√*VC*1	√*VC*2	√*VC*3	√*VC*4
Method 0	112.7	127.0	19.5	15.4	3.9	–4.8	36.9	29.1	13.0	13.4
Method 1	112.1	126.3	18.8	14.9	4.2	–4.8	41.6	32.9	20.3	26.1
Method 3	107.8	107.8	23.6	21.9	18.7	–2.5	69.2	64.2	57.2	74.7
Method 4	108.8	105.5	19.5	18.5	8.3	–0.1	41.9	39.7	31.9	42.9

Table C5. Experiment 5; Model C; central basis, but with 40% equities and 60% index-linked

	*MF*1	*MF*2	√*VF*1	√*VF*2	√*VF*4	*MC*	√*VC*1	√*VC*2	√*VC*3	√*VC*4
Method 0	109.9	109.0	13.9	12.7	4.3	7.3	16.5	15.2	9.6	12.5
Method 1	110.2	109.4	13.9	12.7	4.4	7.2	17.7	16.2	11.2	14.8
Method 3	109.5	109.5	15.0	13.7	9.3	7.1	29.6	27.0	23.3	30.5
Method 4	108.1	100.9	14.2	14.1	4.8	8.9	16.6	16.5	12.1	16.3

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

Table C6. Experiment 6; Model C; central basis, but with 100% in index-linked bonds

	*MF*1	*MF*2	√*VF*1	√*VF*2	√*VF*4	*MC*	√*VC*1	√*VC*2	√*VC*3	√*VC*4
Method 0	96.4	89.3	8.9	10.0	4.4	18.2	5.4	6.0	2.6	2.8
Method 1	96.6	89.4	8.8	9.8	4.4	18.2	5.3	5.9	2.6	2.8
Method 3	102.2	102.2	4.8	4.7	1.8	18.0	5.4	5.3	2.4	2.5
Method 4	95.7	88.0	3.5	4.0	1.7	19.0	3.2	3.7	1.3	1.3

Table W7. Experiment 7; Model W; central basis, but with 60% in U.K. equities, 5% in cash, 10% in consols, 5% in index-linked and 20% in U.S. equities with 1-year currency forwards

	*MF*1	*MF*2	√*VF*1	√*VF*2	√*VF*4	*MC*	√*VC*1	√*VC*2	√*VC*3	√*VC*4
Method 0	110.8	99.7	15.7	15.7	9.5	2.6	28.6	28.6	23.3	31.4
Method 1	110.1	99.1	16.1	16.2	9.4	2.7	29.5	29.8	24.5	33.3
Method 3	109.3	109.3	20.9	19.2	19.5	–3.0	61.8	56.6	53.7	73.1
Method 4	107.3	90.7	16.3	18	10.1	4.6	26.9	29.7	24.0	33.6

Table W8. Experiment 8; Model W; central basis, but with 60% in U.K. equities, 5% in cash, 10% in consols, 5% in index-linked and 20% in U.S. equities without 1-year currency forwards

	*MF*1	*MF*2	√*VF*1	√*VF*2	√*VF*4	*MC*	√*VC*1	√*VC*2	√*VC*3	√*VC*4
Method 0	113.9	109.0	14.3	13.1	8.8	–1.2	29.6	27.1	22.3	29.6
Method 1	113.6	108.7	14.0	12.9	9.0	–1.1	32.3	29.7	25.5	34.8
Method 3	110.3	110.3	20.8	18.9	19.7	–4.8	63.2	57.3	55.1	74.9
Method 4	109.2	92.3	15.2	16.5	10.2	3.2	25.8	27.9	23.3	32.6

Table W9. Experiment 9; Model W; central basis, but with 80% in U.K. equities, 5% in cash, 10% in consols, 5% in index-linked and 0% in U.S. equities

	*MF*1	*MF*2	√*VF*1	√*VF*2	√*VF*4	*MC*	√*VC*1	√*VC*2	√*VC*3	√*VC*4
Method 0	110.6	102.4	14.8	14.4	7.3	4.1	24.0	23.4	17.5	22.6
Method 1	110.5	102.4	14.7	14.4	7.4	4.2	25.6	25.0	19.6	26.0
Method 3	108.5	108.5	20.8	19.2	19.8	–1.2	59.3	54.7	52.0	70.2
Method 4	106.1	89.7	15.7	17.5	9.9	6.5	24.9	27.7	22.8	30.8

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

ABSTRACT OF THE DISCUSSION

Mr S. J. Head, F.I.A. (introducing the paper)**:** The paper is the report of a Working Party, originally set up in the wake of the changes to Advanced Corporation Tax in the 1997 Budget, but whose work has become even more topical since then. We took part in current issues seminars run by the Faculty and Institute early in 1998. It was very clear to us, from the discussions at those seminars, that what the profession was seeking from a group such as ours was research and analysis of different valuation methods, and it was also very clear what the profession was not seeking. Actuaries did not want to be told how to do a valuation, but rather to see some analysis, which would then allow members of the profession to proceed, using their own professional judgement.

So, we set out to produce a paper accessible to all pensions actuaries and actuarial students that would provide the research which the profession was seeking, and this is that paper.

One point that we make early in the paper is the importance of identifying the purpose of an actuarial valuation. Section 2 clearly draws a distinction between calculations carried out for funding (that is setting employers' contribution rates) and other types of valuation, which we describe as 'pricing valuations', where the aim is, not to produce a contribution rate, but to place a value or a price on a pension liability. There is a clear distinction between the two, and it is important to identify this at an early stage.

We then proceed to set out a number of valuation approaches, and we believe that these are all in use to calculate liability values for comparison with the market value of scheme assets. At one end of the spectrum is our Method 1, which simply applies the traditional discounted cash flow market adjustment on the other side of the valuation balance sheet. At the other end of the spectrum is our Method 3, what we call the economic valuation using bond yields, where the market pricing of liabilities is carried out by reference purely to forward rates of interest achievable on fixed-interest and index-linked bond investments. Most, if not all, market-based methods in use can be categorised into one of the methods that we set out in the paper, although we may hear, in this discussion, from those who are using something significantly different from what we have described.

One area that we touch on briefly, but may be one for further investigation, is the smoothing of valuation results. We did not spend a great deal of time investigating different 'smoothing' methods, and we know that there are many in use, particularly when it comes to determining employers' contributions. In ¶4.5.5 we state that: "Armed with an unsmoothed series of results, it is possible" to produce as smooth a result as you wish by some explicit smoothing method, and we leave it to others to take on investigating the different ways in which that can be done.

I have a few comments on what we call Method 4; namely, valuing based on bond yields plus a risk premium. In Appendix B there is the derivation of a formula to determine a risk premium. This aims to achieve the greatest local smoothness of funding level. The results in Section 8 show that, in this respect, it is reasonably successful. However, do not think that this means that we have found 'the answer' to setting the risk premium. It is primarily the reliance on equity dividend yield which generates this smoothness, but this also builds in many of the same characteristics as traditional methods, namely the exposure to changes in dividend yields over longer time periods.

Professor Clarkson has pointed out that the second asset model described in Appendix F has been incompletely referenced. A complete description of the model used is given in a working paper produced by Dr Cairns (1999b).

In our conclusions we draw out a number of key points. Principally we say that, whatever approach is taken to the valuation, professional judgement remains of vital importance. Clearly there are some valuations, for instance for statutory purposes, where the rules of the game must be enforced, although professional judgement still has a part to play in setting those rules. Other valuations, for instance for funding, allow significant flexibility for the actuary to exercise his or her judgement, and, therefore, place a great responsibility on the actuary to do so correctly.

Another conclusion, set out in ¶10.4.2, relates to the MFR basis, which was mentioned in

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

our terms of reference as a Working Party. We use this to illustrate how important it is to identify the purpose of a valuation. If the existing terms of reference for the MFR are retained, we believe that something along the lines of our Method 4, using bond yields plus a risk premium, would be appropriate. If, however, the MFR required the valuation of near certainty of provision, then our Method 3, using bond yields alone, would appear the logical option.

Mr M. S. Demwell, F.I.A. (opening the discussion)**:** The authors set out their terms of reference in ¶1.4, paraphrased as:

(1) to consider the merits of various valuation methods;
(2) to advise what was then the MFR Change of Conditions Working Party; and
(3) to have regard to the needs of users of valuations and the need for our profession to communicate effectively.

If this paper has achieved all of that, it will have made a major contribution to our profession at this time of change. So, has it? It has, at least, produced some very helpful lists.

In Section 6, there is a useful list of seven valuation methods, and there is another useful list, in Section 7, of seven stakeholders in pension schemes (I will call them 'clients'), whose interests we have to consider when evaluating alternative approaches. Here there should have been a mention of pension schemes' governing documentation, which may affect and restrict trustees' and employers' approaches to funding.

Section 9 lists nine attributes by which various methods are assessed. These are very helpful, especially the authors' use of the word 'properties' when describing them, rather than 'advantages and disadvantages', with all the misleading presumptions that those terms carry.

I comment specifically on three of the attributes. First, there is simplicity. In describing 'simplicity' there is some blurring between ease of calculation and ease of determining the assumptions. We should not place too much emphasis on the former, and the latter is covered by another attribute: 'objectivity'. In some situations there is value in deriving assumptions objectively. However, where they are subjective, the profession should produce some appropriate benchmarks, as the subjective element of our work is that which usually adds most value for our clients.

One of the most important attributes listed is: "Applicability to other valuation purposes". Accounting standards are converging on market-based methods. Market-based valuations are already commonplace in commercial transactions. This paper seems likely to assist the trend towards market-based methods for funding purposes. If the MFR goes the same way, perhaps the statutory surplus basis will follow. Harmonising valuation methods over a range of purposes would make pension scheme management easier and more cost-effective.

The discussion in Section 9 is most helpful on the mathematical modelling carried out, and Table 9.1 is an interesting summary of the attributes possessed by each of the methods tested. Some of the conclusions are debatable. For example, is Method 3, the one derived from financial economics and described in Section 6.5, the only method that is durable in the face of changing conditions? The shortcomings of Method 3 become apparent when we look at the results of the back testing; its contribution requirement seems high compared with other methods, and is certainly highly variable.

There are some areas where I hope that this paper will prompt further research:

(1) *Future service liabilities.* In ¶6.1.2 the authors discuss the possibility of using different methods for assessing past and future service liabilities. In the event of a discontinuity in the relationship between asset values and gilt yields, the use of 'set' assumptions for the future service rate may be helpful. 'Set' assumptions are not market-based, but are determined by the actuary, having in mind the assumed average of conditions over a long period. I prefer 'set' assumptions rather than calling them 'long-term' assumptions, because the spot rates used in a market-based valuation are just as much long-term assumptions. Whatever we call them, it is clear that we need to refine and preferably standardise our terminology as we develop market-based methods.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

(2) *Mature schemes*. The model scheme used has some 50% of its liabilities attributable to active members. Many schemes, some of them very large ones, are much more mature than this. Further research is needed into the behaviour of mature schemes under different valuation methods.

(3) *Contributions*. I note that the authors assumed that employer contributions were made "in accordance with the valuation method chosen." There is some logic to this, but I wonder whether a uniform set of employer contributions would have been less liable to distort the results. It would be interesting to see what the results might have looked like on that basis.

(4) *Technical*. The detail of carrying out market-based valuations is not within the remit of this paper. Further work on the practicalities would be valuable, since matters, such as the following, present real challenges under new and unfamiliar valuation methods:
   (1) In ¶4.3.2 it is pointed out that: "consistent application of the traditional method would also apply the asset adjustment to the derived contribution rate", but, unless market conditions remain constant, this problem also applies to market-based methods. We need either to find practical solutions or to make sure that we explain the potential discrepancy very clearly to our clients.
   (2) The choice of the equity risk premium and the question of smoothing are other challenges. The paper sets out, in Appendix B, a method of derivation which aims to smooth short-term fluctuations in funding levels. We should produce, initially, market-based valuation results with a constant equity risk premium. We may use our judgement to smooth the results, and we may use tools such as that in Appendix B, but we should present any smoothing as a subjective and pragmatic step. If we suggest that it is scientifically justified, we risk being accused of second-guessing the market.
   (3) In referring to overseas equities, ¶4.2.5 points out that: "attempts to apply the traditional method to such assets appear to have been unsuccessful." The choice of equity risk premium for overseas equities is no less problematical.
   (4) How much difference time-specific discount rates would make will depend on the degree of refraction in the yield curve and on a particular scheme's liability profile. We need simple rules of thumb, but, in any case, how easily could our computer systems cope, and how easily can we interpret and present the results?
   (5) In ¶6.5.3 the authors discuss non-hedgeable risks. It would be valuable to find ways of managing these. For example, could the 'systematic mortality risk', described by the authors, be offset by self-insuring death in service benefits?

If and when further research takes place, I suggest that we need to market test our findings on our clients. Perhaps we could take a lead from the work done by the Accounting Standards Board recently in advance of issuing their new FRED.

The authors' second objective is: "to advise the MFR Change of Conditions Working Party" or to feed into the new MFR review process. The paper sets out some brief comments in ¶10.4.2. It is for whichever working party takes this on to decide whether they agree with the conclusions reached, or whether they require any further research. Whatever they decide, I commend to them, also, the suggestion of market testing their findings, but I would add another client group to be consulted: civil servants and politicians.

Now I consider the third and final objective: "to address the needs of users of valuations and the need for our profession to communicate effectively". To achieve this, we first need to understand clearly, and I would highlight two particular areas:

(1) *Financial economics*. This paper contains a helpful introduction to the subject of financial economics. However, while noting what we can learn from financial economics, it is important, also, to note its shortcomings as a way of solving actuarial problems. For example, in ¶6.5.3 it states that a matching bond portfolio "leaves the minimum amount of risk with the fund sponsor". This should not be stated without also noting that the price of reducing risk is to increase the cash cost.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

(2) *Business management*. Among their conclusions, in ¶10.2.5, the authors propose that market-based methods should be included in the actuarial education syllabus. I agree, and I would add modern financial management techniques, such as economic value added. When we are advising corporate clients, we need to understand how they run their businesses if we are to adopt actuarial methods which support their business objectives. We also need to be aware of the management approaches being applied in rewarding shareholders if we are to understand and model the behaviour of equity markets.

Next, how effectively do we communicate with the consumers of our advice? The authors refer, in ¶4.1.1, to the presentational credibility of the discounted income method. However, I question whether many of our clients ever fully understood the method, and I suspect that they have only accepted it because we have wielded it to such good practical effect in the past.

We should extend our relationship with other disciplines. To maintain our technical arsenal, and our credibility with clients, we must remain up-to-speed with developments in fields such as business management, accounting and financial economics. However, we must not slavishly apply to pension fund valuations methods designed for quite different purposes. Actuaries remain uniquely well qualified to advise in our specialist fields. We should learn from other disciplines, but not be led by them.

There is a need for effective communication. This starts with actuaries' own understanding, and proposals have been made for the education process. These issues also need to form part of our continuing professional development. Most would agree that actuaries have much to learn from communications experts. We should continue to develop our communication skills, to ensure that we explain what we are doing clearly, concisely, simply and intuitively.

The paper makes a valuable contribution to our understanding of market-based valuation methods. The authors have been thorough in their investigations, and these will stimulate both a lively debate and also the further research that is needed if we are to build on this work.

Mr S. J. B. Mehta, F.I.A.: The authors appear to fail in their stated principal aim of producing a paper that is practical and helpful to pension scheme actuaries. It is, perhaps, too much to expect the Working Party, comprised of mainly United Kingdom pensions actuaries, to achieve anything other than a watering down of the financial economics logic and a restatement of the traditional actuarial technology. Equally, they cannot expect financial economists to tone down criticism of the paper. Nevertheless, the paper is helpful for the actuarial debate, inasmuch as there is no pretence at defending actuarial Methods 0, 1, 2 and 4. A significant part of the case for the financial economic Method 3 is set out.

The authors confuse the unwary by labelling actuarial Method 1 as the market value adjustment approach; Method 2 as having a direct market reference; Method 4 as being based on bond yields plus a risk premium, and attempting to qualify Method 3 as being based on bond yields. Indeed, over the last two years, there has been a marked trend by some consulting actuaries to call actuarial method valuations 'market related'. I suggest that no one will be truly fooled by this trend and the paper's approach. The hope is to take advantage of the recent trends towards the financial economic view of the world, whilst avoiding the investment required in technology and education to undertake a market-value-based valuation.

I believe that this lack of investment is short-sighted, and the attempts to confuse clients could equally prove short-sighted. The greatest shortcoming of the paper is in the conclusions section. It does not take account of the financial economics logic set out in Section 5, and more fully set out in the recent papers by Exley *et al.* (1997) and Gordon (1999). I suggest that it is to these papers that pension scheme actuaries should look for practical and helpful input to the advice that they provide for clients.

In many regards, reference to this paper is likely to be misleading to those actuaries seeking financial-economics-based guidance. The authors further confuse by suggesting that market approaches rely on subjective judgement, and, therefore, that actuarial Method 4 could be used instead. Introducing Method 4 allows the use of Methods 0, 1 and 2 by the back door. One could

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

just imagine a rogue trader at a bank, finding himself short of ICI shares one day. He could argue that one should value the shares at 80% of market value, and then argue for a higher valuation when he finds himself long, using a negative risk premium in the terminology of Method 4. How ludicrous!

It would be most convenient for some to disguise volatility in this way, but, luckily for the U.K., it seems likely that financial economists and the accountancy profession will continue to force traditional actuaries into retreat, at least in this area. Profit in any company is the difference between the two large numbers of revenue and outgo. I believe that it is crucial, in an increasingly competitive world, for companies to assess value and risk accurately. A seemingly small improvement can generate enormous improvement in profitability. It is, therefore, in the interests of executives in British industry to press their actuarial advisers to abandon their actuarial valuation and asset liability management technology and to adopt Method 3. Shareholders benefit from the resulting improvement in share prices. Trustees and beneficiaries also benefit when they learn, for the first time, whether their schemes are solvent and what risks they are running.

Mr J. L. Shuttleworth, F.I.A.: This is a timely paper. One might be forgiven for thinking that nothing could be simpler than a market value valuation. All that one would need to do would be to take the assets at market value; the liabilities would be discounted at either the rate on the best matching assets or the expected return on the investments actually held. This paper suggests something more complex.

I have two main criticisms of this paper. First, there is very little in it on how pensions are valued in corporate finance transactions. This is a crucial aspect. In relatively recent times pension liabilities have been valued in deals by taking the prevailing rate of interest on bonds, and then adding an equity risk premium. The choice of equity risk premium is negotiated between the purchaser and the vendor. Where pensions are large relative to the whole deal, the equity risk premium struck between the purchaser and the vendor is a small one. To take this to an extreme, if pensions are very large, the equity risk premium struck could be nil. This is what is happening when our clients exchange money. To depart from it is to risk our credibility. Logically, this brings us to Methods 3 or 4. The distinction between funding and accounting is a crucial one. I do not agree that it is made in the paper as clearly as Mr Head indicated in his opening remarks. Accounting is about the best matching asset. Funding is about the investments actually held. It is a crucial distinction that we must not lose sight of.

My second criticism concerns Method 4. This recognises, correctly, that the equity risk premium is unknowable. It follows that, where we have a pension scheme with mis-matched assets and liabilities, the surplus is volatile. However, it does not follow, as the authors suggest, that the cash contributions have to be volatile too. There is a perfectly reasonable range of views for what the equity risk premium might be in the future. Nobody knows exactly what it is going to be, but, because there is a range, there is also a range of what the contributions reasonably might be. Hence, it is legitimate for clients to smooth the contributions. What is not legitimate is for us, as actuaries, to hide from our clients the inherent volatility in a mis-matched pension scheme's surplus, and thereby prejudge the debate.

Nor does it follow that pension schemes should invest entirely in bonds. This is a matter for the trustees and the sponsoring employer. Few are so risk-averse as to want to do this. For the employers, this is perhaps not unsurprising. They commonly want the lowest cash cost.

It is surprising that U.K. trustees invest so little in bonds. Their primary duty is to deliver the benefits promised to their members. Do some trustees really understand the level of complexity and of the risks that they are running on behalf of their members?

Actuaries will need to come to a view as to what the equity risk premium will be. This is no more than speculation. However much clever analysis we do, the quantum of the equity risk premium will not, somehow, be revealed to us, nor will complex models, like the one in Appendix B, improve the quality of the answer. Such models serve only to confuse and make opaque what, with a little effort, can easily be made transparent to our clients.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

Appendix B is not a credible model of the equity risk premium, and the authors recognise this in ¶8.2.4.6. If we, as a profession, persevere with it, we will run the risk of inviting scorn.

Mr D. J. Parsons, F.I.A.: At last I know what a market-based valuation is. I have been trying to find out for some years, and suddenly, not only do we have a paper, but I have also been asked to review a couple of valuation reports, and I almost understand it. A market-based valuation is one where you take the market value of assets and choose the other assumptions based on your perception of market forces at the valuation date, based on the difference between various indices.

What is new? This is exactly what we were doing when I started working in 1971. The only difference that I can see is that, at that time we were taking assets at a smoothed market value. So, is this new method the same, but removing the smoothing? I think that the terminology is wrong. Why is this called a method when it is really just a slightly more scientific way of choosing actuarial assumptions? It is a natural evolution from the thoughts set out in Thornton & Wilson (1992). The terminology just gives undue prominence to a procedure which is not new.

It worries me when I disagree with something in the first paragraph of the paper, where it suggests that the method of valuing assets by discounting income is traditional. How long do you have to do things for it to become traditional? I was involved in the use of the discounted income method only once in the years 1971-1986. The actuaries in my firm could not justify putting extravagantly different values on two individual investments which had the same market value, and they did not. If we had felt that we were competent to put ourselves above the judgement of the stock market, we would have been in a different profession. I have not changed my views. I have used the method since, but only through peer pressure. It was not perceived as actuarial correctness to value assets in any other way. However, I justified it to myself and to my clients as an easy way of smoothing market values. As I see it, the problem started when people began to believe in actuarial correctness. They seemed to believe that, by setting assumptions, the market would follow the predicted behaviour patterns. Did we not learn from King Canute?

Pension scheme funding is not a smooth ride. You can get over this by trying to immunise everything at enormous expense to the sponsoring employer, minimising surpluses and deficits, or you can have flexibility. Flexibility can give a lower cost to the sponsoring employer, and, if properly managed, it can still provide a cushion against deficiencies.

Arguably, matters have not been properly managed, so things are being taken out of the hands of individual actuaries. Statutory actuarial bases are being set for us, but what is more problematic is that the scope for discretionary benefits in pension funds is now very small. What do we do if we have a surplus? One thing that I notice from the valuation reports that I reviewed and from this paper is that a higher level of prudence is appearing in actuarial assumptions. It looks to me like funding for surplus. Whatever happened to best estimates? The figures in Section 8 suggest to me that the only way of avoiding a surplus is to immunise everything by investing in bonds and in index-linked gilts. Is this what the financial economists want us to do?

Reference

Thornton, P.N. & Wilson, A.F. (1992). A realistic approach to pension funding. *J.I.A.* **119,** 229-312.

Professor R. S. Clarkson, F.F.A.: I comment on the appropriateness, or otherwise, of the no-arbitrage principle of financial economics that is put forward in the paper as the main justification for a market value approach in general, and a bond portfolio value approach in particular.

In Section 5.1 the authors describe financial economics as a body of theories which seeks to explain the market prices of financial instruments and the development of market prices over time. They also admit that theory has to be tested against real-world observations, but, in my opinion, they are scientifically and professionally negligent in not drawing attention to the many

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

glaring differences between theory and reality. I limit myself to four areas of blatant inconsistency:

(1) The mathematician and fund manager, Edgar Peters (Peters, 1991), has used Hurst exponent analysis to show that medium-term trend persistence is an inherent characteristic of stock market prices.
(2) The economist, Robert Shiller (Shiller, 1989), has documented the phenomenon of excess volatility — the observed volatility of share prices being an order of magnitude higher than what is expected on the basis of the axioms of financial economics.
(3) Warren Buffett (Hagstrom, 1994), by far the most successful long-term investor of modern times, comments as follows: "With prices set at the margin by the most emotional person, or the greediest person, or the most depressed person, it is hard to argue that the market always prices rationality. In fact, market prices are frequently nonsensical."
(4) Benoit Mandelbrot (Mandelbrot, 1999), one of the most brilliant present-day mathematicians, had an article in the February 1999 issue of *Scientific American*, showing that the observed dynamics of stock market prices bear no resemblance whatsoever to the teachings of financial economics.

If financial economics cannot make financial sense of the past, why consider using these methodologies in our endeavours to make financial sense of the future?

In the paper frequent references are made to the financial economics methodologies in Exley *et al.* (1997). At the 1999 Investment Conference of the Faculty and Institute of Actuaries, when the same three individuals were trying to tell us that the risk-adjusted returns on all asset classes are identical, and, accordingly, that pension fund sponsors are misguided to invest mainly in equities, I asked if it had ever occurred to them to look at the real-world history of U.K. investment returns, such as is set out very comprehensively in the annual Barclays Capital (formerly BZW) *Equity-Gilt Studies*. I am disappointed, but not surprised, that the paper makes no reference to this or to similar empirical evidence of what actually happens in the real financial world.

Recently I carried out some research on U.K. investment returns, using the 1999 Barclays Capital *Equity-Gilt Studies*, and my conclusions appear in 'The Long-Term Case for U.K. Equities', in the December 1999 issue of *The Actuary*. My most important conclusion is that the trend of the real rate of return on U.K. equities is 8.7% p.a. as against 3.6% p.a. on conventional gilts, a margin of 5.1% p.a. in favour of equities. More tellingly, if we look at the 71 rolling ten-year periods in the experience from 1918 to 1998, we find that in only one period — not surprisingly from the end of 1928, just before the Wall Street crash of 1929 — was the real return on U.K. equities, at the still highly satisfactory value of 5.2% p.a. over the period, below that on gilts by other than a trivial margin.

To argue, in the face of this empirical evidence, that, for long-term financial control purposes, a bond portfolio can, in any way, reflect the characteristics of a portfolio that is invested mainly in equities is the logic of a lunatic asylum, not of actuarial science.

I now comment on the two stochastic models referred to in the paper. My 5.1% p.a. margin of out-performance of equities over gilts is significantly higher than, but of the same order of magnitude as, the 3.3% differential in the version of the Wilkie model used by the authors.

As regards the Cairns model, the very worrying 3% p.a. discrepancy in nominal yields as against the Wilkie model suggests to me that something has gone very seriously wrong in the calibration process. Furthermore, contrary to what you might reasonably have inferred from Appendix F before this discussion, Cairns (1999a), describing the Cairns model, is not only highly theoretical in nature, but also makes no reference to equities or to the detailed method of fitting the bond parameters. As Mr Head mentioned in his opening comments, an extension of this AFIR paper to equities now exists, but there is still no discussion of the crucial calibration process for bonds, let alone for equities. This is simply not good enough in terms of our high professional standards. If a practical paper, discussing, not only the justification for the equity formulation, but also the crucial calibration process against

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

empirical data, cannot be produced forthwith for those, such as myself, who wish to carry out due diligence on the model, I suggest that all mention of the Cairns model should be deleted from the paper.

Returning now to the authors' brave new world of a market value approach, we learn, towards the end of the paper, that funding rates would be much more volatile than with the stabilising financial framework provided by the Day & McKelvey (1964) methodology, that the proportion invested in equities might have to be reduced, thereby increasing the cost to the sponsors of the pension scheme, and that the funding target might have to be set well below the obvious common-sense figure of 100%. Even worse, the authors have failed to recognise a far more serious financial risk, namely the possibility of triggering a self-feeding downward spiral of equity prices not dissimilar to the chain reaction that wiped out the Long-Term Capital Management hedge fund in 1998, and could easily have taken a large part of the world's financial markets and banking system with it.

To summarise, the no-arbitrage principle on which the case for the unthinking, highly erratic, costly, and potentially destabilising market value approach is predicated is blatantly inconsistent with all the empirical evidence. Hence, I suggest that the market value approach should be rejected out of hand as being totally inconsistent with our stated actuarial science motto of making financial sense of the future.

References

PETERS, E.E. (1991). *Chaos and order in capital markets*. Wiley, New York.
SHILLER, R.J. (1989). *Market volatility*. Massachusetts Institute of Technology.
HAGSTROM, R.E. (1994). *The Warren Buffet way*. Wiley, New York.
MANDELBROT, B.B. (1999). A multifractal walk down Wall Street. *Scientific American*, February 1999, 70-73.

Mr A. D. Smith: The funding results produced by actuarial valuations are not transparent. The most important line in this paper is in ¶2.9: "Neither the income from the assets held nor an assumed return on net inflows or outflows enter an economic valuation". This is the acid test — it distinguishes a complacent fudge, judge and bodge approach from robust economic valuations that deserve, and enjoy, external credibility.

The worst section of this paper is Section 3, the history. The sanitised version presented borders on deception. So what is the inside story? It is rather like a game, but the actual game being fought, and the team line-ups, are not always what you might think.

In the red corner we have shareholders, capitalists, who want to maximise their own wealth. As part of this, shareholders prefer transparent financial reporting, so they can select skilled managers. In the blue corner we have current managers, who also want to maximise their own wealth, partly by controlling information flow, thus maximising their compensation and minimising their chance of being sacked.

Each fighter has his or her own team. In the red corner, on the shareholders' side, we also have the stock exchanges and their regulators, who sponsor various other parties, including accounting standards bodies such as the U.K. ASB, the FASB in the United States of America, and the International Accounting Standards Committee (IASC) internationally. Some investment actuaries have also played on this side, in their capacity as advisors to trustees, who are themselves responsible for scheme investment policy.

Supporting the blue corner, management have engaged various bodies to argue their case, including accounting firms and many members of this Institute. The traditional means by which managers regulate pension information flow is the control of accounts by the use of so-called actuarial judgement — pressure may be brought to bear on an actuary to fudge, judge and bodge, so a predetermined answer is disclosed. Unsurprisingly, the pressure has usually been in the direction of lower disclosed liabilities, for example, the hiding of a deficit. Some actuaries have openly advertised their willingness to use 'equity related' high discount rates to achieve what they euphemistically call a 'realistic' valuation (see Thornton & Wilson, 1992).

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

The public might well expect accounting standards bodies and actuaries to act as impartial umpires in the public interest, but such stated aspirations belie actual observed behaviour. The proper objective for all players is to help their team win. My construction of the teams is simple — to find out who is calling the tune, just look who pays the piper.

For the defining blow in this particular match, we need to look back to 1996. In the red corner, the IASC, backed by the International Organisation of Securities Commissions, released Exposure Draft 54. It sets out clear economic valuation criteria for pension schemes, akin to Method 3 in the paper. The economic logic, drawing on a vast body of rigorously tested methods in finance, was unassailable. Actuarial judgement was relegated to the estimation of decrements. However, fights are not won on intellectual grounds alone. Game theory dictates that a player who would lose to a rational opponent should maximise confusion to confound his opponent's ability to analyse the situation. This is known in the games theoretical literature as the 'enough rope principle' (see, for example, Conway *et al.*, 1982). In accordance with the 'enough rope principle', the blue corner has cynically advanced a series of complex arguments in favour of higher discount rates, the sole objective of which has been to confuse the debate. In approximate chronological order, some such arguments have been:

(1) the need for a 'black box' actuarial asset/liability model;
(2) the long mean term of equities, implying a match to liabilities;
(3) the need for consistency of the liability discount rate, with a high expected asset return;
(4) the high expected return on equities, reducing pension cost;
(5) deliberate confusion of disclosure, with algorithms for funding;
(6) supposed correlations between wages and dividends;
(7) employer options to discontinue a scheme;
(8) allowance for credit risk;
(9) sharing of surplus between members and employers;
(10) a perceived need to adjust 'inefficient' market prices;
(11) blaming the current U.K. tax system for the global failure of 'traditional' methods; and
(12) use of deliberately misleading terminology — for example the description of an arbitrary margin added to discount rates in Method 4 as a 'risk premium' — actually, the margin is simply another account-flattering bodge factor, that has nothing to do with financial risk premiums in any accepted use of the term.

Many of these ideas are documented in the International Forum of Actuarial Associations (IFAA) submission (IFAA, 1997) and Wise (1998), which, although for understandable reasons, has not been formally published, was, until recently, available from the Institute's web site.

So is the outcome clear now? The red corner was smarter than anyone thought, and the 'enough rope' strategy failed to knock them off course. Actuaries have been rightly kicked out of the driving seat, to be replaced by accountants and financial economists.

The Pensions Board is doing a good job encouraging papers like this to be written, and generating debate about valuation methods, MFR and accounting standards. However, this paper puts up no intellectual defence of Methods 0, 1, 2 or 4, as Mr Mehta has already noted. Sadly, the paper's conclusions do not follow from its body, as we cannot discuss economics without spoiling it with self-congratulatory references to actuarial judgement. However, if we leave the bodge, judge and fudge mentality behind us and focus on coherent economics, we may, in the next decade, earn back some of the credibility that we pawned in the last.

References

Conway, J., Berlekamp, E. & Guy, R. (1982). *Winning ways.* Academic Press.

International Forum of Actuarial Associations (1997). *Comments on IASC ED 54.*

Wise, A.J. (1998). Working party report on market based discount rates for pension cost accounting. Institute of Actuaries.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

Mr S. J. Green, F.I.A.: I congratulate the authors on producing a paper which is both comprehensive and comprehensible, but there are one or two blemishes.

Those actuaries who are using Method 3 should note that, if they are advising their clients to alter their portfolio investment policy, they are treading on dangerous ground, and they should look very hard at their professional negligence policies.

In Section 5.2 the authors set out concisely the no-arbitrage theory. There are those who deny that this theory is dependent upon efficient market hypothesis, but none of them question the dependence of the theory on rational expectations, which is one of the tenets of modern portfolio theory or financial economics.

In ¶A.1.1 there are three key financial index figures as at 31 December 1998. The All-Share Index yield is 2.92% p.a. The fixed-interest 15-year medium coupon yield is 4.43% p.a. and the over-five-year index-linked gilt yield is 1.94% p.a. (based upon a 5% inflation assumption). These are not rational expectations. Which rational investor is going to put his money into 15-year fixed-interest gilts yielding 4.5% when he can get 5% plus 1.9% from index-linked? It is an illogical assumption, of course. The investor who puts his money into gilts is guaranteed, over a 15-year period, to lose 8.2% in real returns, whereas the index-linked investor will receive a positive return of 33.2%. So, do we still believe in rational expectation? Perhaps we do.

Using these same initial values, the authors derive a market perceived rate of inflation of only 2.44%, which is not an unreasonable rate. So why did they not go back and use that rate when working out their yields on the index-linked gilts? I will answer my own question. The people who produced this example and the actuaries who advocate the use of Method 3, and the consequent reduction of returns from investments, do not understand financial markets. They do not realise that, like all other markets, market prices are driven by supply and demand at the limit, and by marginal demand within those limits. Prices, particularly those of index-linked gilts, where the market is relatively illiquid, do not reflect value. They do not even reflect the market view of value. They can only, at best, be an indication of the marginal value at a single point of time.

I would ask those actuaries who wish to use Method 3: "Can you really wish to base your calculations solely on transient prices at a single point of time, rather than rely upon judgement based upon long past experience, historic data, hard work estimates of present trends, and future forecasts?" And if they do so, can they really be called actuaries?

Mr R. J. Chapman, F.I.A.: There is not much emphasis in the paper on solvency valuations, but there are two points about solvency which may help on risk management.

First, solvency is one of the few places where actuarial science and financial economics coincide. This suggests that solvency might actually be a good starting point for valuation methods. Other items of actuarial pensions science, such as funding methods, would then be lower order calls, because they are not market consistent. That translates as: any actuary could use any of them to produce any results with any reasonable answer. That is what we do, and that is how we have earned our living. We need to make that distinction, and we also need to make the distinction between solvency and investment calls, which I think that some of the other speakers possibly have not.

My second point on solvency is that more than a few schemes are currently underfunded on a strict solvency basis, and it is possible that solvency for pensions could be what guaranteed annuity options could be, or were, for insurance. In both cases we have failed to do what people might expect us to do as risk experts, which is to anticipate the possibility that financial conditions might tighten. In pensions we rely on off-market actuarial science to gloss over problems after the event.

The paper does not put much emphasis, either, on pension scheme members. What happens if we look at solvency from their view point? If we look at a scheme that is 95% funded, we know that that does not mean that everybody is going to get 95% of their benefit. There is a gearing effect, so that pensioners get 100%, and active members get less. So, the honest message to actives would be that, although they thought that they were in a 60ths scheme, actually they are, for example, in a 120ths scheme, with a promise to get them to 60ths at some stage. That is

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

where risk comes in. Better information about the asset coverage for active members leads to a reasonable series of questions, such as: "How is the employer going to get me from 120ths to 60ths?" The answer is a funding and investment policy. "What is the chance that that policy will work?" That is a risk question. "What is the chance of my employer going bust before he has managed to put me in a position to have 60ths?" That is a credit risk question, although employees probably know about credit risk in the sense that they are taking credit risks by working for the employer anyway. Pensioners might ask: "I am at 100% now, but what is the chance of it becoming less than 100%?" If schemes are not underfunded, active members might ask: "What is the chance of my pension slipping below 100%?" These are all risk questions, and we deal with questions about risk and risk management.

Funding and investment policies determine risk, and the paper summarises various sensible funding methods. It should be permissible for scheme actuaries to use any such funding method, provided that we take solvency as our risk benchmark; we couple the funding method with the investment policy; and we disclose the answers to the kind of solvency questions that I have given.

Why do we not provide good solvency information at the moment? Is it because being honest with active members is going to cause trouble with trustees and employers? Will the extra information be the end of defined benefit schemes? Have tightening conditions just crept up on us unawares, or do we hope that market conditions are going to improve if we hang on and see what happens? None of these reasons should cause us to duck the solvency issue.

To make sense of valuation methods we need to get a better handle on risk, which we do by setting solvency as a benchmark. We need to get comfortable with proper disclosure of the coverage for active members. Disclosure needs to be coupled with funding and investment plans, which ties the plans back into the solvency risks. The next piece of research is the link between funding policy and investment policy.

Mr M. J. Pardoe, F.I.A.: Given the wide range of strongly held opinions within the profession, and no doubt in the Working Party, I consider this to be a well-balanced and readable paper. However, in comparing the methods, the practical implications of calculating the future service contribution rate using a market value basis should have been given more consideration. This was a point also raised by the opener. Method 0 is rightly criticised for inconsistency between past service and future service, but there was only a passing reference that market conditions are likely to have changed between the valuation date and the time when the particular contribution is actually made.

In practice, for many schemes, contribution rates might be changed about one year after each valuation date, and therefore continue until four years after the valuation date, if we assume a normal triennial cycle. We know how significantly market conditions can change, even over the course of several months, let alone several years. Automatically using the contribution rates based on the market conditions at the valuation date will, by no means, always be appropriate.

The comparisons, in Section 8, of the different methods were interesting, but I would have liked to have seen dates other than just year ends. In particular, a comparison of December 1986 and December 1987 results does not do justice to the volatility that would have been observed, particularly for Method 3, for a scheme that had a valuation date of 30 September 1987, as one of my clients did.

When considering the discount rate for Method 3, I would like to see the profession give further thought to the use of the yield on high quality corporate debt rather than on gilts. The use of such a yield does not just make allowance for the small level of credit risk, but also captures the premium that seems to be available for holding less liquid assets. In other words, holders of gilts seem to be paying a price for the ability to be able to move in and out of the market with ease. A closed scheme containing only pensioners with an appropriately matched portfolio of bonds does not need this liquidity, so why should it pay the price for it? Looking over the next few years, I expect to see mature pension schemes investing more in this market than has been the case in the past.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

Clearly Method 3 does have a role to play for some purposes, particularly on discontinuance. However, for funding valuations, my strong preference is to use Method 4. There is a useful clarity to be gained in discussions with trustees and companies, where much of the strength or weakness of the basis can be encapsulated into a single figure. This has always been possible with the traditional Method 0, by calculating the return on the existing market value of assets implied by the assumptions, and comparing that return with the risk-free rate.

I am uncomfortable with using a formulaic approach to calculating the risk premium, such as given in Appendix B. In my view there is no alternative to using actuarial judgement when setting this risk premium at a particular valuation date.

I would echo very strongly the sentiments expressed in ¶¶10.2.5 and 10.4.3. A prescriptive approach could stifle pension schemes and act against the wider interests of the community, but the use of non-prescriptive methods brings with it an enormous responsibility on the actuary to understand the implications of actuarial judgement.

Mr Geoffrey Heywood, M.B.E., F.I.A., F.F.A.: The paper begins by outlining what it calls the traditional method of making an actuarial valuation of a defined benefit scheme, which discounts the cash flow from the liabilities and also discounts the cash flow from the assets to arrive at the answer. The method came into effect in the 1960s, when it displaced the former method of taking the assets at market value or book value, whichever was the lower. This, obviously, was not a very good method of carrying out a valuation. Since the 1960s the traditional valuation method, which is Method 0, has become almost universally adopted by actuaries in valuing pension funds for the best part of some 40 years, and therefore, perhaps, it cannot be all that bad.

The paper then goes on to outline four more methods and variations within these. The opener referred to seven different valuation bases, but the paper does not, however, come to any definite conclusion, nor has any speaker come to a definite conclusion as to which of these methods is going to be appropriate in the future. It seems possible, therefore, that different actuaries will use different methods in the future, and even the same actuaries might use one method at a particular valuation, and then another method at a subsequent valuation.

Consistency, it seems to me, is going to disappear. This was one of the strong features of the traditional method, in that it was consistent over a long period of time. It did not lead to substantial changes in the contribution rate, such as a 2% reduction one year, and then, at the next valuation, perhaps a 2% or 3% increase.

In the paper it is said that actuarial science is a developing process, with which I strongly agree. Therefore, research must continue in all these areas, and it is hoped that the Working Party might reach a more definite conclusion.

If I were still carrying out actuarial valuations these days, I would probably still use the traditional method, except in MFR valuations, where, when the third set of regulations is issued, I am quite sure that it will continue to emphasise market values.

Commenting on market values:

(1) The stock market is an amalgam of all sorts of investors, individuals and institutions, with different rates of tax. Some are long-term investors; some short-term investors; some are extremely short-term speculators; and we have a new group of investors now, the day-traders on the internet. It seems to me that such an amalgam cannot produce a satisfactory market value starting point for valuing the assets of defined benefit pension schemes.

(2) When we arrive at the market value, it could not be achieved in practice, because, if any pension scheme decided to realise some of its assets, it would not get the market value which was used in the valuation. It would depress the value and would get something quite different.

(3) With the sort of volatility that we see these days, when a change of 10% in the value of equities is not out of the question over a short period, market value cannot be a very reliable basis to use in an actuarial valuation. If a valuation is made on 31 December, a very popular date, and a month later, or even a shorter period later, there is a change of 5% to

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

10% in the market value of the assets, surely one must then look again at the liabilities, and revalue them on the rate of interest which corresponds to the new valuation of the assets. In other words, valuations would seem to become a continuous process.

(4) The abolition of ACT is stated to be a reason for discontinuing the traditional method, in that it is difficult to estimate the future dividends. When ACT was abolished in the 1997 Budget, the traditional method devalued equities immediately by some 20%. What happened to the FTSE-Actuaries All-Share Index? If you look at Figure 4.1 you will see that it continued to go up. The investing public was not interested in the abolition of ACT. They were more interested in what the Chancellor of the Exchequer said about future economic development and future interest rates.

(5) Recently the NatWest Bank made a bid for Legal & General Insurance, when the price was 170p. The next morning it was 210p. When the bid fell through, the price went back to 170p. Which of these values is appropriate in arriving at the asset value for pension fund valuations? The same thing can be said in the trend of NatWest's own shares, following the recent bid by the Bank of Scotland.

Commenting on assets, we have a new factor this year, which we have never had before — the 'millennium bug'. What its effects are going to be on the market I do not know, but I do not think that it will be very important, although some financial journalists think that it is going to be very important. In this morning's *Financial Times* it is stated that: "All those forecasts of increasing turbulence and volatility in the stock market in the run-up to the millennium look to becoming very true indeed". So we have more problems, starting with asset values on 31 December 1999, when nobody really knows what the value of those assets is going to be a few days later.

In the traditional method, one of the problems now is to estimate future dividends, because, as the paper says, more tax efficient methods of rewarding shareholders are likely to be introduced in the future, such as share buybacks in the market, and capital distributions. They are not yet prevalent in this country. Dividends are being declared daily, and, in most cases, they go up by 5%, 8% or 10%, and, in some cases, 20%, but are still the predominant way in which companies reward their shareholders.

Even if dividends did become less important in the distribution of companies' profits, actuaries should be able to find a device which would make an allowance for this. That allowance might be more reliable than the somewhat arbitrary smoothing that we have heard about, and the somewhat arbitrary adjustments which are required in the system of financial economics.

Mr P. M. Greenwood, F.I.A.: I substantially agree with the comments of Mr Chapman. I think that solvency is the major issue or the forthcoming issue, especially post-MFR, stakeholder and the move to defined contribution schemes.

Section 5.5 is very negative on the prospects of market pricing for pension liabilities. In practice, that is easily done for accrued rights, with the annuity market giving a price, and all systematic risks covered in that price. In theory, even final salary liabilities can be 'priced' from merger and acquisition deals, and there is a market for these traded liabilities. What is more, many brokers and the banking conglomerates are surveyed to collect views on various future economic factors, including national earnings inflation. In practice, the consensus that emerges from those surveys is often that predicted by the market.

I have doubts about the future relevance, and hence validity, of some of the detailed back testing contained in the paper. That is because we are in a world where, due to increasing globalisation, there is, in the terminology of the paper, much systematic change occurring. The essential problem is that, as a profession, throughout the 1960s to the 1990s we relied on norms called long-term assumptions.

Throughout the 1970s we increased these norms as we released margins via increased returns in bases for non-real benefits. Now, in a world where globalised markets mean governments and central bankers soon pay a price for printing money, the cost of such benefits structures has, in

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

practice, returned to the previous level. I therefore suggest that the long-term assumptions methods that we have been using have failed. However, with the margins previously released and spent and low inflation, those benefit structures, in practice, deliver real benefits that are judged no longer affordable by many employers. There is a danger, as we report on market pricing, that market techniques can take the blame for bad benefit design or previous false judgement.

These are the reasons why smoothing, in the initial presentation of results, is dangerous. It hinders the client's understanding of any mis-matching, other risks being run, and the true 'price' cost of the benefits. That lack of understanding then hinders the establishment of policies, both investment and funding, likely to control those risks and deliver the pensions that the clients can afford.

Therefore, the paper is considerably short in the area of calculating mis-matching reserves. However, having examined or reported the raw market position, we then need accountancy or funding rules which, themselves, do not hide the risks from shareholders and members, but protect against the worst effects of volatility, without permitting 'heads to be hidden in the sand'.

Dr D. Creed (a visitor, Director-General, Association of Corporate Treasurers)**:** I make the very obvious statement that, whatever you, as an Institute, propose, it must, in the end, be practical. It must be possible for treasurers and their finance directors to implement it in a way which causes no particularly raised eyebrows.

One area where we can make common cause is to establish the nature of a surplus in a defined benefit scheme. At the moment it is a one-way valve. Finance directors and treasurers put money into a scheme. It is very difficult to get it out if it is over-funded. We need a change in company law and accounting to make it a mirror image, that what money goes in can come out again, if it becomes clear that the scheme has become over-funded by a change in the liabilities or, happily, a change in the asset values as a result of market performance. I should like to propose to the Institute that we try to make common cause in this ground to both the Revenue and the DTI.

More importantly, I think that the treasurer needs his actuary. We rely on you to give us advice on safe harbours. I am fearful that, if a safe harbour is used, based on bond yields, in time we will see our 'safe harbour' has been moved to a car park ten miles from the seafront.

We cannot afford the luxury of having so low a risk level that all of our pension funds are invested in bonds or gilts — quite apart from the fact that it is totally impractical, unless the government offers more gilts and uses surplus cash to buy the equities that we are all busy selling.

So how do you resolve this dilemma? What I believe that treasurers need from actuaries is a matrix of recommended investments in various asset classes, depending on the nature of the liabilities. Clearly, if all your pensioners are in payment and you have no other liabilities, an appropriate asset class is gilts or bonds. Equally clearly, if you are a start-up company where the employees are all under age 30, your pension fund then can happily invest in equities for many years, in the knowledge that, in the very long run, equities outperform.

We need your judgement in what that matrix should be, so that we can apply it to work out whether we are over or under-funded, and therefore set our contribution rates accordingly.

Mr C. A. Long, F.I.A.: Method 4 increases the equity discount rate by "a variable equity risk premium", in order to achieve smoothed valuation results. This is the right general approach, not just convenient, but also logical. As equity markets move, we would expect the return available from equities to move also, as Mr Heywood said. I would not go for smoothing for its own sake, but, if it comes out of the process, then that is a good side effect. The formula in Appendix B does seem rather arbitrary, and is not fully specified. We would not want too arbitrary a formula to lead to too strong smoothing, thereby removing any 'underlying' investment profits and losses.

It is possible to derive an explicit formula for varying equity discount rates, which allows results to be quite smooth when comparing assets with liabilities. I suggest the simple linear

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

function: $i = a * y + b$, where i is the real rate of equity return expected, i.e. in excess of the assumed rate of price inflation; a and b are constants; and y is a chosen indicator of market level. This could be a gross dividend yield for historical investigations, but is more likely to be an earnings yield going forward. In practice, a and b tend to be about 1% for a and between +1% and −1% for b. The precise value depends on the strength of the basis that you require, and on the scheme's liability duration.

An example of such a formula might be: real return = earnings yield − 0.5%. Using the earnings yield on the All-Share Index, this currently leads to a real investment return of 3.5%, and combining that with future price inflation estimated at 3%, gives a discount rate of 6.5% at present. You can see that a short-term increase in market value of, say, 10% would reduce the earnings yield (currently 4% in the All-Share Index) by 0.4% p.a. This increase in the discount rate would reduce the liability value by about 10% if the liability duration is 25 years. This neatly matches the asset value increase, provided that the actual and notional assets are the same.

It will be noticed that this formula does not depend on gilt yields, and is not derived via an equity risk premium (which has to be derived from it). It depends on an assumed reversion to mean conditions, which, perhaps, needs a little justification. If you hold a million shares in ICI against stated liabilities, this might be considered just enough for liabilities which are many years into the future. However, if the market value of the shares falls by 10% over the next month, should we conclude that the liability cover has fallen from 100% to 90%? Of course not. If a million shares were sufficient for the liability a month ago, then, unless something very fundamental has happened in the economy, they should be sufficient now. You need to recognise that you can now invest more cheaply, so your expected return will be higher and the discounted liability lower. The 'inherent volatility' claimed by some speakers, in this kind of situation, is just nonsense.

The advantage of such a formula is not that it pretends to be exactly correct, but that consistent use from one valuation to the next can result in valuation bases of similar strength. It smooths out variations caused by market sentiment, but leaves in variations caused by real changes in company profits. I can confirm this from a long period of backtesting, the effect being similar to Method 1.

Mr T. J. Gordon. F.I.A.: I have two points, which both address the next steps that we take from here.

What we actually do in practice

This paper is the first step towards the future where actuaries give more relevant financial advice. Before we can do this, we need to be clear regarding the distinction between solvency and funding. The paper refers to this obliquely in ¶ 2.2.1 (c), but then does not develop this theme.

I agree with Mr Chapman and Mr Greenwood that we need to clarify solvency for our clients. Funding is a different issue. It is not applying a standard valuation method with various arbitrary fixes to give an acceptable company contribution rate, but it should address the combination of scheme investment policy, company contribution rates (including how long they are to be fixed and under what conditions they may be changed) and the solvency of the corporate sponsor. The only coherent framework for addressing these more difficult issues is one which makes a sensible financial (not probabilistic) assessment of risk. For this we have to turn to financial economics, because: we have not developed a credible alternative; and what we do in this area should constitute a (possibly new) subset of financial economics. Within this framework we can deliver useful advice to our clients. There is no unique funding method which can be derived from financial economics, and this does not mean that you have to use Method 3, as some speakers seem to assume.

Education

That U.K. actuaries' representations to the IASC and the ASB were so strongly rebutted, and that the MFR failed so obviously within six months of its inception, should bring home to us

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

that we are missing some key points. However, even holding a debate on this subject is difficult, because we, as actuaries, have failed to educate ourselves regarding the very basics of corporate finance, and compound this error with the education of our students. Modigliani and Miller's propositions regarding capital structure date from 1958, and they are still not covered in the actuarial examinations. Yet, these propositions are fundamental to any corporate financial advice on occupational defined benefit pension schemes. We should note that other finance professionals are not so reticent in commenting on pensions. Defined benefit pension liabilities are dealt with explicitly in numerous texts on corporate finance, of which the simplest is Bodie & Merton (1998), a popular first text for many MBA courses. The context for their treatment is the chapter on capital structure and Modigliani-Miller. All pensions actuaries should read this. The reading material for the Institute of Investment Management and Research examination paper on corporate finance deals explicitly with pension funds, again in the Modigliani-Miller framework.

The syllabus for our pensions examinations is in desperate need of rewriting, and I hope that this will be addressed in the forthcoming education review.

Reference

Bodie, Z. & Merton, R.C. (1998). *Finance* (preliminary edition). Prentice-Hall.

Mr C. J. Exley, F.I.A.: In the past, the fact that a method supported equity investment was regarded as necessary and sufficient technical justification for the method. The paper got beyond that point until Professor Clarkson raised the same issue earlier. The response to BGI study — and I do not dispute the fact that equities are more likely than not to outperform bonds over the long term — is obvious. Who issued the equities, and who would have issued the bonds had pension funds invested in bonds? It has been pointed out correctly that there were not enough gilts for pensions funds to buy, so presumably companies would have issued bonds for pension funds to invest in. In very simple terms, this means that the fact that the pension returns would have been low would have been offset by lower returns paid to the bondholders providing capital for the firm. That explains, for example, why we do not see the German, Dutch and Swiss economies on their knees, despite the fact that they have not had the same benefit of equity returns from the pension funds. They have also had bond finance for their companies.

The second issue, and another confusion that is absent from the paper, but was raised by Mr Green, is that financial economics is about modern portfolio theory. It is not. It goes far beyond modern portfolio theory, which was one of the theories, but financial economics has gone beyond that and it is not an axiom. I also say that it does not rely on rational expectations. The crucial no-arbitrage principle does not rely on rational expectations, but on rational behaviour. It relies on the no free lunch principle, which says that, if there is a risk free profit to be had, investors will take it, but it does not rely on rational expectations, which is a much stronger hypothesis about market prices.

Concerning Appendix A, this appendix has more to do with traditional actuarial mathematics than with financial economics. Any confusion within it does not make financial economics unsound.

Mr M. A. Pomery, F.I.A. (Chairman, Pensions Board)**:** On behalf of the Pensions Board and the profession, I express my thanks to the Working Party for all their hard work in preparing this paper and the valuable service that they have performed for pensions actuaries. The remarks which follow are my personal opinions, and do not represent the views of the Pensions Board.

I am sometimes asked when the Pensions Board is going to tell actuaries that they must stop using the traditional method and start using market-based methods. The Institute has never laid down how actuaries must do valuations for funding purposes, and I do not believe that it should. Our role is to stimulate research and debate and to educate. This we have tried to do recently through our current issues seminars and our annual conferences.

Concerning research, I would like to see further work published in two areas at least: future

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

contribution rates, as mentioned in ¶6.1.2; and smoothing, as mentioned in ¶6.7. These are both areas where it would be helpful for practitioners if the profession were to collate and analyse the various methods being adopted in practice.

Moving from funding valuations, in the context of MFR and the proposed new accounting standard, I have a particular concern over the issue raised in ¶9.2.8; namely, the propensity for valuation Methods 3 and 4 to drive investment policy, particularly out of equities and into bonds. I have no doubt that, if you want an objective valuation methodology, you are driven towards Methods 3 and 4, but, in this world, what you measure is what you get, so, if your measurement of liabilities is driven by bond yields, you seem destined to get more and more bond investment of assets. We are already seeing some signs of this as a result of the introduction of MFR, although probably less than some commentators would have us believe, and it is more a result of the greater recognition of risk. The Investment Committee of the Wider Fields Board has been looking at the question of the demand for gilts at the request of the Pensions Board, and I hope that they will be able to publish some results shortly.

On MFR, this is not the right time or place for a major debate, as our review for the DSS has another six months to run. I would merely observe that the MFR test does not seem to know whether it is a solvency test or a funding test, as illustrated in ¶10.4.2. It came as a political compromise, and while actuaries know that it is not a solvency test, it would appear that many other people believe that it is, which I consider to be a very dangerous situation. Like other speakers, I would therefore add my strong support to Mr Chapman's comments on solvency and risk.

I now repeat some words from ¶10.4.1, which sums up the message that we actuaries need to get across to all users of valuations: "the holy grail of an objective" [valuation] "methodology and smooth results is unobtainable."

Very shortly the exposure draft on the new accounting standard for pension costs in company accounts will be published. The Accounting Standards Board wants to have an objective standard. U.K. business wants smooth numbers in its profit and loss accounts and balance sheets. We will have an early opportunity to say, loud and clear, that these two aims are irreconcilable. We should also be very aware of the danger of each side blaming the actuarial profession for failing to reconcile them.

Mr T. G. Arthur, F.I.A. (closing the discussion)**:** I thank the authors for a very comprehensive and organised paper. I do not think that one needs to look any further for the success of the paper than this discussion, which I will attempt to summarise, and inject some of my own thoughts.

The purpose of valuations

Are we considering past service, solvency, other forms of accrual, future service, or what? There have been some references to this issue in the discussion, and I agree that it is absolutely crucial.

My standpoint tends to be that of a trustee, which is one of my professions now. I am more interested in past service pensions, particularly on the question of the differential between past service and future funding, as discussed by Mr Chapman, and echoed by other speakers.

I cannot see any problem in the use of different funding methods for, say, the past and the future. For example, one might have a margin or a cushion for past service, but none for future service. That seems fine, provided that any past service shortfalls are addressed. I was going to say 'quickly', but perhaps I should say, taking on board one of the points that the opener made, 'in accordance with the documentation'. This is a very important point. There is no reason why all pension schemes should have similar documentation with regard to funding, surpluses, or deficiencies. I think that that may provide some of the answers to Mr Creed, although he is obviously very sensible in asking us to be practical and to help our clients.

Mr Smith has probably invented one corner too many. It does not seem to me that it is necessarily true that all employers want to keep costs down. Some may wish to make a virtue out

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

of maintaining a high asset cover, for example. They may get a competitive advantage that way. They may say: "Our scheme is an 80th and not a 60th, but at least it has plenty of money in it, which is more than you can say for our competitor down the road".

One of the problems with crude game theory is that it does assume that there is no reputation issue with regard to any of the contestants; yet guarding a reputation is important.

Discounting

It is worth spending a moment on to what the discounting is to be applied. Mr Heywood raised the point that, so far as he is concerned, it is applied to both assets and liabilities, because we are talking about cash flows. I have sympathy with that. The liabilities and assets are in the end cash flows, and if those flows were matched, then there is nothing more to say, and the market value is irrelevant. So, conceptually using a market value for assets may be a retrograde step in that regard. I appreciate that liability on the left-hand can compensate for the right-hand, and vice versa. It probably makes sense to discount only the differential cash flows, otherwise we are doing the same thing on both sides of the balance sheet, which seems a waste of time. So it is a pity that the profession is being pushed down this particular road of market value for assets.

However, since the liabilities can be adjusted accordingly, surely we can live with a market value of assets. Indeed, one benefit of it would be that we would be able to kiss goodbye to a flawed dividend discount model. It is flawed, not only because of the ACT changes, but any dividend discount model which links dividend growth to economic growth is fundamentally unsound.

It is now almost 40 years since an actuary, the late J. R. Hemsted, demonstrated that dividend growth is a function of pay out ratios. So, given the market value of assets, then outside Method 1, which adjusts the liabilities directly, the question becomes one of selecting discount rates for the liabilities. As might have been expected, that is the core of the paper, and accounts for most of the comments.

I make my remarks particularly with reference to past service. I do appreciate, as I have said, that it is not the only criterion. Here we seem to have, basically, a battle between financial economists and sceptics of financial economics. We had Mr Mehta, Mr Smith, Mr Shuttleworth, Mr Gordon and Mr Exley all extolling the virtues of financial economics. That means that you go basically for Method 3, although Mr Shuttleworth mentioned Method 4. There is a big difference between Method 3 and Method 4. I am not sure that all the dissidents to financial economics agree with Method 4, although it seemed that Mr Long did. Professor Clarkson is very sceptical of financial economics. So am I, but only of parts of it, and not of all of it. It may be better than extrapolation, for example. Mr Green is also sceptical of it. I think that it is rather simpler than that for this particular debate, because, if the liability flows are presumed to be certain, and they may not be presumed to be certain, this is probably depending on the purpose of the valuation. It may be sensible to use corporate bonds; it may be sensible to use even junk bonds; it may be sensible to use something else for discretionary benefits, but to the extent that the liability flows are considered to be certain, then surely the asset flows are equivalent only if they are also certain. That points me to Method 3 and bond yields, or, alternatively, assuming that the equity cash flows are first reduced before they are discounted to take account of the risk.

If that is financial economics, I am all for it. It seems more like common sense to me. That would put Method 2 and Method 4 out of court, provided that the liabilities are certain. If that is the case, a profession that can count has surely no excuse to double count, which is what happens when we accept the reward, but ignore the risk. Do we really need to bring financial economics into that? Financial economics seems too simplistic, in the sense that what we are interested in is not the risk premium, but the pension fund risk premium. We are not interested in the risk premium for the totality of investors. However, given the increase in the maturity of most funds, and also the dominance of institutional investors, I suggest that there is probably

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

little comfort there for those who wish to have their cake and eat it, so far as risk and reward are concerned.

I expected many more remarks on smoothing than we received. Mr Pomery wanted more research, and I am sure that he is right. You can only smooth if you know the points between which you are smoothing.

I now come very briefly to the MFR. There were some extremely sensible remarks and distinctions made about the MFR as opposed to other methodologies, for example by Mr Chapman and Mr Greenwood. Those distinctions take us back to the question of how we view the liabilities with regard to certainty. I believe that a one-size-fits-all MFR, excluding the privileged public sector, where many schemes are totally exempt, prescription is a profound mistake. I believe that this profession should be busy developing scheme financial ratings, not pandering to a government's erroneous ideas. I wish that Mr Smith would produce some of his most forceful remarks against a prescribed MFR, where I think that any single prescription will fail the public tragically, with or without the benefit of financial economics.

I hope that the discussion helps to bring this into the open, as it has helped to bring many other things into the open. I am sure it has. Certainly it has displayed a great diversity of views on many topics, and it will stimulate more research in various areas, as required by several speakers.

Mr A. J. Wise, F.I.A. (replying)**:** On behalf of the authors of the paper I express our thanks to all the speakers. I thank those of you who expressed the middle-of-the-road view, and acknowledged that the paper had, broadly speaking, met its objectives as per its terms of reference. I hope that those few of you who expressed those comments were, in fact, representing a large, but silent, majority of people who did not get an opportunity to say anything.

To those of you who expressed more strongly worded and almost extreme comments, either on one side of the argument or on the other, I thank you for your contributions, which do give us grounds to move forward. We are still hearing diverse views, and there are still misunderstandings. This proves that there are more papers begging to be written on the subject, and I am quite clear that there is a reconciliation in the different points of view. What we, as a profession, need is to bring out the reconciliation of these ideas. That is the way to move forward.

The President (Mr P. N. Thornton, F.I.A.): I also thank the nine authors. It has been very helpful to have had this paper and this discussion. We are at a transition point, where new approaches to pension fund valuations are needed. The traditional methods served us well for a good period, but the reliability of the dividend stream has caused a number of concerns. We should not forget that, in 1973 and in 1987, the discounted income method gave clients a lot of reassurance, because the investment income that the funds were earning was not affected in the same way as the markets, and, of course, the markets bounced back. So, at that time they felt that the traditional methods were quite robust.

Having said that, I do not think that it is just the ACT change that has caused doubts about those methods, or just the introduction of financial economics ideas into the profession, which has been extremely important. I think that it is the fact that, when the ACT change took place, the market did not appear to change.

I am very pleased to see, in the paper, the breakdown into the different purposes described. I strongly agree with the need to look closely at solvency. For those who like the dividend discount method, Method 4 is the one that is likely to appeal. Part of that is to do with the wish that we have to be able to continue to exercise professional judgement. Professional judgement needs to be defined as: "using our technical skills in the light of experience". I do not accept that professional judgement is the same thing as fudging and bodging. I think that the exercise of that professional judgement — that is, using our experience and skill — is what clients pay us for, and that is indeed where we add value, as one of the speakers has said.

At the moment a number of actuaries doing pension fund valuations are using more than one

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

method at the same time. They are not changing backwards and forwards. It is like yacht navigation: you take bearings from various points and you plot lines on your chart, and usually it gives you a triangle within which you think you might be. I believe that a number of actuaries are trying different methods of valuation, and gaining confidence if they seem to come to similar results.

We need to allow for the continuing evolution of ideas, and the paper mentions this in ¶5.1.5. Scientific theories are never absolute, but they are always being tested against reality and improved.

Finally, I comment that we have now introduced Financial Economics as a 100 series subject in the examinations, and I have no doubt that, over time, financial economics ideas will flow through into the later subjects, and that the education syllabus will continue to evolve.

I now ask you to join me in thanking the authors, the openers and closers and speakers for what is been extremely good debate.

WRITTEN CONTRIBUTIONS

Mr C. J. Exley, F.I.A.: I suppose that this Working Party could only ever hope to reach a compromise solution.

The observant may have noted a subtle difference between the title of the Working Party established by the Pensions Board and the paper itself. The paper removes reference to market valuation in place of the less contentious 'pension fund valuations and market values'. From Section 6 onwards it abandons any attempt to develop further the technical aspects of true market valuation (that is Method 3) based on financial economics. Instead, it focuses on discussion of a number of other methods whose only common link is that they take the assets into account at market value — hence the title. This includes the thinly disguised traditional Method 1, which is currently in vogue, and simply ratios up the past service results to give a pretence of market valuation.

I think that the most important issue to highlight is what even this consensus paper could not bring itself to say:

(1) There is no real attempt to defend any technical justification for the traditional method, it is merely recorded as a matter of history in Section 3.

(2) In particular, there is no attempt to support the idea that equity dividends match salary growth, or that the traditional methods reveal some fundamental 'long-term' value, which is ignored by short-term market movements. These issues are covered in Section 4.

(3) There are no serious arguments against the application of financial economics, as set out in Section 5, which then supports Method 3.

(4) There is subsequently no attempt to provide any theoretical justification for Methods 1, 2 or 4, which appear in Section 6.

(5) There is no attempt to suggest that *solvency* can be measured on anything other than Method 3. Only a few years ago we might have seen reference to this method as only 'technical solvency', meaning, I believe, that it was only relevant if a scheme was wound up! There is no attempt in the paper to suggest that a 'realistic' solvency assessment would assume continued equity investment, although this anachronism still appears in the current MFR basis for public ridicule. In Exley *et al.* (1997) we argue that solvency is really the key measure of both a pension scheme's financial position and the 'pricing' of liabilities. All 'ongoing' bases (including attempts to use ongoing liabilities for accounting) introduce an unnecessary element of subjectivity, and represent less meaningful economic measures. Thus, the paper's acceptance of Method 3 as a solvency standard is, perhaps, more profound than is generally recognised.

(6) Although much is made of the value of professional judgement, nobody has attempted to provide any technical or empirical justification. It is thankfully acknowledged that the testing of Method 4, which supposedly uses judgement, actually uses glorious hindsight.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

Those of you with even short memories will remember the value of professional judgement in the practical situation of establishing the original MFR basis. Although judgement is extolled, there is no attempt to justify the judgement publicly exercised in the choice of 'long-term' assumptions here.

(7) There is no attempt to defend equity investment by pension funds and no suggestion that equity investment can reduce the cost of the liabilities. It is accepted that using the valuation basis of Method 3 may affect investment policy, but the paper is careful not to say that the effect would be adverse.

The last point is important, because, in the past, the fact that a method supported equity investment appears to have been regarded as sufficient and necessary technical justification alone. It seems that the logic used to be that the method supported equities, equities are good, therefore the method was good. Alternatively, the method makes equities look risky, equities are good, therefore the method is bad. The paper thankfully gets beyond this.

Although I do have some regrets over the anodyne conclusions in Section 10, I am happy to see a Working Party paper which takes such an enlightened view on these seven issues, and I trust that, finally, these points can all be taken now as read without further debate.

Professor A. D. Wilkie, C.B.E., F.F.A., F.I.A. (who spoke at the meeting, and who submitted this amplified contribution as a replacement for what he said)**:** I am all in favour of actuaries learning about financial economics, and of making use of the principles and methods of that subject wherever it is appropriate, but we should also recognise that there are circumstances where these methods may not be appropriate, or rather, where they may need substantial modification. We should also not swallow elementary financial economics naïvely.

A pension right, treated as an asset, is not like the assets usually dealt with by financial economics. It is not marketable, it is not divisible, it cannot be made part of a diversified portfolio, or part of what might be known as 'the market portfolio'. This means that its specific risk cannot be diversified away, but must be carried by the owner of the right. Further, a pension is very specific to the owner, because it suits his or her needs. Some other person B, does not really wish to own a pension that depends on A's salary, starts when A retires, and ends when A dies.

Looked at as a liability, pension rights for defined benefit schemes are equally unmarketable, and also cannot be diversified. They must be carried by the relevant employer. They cannot be insured exactly, though it may be possible, through insurance, to provide similar benefits. They also cannot be diversified, though the specific risk of a portfolio of pension rights may be proportionately less than the sum of the risks of the individual rights, i.e. there is some possibility of diversification.

Financial economics, so far as I am aware, does not deal easily with such a contract. Its value as an asset may lie within some range; its value as a liability may also lie within some range. These ranges may not even overlap; as an asset it may be certainly worth less than X; as a liability it may be certainly worth more than X. No one value meets both constraints, and X meets neither.

Further, the range may be inconveniently wide. Financial economics may state only that the value of a life annuity must lie between zero, if the annuitant dies immediately, and the value of a perpetuity, if he lives for ever. This is not a very useful range. It is in this sort of area that traditional actuarial values, taking account of the constraints of financial economics, are essential. In Section 5.5 the authors refer to the possible existence of a range of values, but do not point out how wide it may be.

We are in what may be called an 'incomplete market', and usually utility functions, which are personal and subjective, come into play in the financial economics literature. Therefore, we should not necessarily justify the use of market values in pension fund accounts on the grounds that this is prescribed by financial economics. Further, before we all rush to a market value basis, we should think also of some of the disadvantages.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

A market value applies only at one point in time. It is very important for a derivatives house to mark to market every evening, so as to know its starting position the next morning, and probably to keep track of its position throughout the day. It is less obvious that it is of use to state the value of a pension fund in market value terms on some date that may well be several months prior to the report. It is already out of date. Also, I do not expect companies to be asking actuaries either to provide daily valuations of the liabilities of a pension fund or to provide them within a few hours after the markets close on the valuation date.

Then there is the problem of the contributions. The authors are aware that they are in a different 'currency'. How should we deal with contributions? One way would be to mark them to market every month, and collect a variable amount that depended on some market value indicator on the day of payment; this is hardly practicable, especially if the scheme prescribes contributions of $x\%$ of salary from employees, and, for some federated schemes, contributions of $y\%$ from employers.

Another method would be to keep the contributions stable, and purchase whatever benefits market conditions on the date of purchase would buy; but this is turning the scheme into a defined contribution scheme, or one of the older types of insurance company deferred annuity schemes. The only practicable method, it seems to me, is to collect contributions just as we do at present, and then to calculate, at the end of each year, the discrepancy between what the contributions have bought and what they were intended to buy. If we use a fixed valuation basis there may be no discrepancy; if we use a market value basis there is likely to be one.

This leads to the topic of the analysis of surplus. Some actuaries may not bother nowadays with this, but others still believe it to be useful. It is extraordinarily complicated to carry out an analysis of surplus on a changing basis. One really has to keep the basis constant during the period of analysis, and then to allow for the change of basis as an item at the end of the period.

Then there is the question of valuing benefit improvements, or changes in the structure of schemes. I would expect trustees or employers to find it more helpful to be told that the provision of, say, widowers' pensions would cost on average, over the long run, $z\%$ on the contribution rate, than to be told that they would have cost $w\%$ on some recent date, but will cost a different amount by tomorrow.

So, while I would certainly expect to see the market values of the assets shown in any report, I am not convinced that market valuation throughout is ideal.

Further, the automatic use of gilt interest rates seems to me to be flawed. If pensions are subject to discretionary increases, in line with inflation if the trustees think it can be afforded, then we are in a range problem again. An upper limit to their value may be the value as if they were fully index-linked, using the yields on index-linked gilts; a lower limit may be the value as if no increases at all were given, using the yields on conventional gilts. Between these limits it then becomes a matter of the actuary's discretion, which could be narrowed down if the discretion of the trustees was more tightly defined. However, using an equity rate of return may be the best match to what the liabilities are going to provide. This points us towards the authors' Method 4.

I should also like to touch on my view as a shareholder. If I own shares in a company making widgets, I wish to be told its trading position as a maker of widgets. If I hold shares in an investment trust, I wish to see its results in terms of the market values of its investments, but I do not wish to see them mixed together. This means that I do not want the fluctuations in the pension fund of the company (analogous to the investment trust) to impinge on the trading position of the widget-maker.

What I require is that the pension cost in the company accounts should be stable, and should reflect the long-run expected value of the pension liabilities. These requirements may be in conflict, but I would prefer to see the pension charges changing slowly, in line with changes in long-term expectations, rather than jumping up and down along with the market values of anything, whether shares or bonds or the actual assets of the pension fund. If it is necessary to make a special adjustment, either because long-term expectations have changed substantially or

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press

because the actual experience (either of assets or liabilities) has been very different from what was expected, I would rather see that adjustment shown as an exceptional item (if it is material), rather than being concealed in, but affecting, the trading profit of the company.

Since the authors' Method 3 (using economic bond yields) is the one method that does not produce stability of values (and I expect that it would produce instability of values in company accounts too), it is one method that I would not like to see used. Method 3 is the only one to be given ticks in Table 9.1 for durability, objectivity and targeting security, all of which are worthy objectives, but, since it fails on my stability test, I would disqualify it, and look for the method that has the most ticks elsewhere. This turns out to be Method 1a. I appreciate that I am mixing up valuation and expensing in company accounts, but many of the same principles apply to both.

Incidentally, being objective, but wrong, is not necessarily an advantage over being subjective, but right.

I would expect that investment analysts might well think in the same way as I do in relation to what appears in company accounts. I am not sure where we are in relation to what accountants are doing or planning about the calculation of pension costs in company accounts, but if these arguments can be used by the representatives of the actuarial profession to move the accountants away from a pure market value approach, I should be well pleased.

Finally, should it be argued that today's market price is always the best estimate of the value of a marketable asset, I would reply: first, the market price six months ago is not today's best estimate; secondly, no serious financial economics model for interest rate does not have some autoregressive features in it, implying that the best estimate for the future is not necessarily today's value; and thirdly, that some financial economists are beginning to realise that the value of the shares of any company may well be related to the financial position of that company, whether expressed as dividend per share, earnings per share, or net asset value per share. The pure random walk model for shares is, in any case, internally inconsistent, since one cannot have a pure random walk model for both shares and total returns (unless dividend yields are constant, which they manifestly are not); but that is another story.

The Chairman of the Working Party subsequently wrote: We are very grateful to all those who contributed to what was a most lively and stimulating discussion. Whilst it is tempting to respond to almost all of the contributions, in the interests of conserving space, I will respond only to those contributions which questioned the content or calculations within the paper.

Professor Clarkson questions the use of the Cairns model. I referred, in my introduction, to the description of the model which is now deposited in the Institute and Faculty libraries.

Mr Green questions the validity of our calculations in Appendix A, which illustrate the way that assumptions might be set under the different methods. He is correct in pointing out that, strictly, real yields on index-linked gilts should be interpolated between the published yields assuming 5% inflation and those assuming 0% inflation to be consistent with our derived inflation assumption. The practical effect of doing this is quite small, adding around 0.1% p.a. to the real return assumed on index-linked gilts in the example given. This was a case of actuarial precision being forgone for the sake of simplicity. Mr Green is incorrect, however, in implying that we are, therefore, assuming a nominal return of 5% p.a. plus the index-linked yield in our calculations. This should be clear from a closer examination of Appendix A.

It only remains for me to echo the comments made by Mr Wise, in replying to the debate. I hope that further research and discussion will enable some reconciliation between the very different points of view that we have heard expressed.

https://doi.org/10.1017/S1357321700000830 Published online by Cambridge University Press