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THE FINANCIAL THEORY OF DEFINED BENEFIT PENSION SCHEMES

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ABSTRACT

Increasingly, modern business and investment management techniques are founded on approaches to measurement of profit and risk developed by financial economists. This paper begins by analysing corporate pension provision from the perspective of such financial theory. The results of this analysis are then reconciled with the sometimes contradictory messages from traditional actuarial valuation approaches and the alternative market-based valuation paradigm is introduced. The paper then proposes a successful blueprint for this mark-to-market valuation discipline and considers whether and how it can be applied to pension schemes, both in theory and in practice. It is asserted that adoption of this market-based approach appears now to be essential in many of the most critical areas of actuarial advice in the field of defined benefit corporate pension provision and that the principles can in addition be used to establish more efficient and transparent methodologies in areas which have traditionally relied on subjective or arbitrary methods. We extend the hope that the insights gained from financial theory can be used to level the playing field between defined benefit and defined contribution arrangements from both corporate and member perspectives.

KEYWORDS

Asset/Liability Modelling; Pensions; Market Value; Economic Value; Funding; Risk; Minimum Funding Requirement; Defined Benefits; Stochastic Model; Asset Allocation; Derivatives; Term Structure; Assessed Value

1. INTRODUCTION

"Modern finance theory ... has radically changed the way we think about financial structures, financial markets, and indeed about what firms are. The five building blocks of modern finance: utility theory, state preference theory, the capital asset pricing model, the Modigliani-Miller theorems, and option pricing theory ... together these break throughs have thrown new light on all the issues related to the fundamental question of how individuals and society allocate scarce resources. Furthermore, there is some evidence to suggest a link between management education of this more rigorous kind, and business success."

Howard Davis, Deputy Governor of the Bank of England, Lubbock Lecture, Oxford. November 1996

1.1 *Pension Schemes in Context*

1.1.1 There are many companies across the world running occupational pension schemes of one form or another. These companies do not exist purely for the purpose of providing pension benefits, but are set up with a core business in mind; for example, supplying goods or services to customers. However, the assets and liabilities of a pension scheme can be very substantial in relation to the size of a company, and the value of the pension promises can constitute an important component of the members' aggregate wealth.

1.1.2 The purpose of this paper is to apply the principles of modern corporate finance to such pension provision, to review and reconcile current actuarial approaches with our analysis and to suggest a framework for the valuation and management of a defined benefit (or DB) pension fund consistent with financial economic theory and practice.

1.2 *Management of Economic Value*

1.2.1 Recent years have seen substantial advances in the study of what constitutes good business management. One of the key precepts is that commonly referred to as economic value added or shareholder value analysis. The theory asserts that:

— A meaningful economic value can be assigned to future net cash flow streams.
— In particular, this value is independent of ownership — a given set of net cash flows has the same 'value' to members of a pension scheme or shareholders in a company — and is also independent of the vehicle in which the cash flow arises.
— This value concept looks through accounting conventions to an underlying economic reality.
— The key reality check for such a value concept is current prices and market conditions.
— A management can best serve shareholders by maximising the value of future cash flow.
— Such management actions also generate wider social benefits, for example efficient use of capital and labour.

1.2.2 In relation to these points, the authors would note that:

— they have been broadly accepted by the academic community;
— they form the foundation of much modern management consulting;
— a number of corporate success stories are widely attributed to these techniques; and
— the principles continue to be accepted, after a great deal of exposure in the press and elsewhere.

1.3 *Accounting and Economic Valuation*

1.3.1 Companies produce financial statements for a number of reasons, such as:

— providing information to existing and potential stakeholders;
— bookkeeping, compliance with regulations and detection of fraud;
— assessment of tax liabilities; and
— general management purposes.

1.3.2 It is generally found that no single set of financial statements will satisfy perfectly all of these objectives. In particular, those who advocate shareholder value analysis will often draw a distinction between accounting

quantities derived, more or less objectively, based on historic transactions within a detailed framework of guidance, and economic quantities which, generally, contain more contemporary market input.

1.3.3 For example, a saucepan manufacturer may hold stocks of aluminium. For accounting purposes, the aluminium may be valued at the price for which it was acquired. This is important for bookkeeping and reconciliation, but has some bizarre consequences if these are regarded as economic values — for example identical blocks of metal may be assigned different values according to when they were purchased; one must also adopt essentially arbitrary conventions as to which blocks were sent to the foundry and when. For a vertically integrated commercial operation the recorded value may not relate to a real price at all, but rather a transfer price which is deemed to measure the cost of mining and reducing the ore. By contrast, the economic value of a stock of metal will be the value at which that metal trades in the market — irrespective of the price originally paid.

1.3.4 We should stress here that we do not need to bestow on market values the status of unique arbiters of fundamental or true worth for them to be our preferred measure. Market values have two big advantages, whether or not they offend our personal convictions:

— They represent the views of marginal investors. Although, as noted by Dyson & Exley (1995) there has been a tendency for marginal investors to be regarded as rather fickle, in reality the marginal players probably have access to the best information and are best placed to make fine judgements (the 'lead steers' as described by Stewart, 1990). This is discussed further in Section 5.
— The rest of the world uses market values to make decisions. If we try to use our own measure of value we will always encounter what Smith (1996) describes as a 'fault line', where we need to reconcile some quantity with a market price. The problem with these fault lines is that they generate problems of arbitrage and selection if investors are allowed to pick and choose between the two sides.

These two advantages are, in fact, linked. If we are interested in optimal *decision* making, then the first order condition for optimality is really just a requirement for an investor to be indifferent between *marginal* reallocations of his portfolio. These reallocations must, by definition, take place at market value.

1.4 *Previous Work on the Subject*

1.4.1 In their classic work on securities valuation, Graham & Dodd (1934) suggest treating a pension fund as a combination of an investment (at market value) less a debt on the firm (the liabilities).

1.4.2 A number of subsequent textbooks have commented on the effect of pension funds on corporate valuation. Copeland, Koller & Murrin (1995) provide a typical approach, starting with the premise that "for fully funded plans, no adjustments are necessary". This statement is intriguing, as it suggests a direct link between actuarial values and economic value. In the distinction between

economic and accounting values, actuarial valuations are placed firmly on the side of economic values.

1.4.3 This gives rise to a number of odd features. One of the key precepts of economic value is that it cannot be influenced by arbitrary accounting conventions (except so far as these affect cash flows). However, many actuarial bases contain a degree of arbitrariness and subjectivity. One might suppose it appropriate to take account of known differences in valuation bases — contrary to the recommendations of Copeland, Koller & Murrin. Furthermore, actuarial bases often fail the key reality check of reproducing market values.

1.5 *Structure of this Paper*

1.5.1 Section 2 provides an introduction to the principal features of a pension scheme, starting from the interests of shareholders, management and trustees and proceeding to highlight characteristics of the liability cash flows and considerations behind the asset allocation choice.

1.5.2 Section 3 examines the traditional funding-based techniques for valuation, in an attempt to reconcile some of the basic results of Section 2 with contrary conclusions derived from actuarial values.

1.5.3 Section 4 discusses the alternative market-based approach to valuation, and contrasts it with the funding-based approach.

1.5.4 Section 5 proposes a blueprint for applying this market approach to pension funds, Section 6 then presents some techniques which enable us to use the approach in practical situations, while Section 7 gives two examples of these techniques being used to solve real problems.

1.5.5 Section 8 considers some of the more subtle issues associated with setting funding and investment strategy ignored by classical theory, while Section 9 draws on some standard financial techniques from commodity pricing to cast new light on the valuation of corporate pension benefits within an employee's overall remuneration package.

1.5.6 Section 10 summarises our conclusions.

1.6 *Conclusions*

1.6.1 We originally set out to write a positive paper, providing a rationale for current actuarial pensions practice. Although current practice had moved on in the last decade, much of this progress was undocumented, and we felt it would be worthwhile to write up the new developments in the language of shareholder value. On this journey we did, however, encounter a number of areas where further improvements could be made, both in the calculations themselves and also in the manner in which they are rationalised. Anecdotal evidence suggests that this realisation is slowly dawning on the industry as a whole.

1.6.2 It is our contention that previous work on the valuation of pension liabilities in the context of corporate finance has often been overly simplistic. For example, if the implications of textbooks such as Copeland, Koller & Murrin were reflected in market prices, companies funding on a strong basis would be

underpriced, and companies with a weak basis would be overpriced. Actuaries have a valuable role to play in providing a more informed basis for valuation and corporate decision making.

1.6.3 Much of the underlying theory associated with our alternative approach has a reputation for being rather highly mathematical, which, unfortunately, has restricted its appeal among practitioners accustomed to applying only compound interest techniques to advise clients. We have attempted to make this paper as accessible as possible for the majority of pensions actuaries — which means that we have, reluctantly, trimmed down some of the mathematics. The result is a paper which contains more exposition of ideas than formal proofs. However, we must emphasise that the conceptual rationalisation developed as a result of our trying to solve detailed numerical problems. The reader who wishes to enhance his understanding or apply these techniques in practice will find no substitute for advanced mathematics, such as is contained in the references.

1.6.4 The authors hope that this paper will show how widely accepted modern financial theory can be used to understand more fully the interaction between shareholders, management and trustees, and also explain how well tested market valuation techniques can be applied to solve some of the practical problems which arise.

1.6.5 We understand that financial economists in the United States of America turned their attention to defined benefit pension schemes in the late 1970s and early 1980s. In particular we should give credit here to the work of Black (1980), Sharpe (1976), Tepper (1981) and Treynor (1977). To provide a flavour of this earlier work we would highlight the wonderful passage in Treynor; "corporate pension plans have traditionally had a 'something for nothing' aspect about them, whereby their value to beneficiaries seemed to exceed the financial burden they imposed on the sponsoring company" — a theme to which we will return several times. Unfortunately, this work seems not to have received widespread recognition among practitioners or their clients on either side of the Atlantic. One explanation may be a mistaken belief that the ideas relied heavily, or even crucially, on capital market efficiency, with which some of the financial economists were associated at that time. In our paper we have been careful to ensure that none of our main conclusions depends in any way on markets being efficient, thus criticism of the efficient markets hypothesis is in no way sufficient to invalidate our work here. Rather, the basic ideas follow from the more general theories of Modigliani & Miller (1958) — especially their first irrelevance proposition; only in our later work on funding and investment strategies will we need to consider any perfections (or otherwise) in capital or labour markets.

1.6.6 Finally, although we are unable to reconcile this financial theory with all current practice, we do end on a positive note of a different kind. The reward for our unravelling of existing practice and our pursuit of financial theory is a new insight into the way corporate pensions interact with the labour market. It is with great satisfaction that, as a result of this insight, we can conclude our

paper with elementary, but far reaching, proposals which could adapt defined benefit pensions to the modern business environment.

2. PENSION SCHEMES AND CORPORATE FINANCE

2.1 *Why Provide Pensions?*

2.1.1 A recent survey by the DSS has investigated the reasons why a large number of private sector organisations make pension provisions. The most common reasons stated were

— a wish to provide for employees in old age (43%);
— recruitment and retention (29%); and
— reward of particular groups of employees (9%).

2.1.2 In today's commercial environment it may seem strangely anachronistic for paternalistic motives still to be so widespread. Many employees, if given a choice, prefer cash today rather than the promise of a pension tomorrow. Are companies acting contrary to the interests of shareholders in taking such a paternalistic view? This cursory inspection suggests that companies could save on pension scheme contributions by increasing flexibility in the total remuneration package and restricting scheme membership to those who prefer it.

2.1.3 Furthermore, other things being equal, one would not expect a saucepan manufacturer, for example, to be an efficient provider of financial services, given the existence of a specialist financial services sector enjoying the benefits of economies of scale and specific management expertise in this area. Therefore, it is also, at first sight, rather surprising that such businesses should commit themselves so heavily to a venture outside their core activity.

2.1.4 These anomalies appear sufficiently large to warrant asking whether company management is necessarily acting in the interests of shareholders in running its own pension scheme for employees. For example, could a final salary vehicle be manipulated by senior executives for personal gain or to limit the attractiveness of corporate take-over? To illustrate this, the former might result if managers could influence each other's salary just prior to retirement and the latter might hold true if the granting of over-generous benefit commitments restricted the synergies that could be obtained in the event of a take-over, which would otherwise have enhanced shareholder value.

2.1.5 However, in practice, with a defined benefit scheme, contributions are not earmarked for specific employees and the cost implications of a final salary related promise are typically much smaller for younger employees than for members approaching retirement. The degree of wastage (employers paying contributions which are not appreciated by employees) resulting from not catering to preferences for cash over future pension may, therefore, be relatively small. This is because those employees with the strongest preferences for cash could well be the younger members of the scheme, for whom the funding costs are relatively small. Clearly, legislation to impose vesting may increase the mismatch and result

in inefficiency (that is, a loss of opportunities and lack of flexibility for employees and employers to make their preferred choices).

2.1.6 There may also be some tax or expense efficiency advantages to the corporate rather than personal provision of a pension (via the financial services sector or otherwise). Prior to the advent of modern computing power and rather intrusive legislation, defined benefit arrangements may have entailed lower administration and other costs than alternative group insured money purchase arrangements. For example, in the early years of defined benefit schemes it was sufficient to keep a card record of only an employee's date of birth, service and salary in order to compute his basic benefit entitlement. Anyway, all of this information would be held as a matter of course by a payroll department. The scheme could also be run under a single Trust for all employees and, prior to 1988, on a compulsory basis. By contrast, an individual providing his own pension arrangements would typically incur much greater expenses associated with the pension provider reconciling his individual allocations and setting up the legal documentation and other sales expenses.

2.1.7 Perhaps, most importantly, employees may prefer having a pension which is effectively paid for by sacrifice of today's pay, but subsequently increases in line with future pay, and only a vehicle backed by the employer is able to achieve this. One interesting suggestion from the recent debate in the United Kingdom over income taxation is that steeply progressive systems have a disproportionate effect at the ballot box, since many individuals have aspirations to earn substantially higher incomes in coming years. The value placed on a final salary promise may partly reflect this phenomenon.

2.1.8 Finally, the granting of some form of pension promise (defined contribution or defined benefit) may be optimal if employers could expect that, in the absence of such a promise, with employees remunerated through salary alone, there would be social or other pressures on them to provide pensions for spendthrift former employees.

2.1.9 Overall, the analyses set out in ¶¶2.1.2 to 2.1.8, although not quantitative in nature, help to explain why employers provide pension schemes for employees and the historic preference for final salary related benefits.

2.2 *Pension Schemes and Risk*

2.2.1 In the absence of a fund, the decision to pay a part of an employee's remuneration in the form of future pension creates a risk to the employee, and a benefit to the employer — the firm could ultimately default on its promise. A natural mechanism to reduce this risk is to create a special purpose vehicle to hold assets broadly corresponding to the value of the liabilities being created. Employees are then largely insulated from the possibility that the firm will go bankrupt.

2.2.2 Despite the creation of the pension fund the ultimate liability to meet employee benefits continues to reside with the employer. If the pension fund assets fall in value, the employer will need to make additional contributions to

make up the shortfall. If the assets increase in value, the employer gains because future contributions can be reduced. In this sense the pension fund assets and liabilities are off balance sheet items of value and liability to the firm's shareholders. This is the view taken by Graham & Dodd (1934).

2.2.3 Since the ultimate liability rests with the employer, a pure defined benefit scheme (that is, a defined benefit scheme in which the trustee or company exercises no discretion in any of the benefits provided) is fundamentally different from a pure defined contribution scheme (that is, a defined contribution scheme in which the benefits depend only on the returns achieved on contributions put into the scheme and no guarantee or underpin is provided by the company). If assets and liabilities are mismatched in a defined benefit scheme, for example if a high equity investment strategy is adopted, the level of market value volatility could generate a far greater source of uncertainty in the value of the firm than that resulting from normal management of the underlying business. There are no such consequences in the case of a defined contribution scheme.

2.2.4 In practice, and certainly in the early years of defined benefit schemes in the U.K., it can be argued that many arrangements had some hybrid features. For example, prior to legislation on vesting there was enormous flexibility in the actual level of benefit paid to early leavers, who may, in practice, form the majority of beneficiaries in many schemes. For such leavers, the minimum benefit was typically (prior to 1973) a return of member contributions only, perhaps rolled up at some low (typically 3% p.a.) rate of interest. Any other benefit (such as a transfer value) was largely discretionary. Similar comments applied to pensions once in payment, which were originally (in the private sector) promised without any increases except at the discretion of the trustee, perhaps with employer consent.

2.2.5 The level of discretion available adds considerably to the complexity surrounding the hybrid nature of many defined benefit schemes. The responsible exercise of such discretion requires the involvement of suitably qualified professionals; a role which the actuarial profession has often fulfilled, albeit usually in an advisory capacity. However, the scope for such discretion has been eroded in recent years, in the following ways:

— statute law in the case of early leavers and pensions in payment;
— case law, which has established that both the pension promise and even a long standing discretionary practice can be deemed to be part of an employee's pay;
— a general shift in financial service products away from the collectivism and mutuality associated with trustee discretion; and
— following recent court rulings on ownership of surplus, there has been a tendency for newer Trust Deeds to clarify the employer's ownership of surplus; one implication of this must be less discretion in the trustees' use of surplus.

We are not convinced by the argument that hybrid characteristics of defined

benefit schemes give sponsors unfettered access to surplus whilst retaining the right to scale back promised benefits when times get tough. We would suggest that members should rightly place an appropriately reduced value on such a 'win win' conspiracy. The valuation of such options will be discussed in more detail in Sections 8.6 and 8.14 as well as in Section 9.

2.3 *Three Ways of Investing*

2.3.1 We can see from the above analysis that, from the member's view, for a *pure* defined benefit arrangement investment policy has only a limited impact. A high risk strategy appears only to be detrimental in the joint event of corporate bankruptcy and a pension fund shortfall, which could result in some reduction in benefits. The loss in benefit would be all the more serious here, since corporate bankruptcy could also trigger redundancies and a loss of employment income not fully compensated by redundancy benefits. However, although such an event deserves quite a significant weight, the likelihood of corporate bankruptcy is generally small, and overall the preference for a low-risk investment strategy arising from this scenario may not be particularly marked. Furthermore, it can be argued that this risk is part and parcel of the remuneration package for employee members (who, owing to priority rules on wind up, generally bear the brunt of credit risk) and that the employer is at liberty to adjust salaries upwards or downwards slightly (for example) if the risk is modified by the trustees adopting a higher or lower risk strategy.

2.3.2 With the exception of this option to default, for a pure defined benefit arrangement, shareholders bear the remainder of the investment risk arising within a pension fund. However, they also gain full reward from favourable investment performance.

2.3.3 In shareholder value terms, the effect is therefore much the same as if the assets and liabilities were directly held on the balance sheet, or, taking the analysis a step further, held directly by the shareholders of the company. In other words, shareholders of the company have three broadly equivalent ways to gain any given level of equity exposure:

(1) to manage their directly held assets;
(2) to achieve this by changing the balance sheet of their company; or
(3) to modify pension fund asset strategy.

2.3.4 If trustees control investment policy, shareholders can use one of the alternative ways to obtain their desired asset mix. Leaving aside tax and other such considerations (which we return to in detail in Section 8) there is, therefore, no specific reason to suppose that one asset class is preferred for the pension fund over any other. This is really the litmus test against which theories of pension fund investment must be measured from a shareholder perspective. It is a sufficiently important issue (arguably the most important issue raised in this paper, to which we will return again, in one form or another) to merit a simple example before we proceed further.

2.3.5 Suppose that our saucepan manufacturer, in whose equity our individual shareholder invests, has £100 of pension liabilities (per £100 of equity) and these liabilities are currently matched with bonds, but the trustees of the pension scheme decide to switch into equities. The first point to grasp is that, if this represents only a marginal change in the ultimate shareholder's total portfolio of assets and he arranges this total portfolio optimally, then he should be indifferent between a marginal increase or marginal decrease in equity exposure. However, pursuing this further, even for larger changes in investors' portfolios (such as a wholesale change in the investment strategy of U.K. pension funds), what our analysis says is that, if the shareholder is informed of this change and he was happy with the original asset allocation of his personal portfolio, he can respond to each £100 switch from bonds to equities within the pension fund by switching £100 from equities to bonds in his personal wealth portfolio outside this particular shareholding.

2.3.6 It may appear to be unrealistic to assume that individuals will behave so rationally in response to changes in asset allocation within their overall portfolio. However, the three important issues raised by this example are:

(1) The fact that the individual *can* rearrange his personal portfolio in this manner makes the search for an optimal asset allocation based on risk and return preferences at the level of the company pension fund a fruitless endeavour. For any individual pension fund there may be no optimal asset mix at all, and a low risk/return (100% cash or index-linked) strategy would be just as good as a high risk/return (100% equity) strategy. This conclusion has profound implications. Although the traditional concept of matching is important for pricing and hedging liabilities, the above analysis suggests that it is by no means obvious why a shareholder should prefer to adopt either a hedged investment policy, an 'efficient', but mismatched, policy or an inefficient and mismatched policy, if the assets and liabilities represent only part of his total wealth.

(2) Whether or not all individuals are rational, and *without* assuming that all individuals have identical risk preferences, it seems reasonable, at least, to assume that the price levels for equities, bonds, and all other traded assets are such that prospective returns are balanced against the risks (again without specifying how risk or return is measured). After all, someone must be holding bonds and someone must be holding some cash. It cannot be the case that everyone wants to hold equities, because if they did the equity risk premium would fall until bonds and cash became attractive again. In this context it seems particularly presumptuous to assume that, for some reason, shareholders of saucepan manufacturers chronically fail to hold enough equities in their personal portfolio.

(3) It is clear that our example works on a macroeconomic level, since someone must sell the equities for the pension fund to buy!

2.3.7 To the extent that there is still a 'hybrid' element to a defined benefit

scheme (in the U.K. this is now restricted primarily to pension increases above the level provided under the rules), members do bear some investment risk and it would be feasible for trustees to seek to arrange the assets and liabilities to reflect members' risk preferences. Potentially, the gains from such an 'optimum' arrangement could be shared between both the shareholders and members, since employee members would place a higher value on such pension benefits, allowing the company to pay slightly lower salaries. However, focusing at the member level still does not get us off the hook, for the following reasons:

(1) Ultimately, all shareholders are individuals, so although the shareholder/employee group may not be homogeneous the same basic issues must arise.

(2) In particular, the pension fund benefits will typically form only a part of an individual's total portfolio of wealth (at its broadest definition, the future earnings prospects of an individual may form part of this portfolio), so, again, optimisation should not be undertaken by reference to the risk and return profile of the pension benefits in isolation, but must take account of other assets and liabilities in the member's personal wealth portfolio (his house and mortgage, for example).

(3) To the extent that the individual's other assets and liabilities are liquid, or he has access to liquid and inexpensive vehicles to modify the risk and return profile of his personal wealth, an optimal pension fund asset allocation policy (based on risk and return characteristics alone) may not exist at all. In order to establish a preference for gaining equity exposure within the pension fund, for example, we would need to establish that exposure could be achieved at a lower cost or on a more tax efficient basis through this vehicle.

2.3.8 However, even if we assume that some individual pension scheme members are, in practice, denied access to complete financial markets and have illiquid personal wealth, it is by no means straightforward to establish, on their behalf, the optimal pension fund asset allocation when there is an element of investment participation in the pension benefits.

2.3.9 Although it is broadly accepted that, empirically, younger individuals show greater risk tolerance with their financial wealth than older individuals, the reasons for this phenomenon are the subject of fierce academic debate. In particular there is debate over the existence and implications of both mean reversion and 'time diversification' effects in financial markets (see, for example, Bodie, 1995; Thorley, 1995; and also Sections 5.4 and 5.5).

2.3.10 The rationale for 'lifestyle' approaches to asset allocation of pension funds, which switch from equities into bonds and cash as members mature, are not well understood. Superficial explanations for apparent differences in risk aversion with age are often inadequate, and it is necessary to proceed with extreme caution when advising trustees on this issue. For example, factors other than age (such as an individual's total wealth, the correlations between different components of his wealth and the risks he takes with that wealth, by mortgaging

his house to the hilt) may be equally important in determining preference for risky financial assets within the pension fund. We will consider these issues again in Section 8.

2.4 *Matching of Pension Fund Assets and Liabilities*

2.4.1 We have shown above that it appears to be impossible to establish the existence of any optimal investment policy by looking only at the pension fund assets and liabilities. Even if we allow for what we might describe as 'second order' effects, such as the potential windfall gain to shareholders (that is, release from liability) on bankruptcy or, for example, embedded options arising from equity participation in the overall benefit, we will need to look at the total remuneration package to find whether there really is an overall gain to shareholders from adopting a particular investment strategy. Since rearranging the assets is, at best, a second order play and may turn out to be, broadly, a zero sum game, it is worthwhile to consider first whether there are any advantages in attempting simply to match the assets and liabilities as closely as possible.

2.4.2 This is, after all, common practice in most areas of financial risk management by corporations. We will, therefore, borrow a few basic ideas on optimal capital structure from textbooks on corporate finance to determine whether the shareholder might benefit from a policy of matching assets and liabilities inside the pension fund as closely as possible. If we can establish some benefit to matching, then, mathematically speaking, we have a neat special case. Although we are looking at the pension fund and the company as a single entity, the 'optimal' asset allocation can, conveniently, be identified, by asset and liability modelling, without reference to the other assets and liabilities of the shareholder or member. As we shall see in subsequent sections, if we price the liability using market-based methodology, this 'hedge' will also fall quite naturally out of our valuation.

2.4.3 One obvious observation in support of matching is that departure from a matched position may result in an increase in the variability of a company's value, giving rise to risk that outside events will divert management effort away from shareholder value enhancing strategies and that costly remedial action may be required. If there is a serious danger that our management will spend time fire-fighting in this arena, which could be better spent managing saucepan production, then there would be a strong case for matching the pension fund assets and liabilities.

2.4.4 This firefighting is not restricted to managing the emergence of large deficits. Managing surplus can also be demanding. If trustees have full discretion, or at the very least have some leverage on the company (by withholding consent for contribution reductions for example), then management loses direct control of part of the remuneration of existing employees and, more seriously, former employees. Of course, management can conduct a rearguard action to claw back distributed surplus indirectly, by adjusting current employees' pay to reflect their improved pension benefits (or their improved

expectations of benefits). However, this seems, at first sight, a rather unnecessarily complex way to run a business.

2.4.5 Furthermore, in the financial literature, one of the reasons put forward in favour of a high corporate gearing ratio is to facilitate 'monitoring' of management (see, for example, Jensen, 1986). A company which has a high level of gearing will have high calls on internally generated cash and will, therefore, need to obtain external financing, via the securities markets or through the banks, to finance its capital investments. The extra discipline this imposes raises firm value, unless the level of debt becomes excessively high (in other words there is an optimal gearing level). In this context, closer matching of pension scheme liabilities could reduce the volatility of corporate earnings, increase a company's ability to raise debt and enhance company value.

2.4.6 The tax advantage to borrowing relative to use of equity capital acts in the same direction, of encouraging firms to match the pension fund so as to maximise their ability to issue debt themselves. Leland (1994), for example, demonstrates the existence of an optimal level of gearing which maximises the trade off between the tax advantage of debt over equity finance and the increased risk of bankruptcy and associated costs. Under this simplified model it can be demonstrated that a mismatched pension fund would increase the risk of the firm, reduce the optimal level of gearing and thereby reduce firm value (as described by Bezouyen, Exley & Mehta, 1997). Also, as we illustrate in Section 8, there are tax advantages to shareholders associated with sheltering company assets within a pension fund. If the scheme is very well funded, then at first sight, it makes sense to match the surplus basis to avoid going over by mistake and paying tax. Unfortunately the basis prescribed under the 1986 Finance Act is not an investable index, so this cannot be achieved. On the other hand, matching the funding basis will allow a scheme to be funded more strongly (exploiting the tax shelter) without triggering surplus distributions to members. This also requires the funding basis to be investable.

2.4.7 In terms of the aggregate supply of financial assets to individuals, a move by pension schemes from equities into corporate bonds would be neutral, since companies would effectively be buying back their own equity and issuing debt, whilst their pension funds would be selling equities and buying corporate debt. However, if the above factors do indeed serve to increase shareholder value, the net result would be a (small) positive economic gain.

2.4.8 Company management may, of course, take the opposite view and prefer equity investment, since this could enhance their ability to fund investment opportunities internally, without testing using external finance. However, the introduction of the U.K. minimum funding requirements (MFR) under the 1995 Pensions Act may serve to increase further the advantages to both shareholder and management from a matched investment policy. As a consequence of this requirement, companies in future may face a cash call at a time of a decline in equity markets. Since this could well be when companies experience difficulty in raising funds, it could trigger corporate bankruptcy.

2.4.9 It is, perhaps, stating the obvious that, as well as management being averse to losing their jobs, the costs to shareholders associated with bankruptcy can also be very high. Besides direct costs such as redundancy payments and legal and accountancy fees, goodwill value associated with the possibilities for profitable trading in the future can be lost.

2.4.10 In the past, a pension fund shortfall had few adverse consequences (other than the need to make good the shortfall), since companies could make up the amount over a period of many years. The effect of MFR is potentially to shorten dramatically the timescales over which deficits need to be covered and therefore to trigger bankruptcy where a company is made to access internal or external funds within the period. A policy of matching, albeit, as we discuss later in Section 7, to a basis which flies in the face of the financial theories we propose, will reduce this risk.

2.5 *Conclusions*

2.5.1 The implications of the above analysis are very far reaching for pension scheme financial management.

2.5.2 We will pursue further, in the following sections, the argument as to why it is wrong to use the return on equities to price or cost prospective pension liabilities. Here is the place to use our 'three ways' argument from Section 2.3 to explain, as our first major implication, why historic equity investment by U.K. pension funds has *not* reduced the cost to shareholders of defined benefit pension schemes. The favourable U.K. equity performance since the Second World War has, in the minds of several commentators, vindicated the U.K. equity approach to pension funding against bond dominated approaches elsewhere in the world; we would question this logic.

2.5.3 Undeniably, the investment returns achieved by U.K. funds have been higher than would have occurred if they had been more heavily into bonds. However, we do not accept the curious notion that this self-investment has enabled U.K. industry to pull itself up by its own bootstraps to a level it would not otherwise have achieved. If the schemes had held bonds, then the equities would not have ceased to exist — rather, existing bond holders would have held more equities. Perhaps a greater demand for bonds would have led to more significant debt financing, with the remaining equity being more highly geared to compensate, but this would not have increased economic wealth, and the total returns to investors would not have been affected.

2.5.4 Indeed, we can even argue that the current equity-based system has expropriated wealth from shareholders to employees, as the beneficial investment performance did not always accrue to the sponsor, but was spent, instead, on unplanned benefit improvements. This would not have happened if the schemes had invested in bonds and shareholders had held the equities on their own account.

2.5.5 The second important implication is that we cannot find an optimal unmatched pension fund investment strategy by looking at pension fund assets

and liabilities in isolation. Even if we consider second order effects, such as the credit risk associated with equity investment or the possibility of benefit improvements, we must be very careful to consider the wider implications for overall employee remuneration, which leads us to conclude that, at the very least, we need to devote attention to the interaction between the company and the pension fund. Seen in this light, there also appear to be some important advantages to matching (especially in the light of the U.K. minimum funding requirement), although the use of diverse and non-investable bases conspire against this.

2.5.6 Our third observation is that, although the issues seen from a trustee or member perspective, rather than that of the shareholder, may appear different at first sight, in reality there are a number of strong similarities. In particular, members also have other assets which they can rearrange and any expense or similar advantages associated with particular investment policies within the pension vehicle are likely to be shared, via the wage bargaining process, with shareholders. The similarity between the value perceptions of members and shareholders is consistent with the fact that many individuals fall into both camps. However, this does mean that, in most cases, a benefit to members represents an equal and opposite cost to shareholders. It is extremely difficult to create a remuneration structure which drives a wedge through this identity to generate economic benefits both to members and to shareholders.

2.5.7 Finally, we should, perhaps, conclude this section by nailing one point of detail, since we have now marshalled together enough of the main issues to hammer it home, and it may otherwise crop up again later on in the paper. We accept that legally the choice of investment policy is usually the responsibility of the trustee, not the company. However, the 1995 Pensions Act, for example, requires consultation with the company and, in practice, such consultation is already common. Furthermore, regardless of the policy adopted by the trustee, the fact that the company or shareholder may also be able to rearrange assets outside the pension scheme, as described above, will be more relevant to many of our discussions than the strict legal construction of the pension scheme in isolation. There is, though, a more subtle issue, which we have already touched on. If we cannot drive a wedge between the above identity, then we have the 'zero sum game' to which we referred in Section 2.4. Although, at first sight, rather discouraging to those seeking a consensus between the members and the shareholder, this means that it is in the interests of both to go in search of policies which either exploit the common advantages of matching (as described in Section 2.4) or minimise leakage of wealth to third parties (for example taxation, transaction costs, etc.), the benefits of which could, in both cases, be shared. The rationale for such a search would be that whichever policy turns out to maximise the common good should then be followed, since the 'zero sum game' ensures that any apparent savings by the shareholder at the expense of members (or vice versa) should be offset by other checks and balances (such as the wage bargaining process, for example). This is pursued in Section 8.

3. THE FUNDING APPROACH TO LIABILITY VALUATION

3.1 *Introduction and Background*

3.1.1 In the previous section we considered, from the perspective of both a shareholder and an individual employee, the underlying reasons why companies might provide defined benefit pension schemes for their employees, and also the issues involved in deciding how to invest assets set aside to meet these liabilities.

3.1.2 Our analysis and conclusions were based on theories of corporate finance, adopted by financial economists, management consultants, banks and many other financial institutions. However, many of the conclusions drawn from our analysis appear to conflict with the messages coming from conventional actuarial approaches. In particular, our 'three ways of gaining equity exposure' argument from Section 2.3, and the conclusion that how you arrange the assets between equities and bonds does not materially affect the economic cost of the liabilities, may seem at odds with the actuarial concept of value.

3.1.3 At the heart of these *apparent* contradictions is the difference between the economists' definition of value, based on market-based approaches, and the construction of actuarial values for the purposes of *funding* pension schemes. In this section we therefore describe what a funding value really is and what it is used for. In doing so, we can basically reconcile the differences. However, in scratching this surface we also identify a few other areas where a little financial theory may be able to improve the quality of corporate management decisions based on actuarial advice, with potential gains for both the shareholder and scheme members.

3.1.4 In the discussion of Smith (1996), P.D.G. Tompkins raised a "challenge for the theoretician: that the impure work that we carry out does work in many practical circumstances". In this section, we take up this challenge by examining some consequences of a mechanical application of some traditional funding methodologies. This suggests a level of inconsistency which some readers may find disturbing. In practice, the picture is not uniformly bleak, and various adjustments can be made to produce results which can be (although may often not be) consistent with some of the market-based valuations considered subsequently in this paper. However, before we document these practices in the language of shareholder value, it is useful to explore what is, and is not, possible with a strict application of the actuarial tools which have been at our disposal for decades.

3.2 *The Funding Approach*

3.2.1 The funding approach to asset and liability valuation dominates current actuarial techniques applied to U.K. pension schemes, although insurance actuaries often favour market-based approaches, and pensions actuaries have, historically, adopted a variety of techniques.

3.2.2 Strictly speaking, the funding techniques do not result in a liability valuation at all, but rather a statement that a certain set of assets '100% fund' a set of liabilities. The *funding level* is determined by projecting asset and liability

cash flows, if necessary allowing for the need to reinvest asset income or realise assets to pay liabilities. The assumed rate of reinvestment return is a 'long-term' assumption, which need not necessarily correspond with the internal rate of return implicit in the asset cash flow projections. In some valuations an equivalent discounted cash flow approach is used, as noted below.

3.2.3 The funding projection normally entails a single scenario. Typically, the long-term assumption is chosen subjectively, so that one actuary may select a different number from another, and, therefore, generate different assessments of funding level. In turn, this has a geared effect on the level of contributions deemed necessary to fund past service liabilities.

3.2.4 A scheme is said to be *100% funded* if, under the assumed projection basis, at some future point in time, all assets and liabilities have been extinguished. Other funding levels are described as a proportion of the liabilities — for example, if the assets were sufficient on projection to pay 1.05 times each liability cash flow, then the scheme is said to be 105% funded.

3.2.5 It is important to appreciate that valuation is not the final objective of the funding methodology. Instead, the ultimate requirement is to come up with a funding plan, confirming that, under plausible business assumptions, the assets are sufficient to pay benefits or that assets plus future contributions will be enough to pay future benefits. If the assets are expected to earn a high return, for example on account of their riskiness, it could be argued that it is appropriate to take this into account when drawing up a funding plan, particularly given the special circumstances of having an underlying promise to pay from the employer, as we described in Section 2. In other words, although the funding basis is weak and the pension fund assets may not be sufficient to meet the promised benefits, the additional security afforded by the employer results in an overall acceptable level of risk. The liabilities are not being 'valued', but rather budgeted for.

3.2.6 Given a projection of asset and liability cash flows, the straightforward method of assessing funding levels would be to project a rolling cash balance, allowing for returns on reinvested cash flows. The funding level may then be obtained by trial and error, to find the liability scaling which uses up all the assets.

3.2.7 However, such calculations are cumbersome — it would be helpful to have a simple rule of thumb to determine whether or not a scheme is adequately funded. To this end, it can be shown that, if asset and liability cash flows are both discounted at the assumed reinvestment rate, then the ratio of the discounted amounts is exactly the required funding level. This is a convenient computational shortcut which avoids the need for explicit projections. There is no reason why discounting asset cash flows at the assumed reinvestment rate should reproduce market values — in general they will not, but, instead, give rise to a so-called 'assessed value' or 'actuarial value' of assets. The reinvestment rate assumption is sometimes, and *arguably* rather confusingly, called the 'long-term return'.

3.2.8 The use of assessed values for assets reflects an underlying philosophy that funding levels and professional judgement matter, while absolute sterling

amounts and market values do not. This exemplifies the 'scheme centred' approach which actuaries have traditionally adopted.

3.2.9 There is a danger of elevating these assessed values to a status which they do not deserve, even if two actuaries could agree on a common set of long-term assumptions. The difference between assessed and market values arises because our long-term view of asset returns is different from the internal rate of return on current assets. This suggests that the expected returns as at the valuation date are not constant for all future time horizons. However, the established actuarial techniques and computational shortcuts of benefit valuation do rely on a term-independent discount rate. The assessed value is an inconvenient loose end that drops out from trying to square this circle. Some commentators suggest "the actuary is saying that the market has temporarily got it wrong, but in due course, it will get it right" (Wilkie in the discussion of Dyson & Exley, 1995). In our view this stance is illogical — term-dependent return expectations do not imply market inefficiencies, and we cannot see why an assessed value should give a fundamental assessment of cheapness or dearness.

3.2.10 A number of recent actuarial papers have set up the funding methodology as a blueprint for more general assessment of economic cost or value. For example, Thornton & Wilson (1992) in a pensions context, Lewin *et al.* (1995) in the context of capital projects, Pemberton (1996) and Clarkson (1997) in the context of option pricing. Although these extensions are of some interest, in this section we will seek only to assess the more modest original ambitions for funding valuations.

3.3 *A Conjuring Trick*

3.3.1 As we have noted, funding valuations provide a convenient algorithm for budgeting company contributions. However, on the downside, actuaries need to be alert to the danger that such 'valuations' can produce results which look very odd at first sight, as noted by Arthur & Randall (1990).

3.3.2 As an example, let us assume that the current yield curve is flat at 8% and that the expected return on equities is 10%. Let us suppose further that a fund of 100 is invested in equities to meet a pension promise of 109 fixed one year hence. According to the funding method, there is an expected surplus in one year's time, and so the scheme is overfunded. On the other hand, if we hold our assets in gilts and use the gilt discount rate, we have assets of 100 against liabilities with a present value of 101, and thus the fund, as a whole, is an economic liability to the sponsor, notwithstanding its apparent actuarial surplus.

3.3.3 Suppose we then consider the following two schemes:

Scheme 1

Assets: 100 (by market value) in equities
Liabilities: 165 payable in 5 years' time

Scheme 2

Assets: 115 (by market value) in gilts
Liabilities: 250 payable in 10 years' time.

A simple discounted cash flow calculation reveals that both schemes are marginally underfunded. Now let us consider interchanging the asset portfolios of the two schemes (leaving the liabilities untouched). Miraculously, both schemes are now overfunded!

3.3.4 The question arises as to where this wealth has come from. The answer is that, by hypothecating the better performing asset class to the longer dated liabilities, we obtain a greater total asset return.

3.3.5 This is roughly typical of the puzzles that arise with the funding method — anomalies that can be explained in terms of the arcane mechanics of the calculation. It means that, if we interpret the actuarial numbers as values, a conglomerate with two separate pension schemes could apparently enhance its 'value' by swapping assets between schemes.

3.3.6 Likewise, the Government would appear to achieve a similar result for the economy as a whole if it discounted personal pension provision at 4.5% p.a., on account of the possibility of equity returns, while discounting state provision of equivalent benefits at 3.5% p.a., reflecting the Government's cost of capital via the index-linked gilt market.

3.3.7 Of course, such wealth creation wheezes reflect the artificial nature of the valuation basis rather than any economic reality. They tend to trigger alarm bells in the minds of financial economists, since tricks like this tell us that something is wrong or inconsistent in the mathematics, making all conclusions, potentially, a bit suspect. Instead, financial economists prefer a concept of value which is conserved under such pencil and paper games.

3.4 *Arithmetic and Geometric Means*

3.4.1 Another slight problem associated with holding up funding liabilities as 'values' is that the approach considers only a single scenario. This is a simplification of the reality of a large number of alternative possibilities in the non-deterministic world out there. It, therefore, is of interest to consider how the chosen scenario should relate to the spread of possible outcomes. For example, should return assumptions be arithmetic means, geometric means, medians or modes?

3.4.2 It is worth mentioning that the difference between arithmetic and geometric means is highly material — the difference in historic equity returns estimated by the two methods is around 2% p.a. In many actuarial calculations this decision has a similar effect to the choice of equity or gilt-related discount rates, but for some reason has attracted far less attention.

3.4.3 The estimation process employed by Thornton & Wilson (1992) produces geometric mean estimates (although they do not comment on this). Wilkie (1995a) suggests use of geometric mean returns, combined with median cash flow projections. The use of geometric means is convenient for projecting over time, but very awkward when combining portfolios over a single interval (see, for example, Wise, 1997). The constraints to make sure that a bundle of cash flows is priced consistently with the sum of the values taken separately also

appear clumsy in a geometric mean context. For this reason, academics typically favour the use of arithmetic means.

3.4.4 The only real answer to this is that there is unwelcome arbitrariness at the heart of funding values. Again, such arbitrariness is rather an unsatisfactory base on which to build a theory of value.

3.5 *Assets with Uncertain Income*

3.5.1 Assets with uncertain income cause yet more problems. The computational shortcut of discounting expected asset and liability cash flows at an assumed reinvestment rate applies generally to many different types of asset. However, a troublesome complication arises when, in addition to the reinvestment rate, assumptions are required to project the future income stream in the first place.

3.5.2 If we look at the assumed level of income growth from the assets, we see that this introduces an unwanted degree of freedom in assessing the funding level and setting the contribution rate. Even if two actuaries based a funding plan on the same long run investment return (10% p.a., say), the value placed on existing assets depends on how this is apportioned between the long run income yield and the rate of income growth. For example, in the case of equities, a return of 10% p.a. could easily be constructed from anywhere between an income yield of 3.5% p.a. with growth of 6.5% p.a. and an income yield of 4.5% p.a with growth of 5.5% p.a. Although a 1% p.a. difference in assumed growth looks innocent enough, it leads to an asset value nearly 30% higher in the first extreme when compared with the second. According to Wilkie (Dyson & Exley, 1995, abstract of discussion), statistical analysis does not allow us to narrow down this assumption any further, suggesting that real dividend growth could only be pinned down to between –1% p.a. and 2% p.a. Wilkie commented at the time that "This may be uncomfortably wide in relation to the valuation of a pension fund, but this range does, at least, exclude a large number of wholly implausible values.".

3.5.3 This issue is causing particular problems in the U.S.A. at the moment, as companies have twigged that a share buyback program has the same effect as a dividend, but without triggering a tax payment. In this case, the cash distribution to shareholders comes through as a capital gain rather than an item of income in the index calculation. As dividends fall, the assessed value falls too, despite the fact that market values are rocketing.

3.5.4 Day & McKelvey (1964), in proposing the income-based approach to equity valuation, basically assumed that dividends grew with inflation, but then reflected this extra degree of freedom by adding a parameter they called, up front, an 'arbitrary multiplier', which they then applied to their final asset value. Thirty years on, little further progress seems to have been made with the methodology, although the arbitrary multiplier is now identified as a real dividend growth assumption.

3.5.5 In practical terms, uncertainty in the income growth element of the cash flow projection leads to the joint problems of estimating the appropriate long run

growth rate and dealing with the effect of emerging variations from the fixed assumption. If an assumption (for example retail price inflation, used to project index-linked gilt proceeds) has a similar impact on both sides of the balance sheet, then these problems may be minor. However, in the case of the rate of dividend growth from equities, expressed as a margin above national average earnings growth, for example, we have an extra growth assumption which applies to only the asset side of the balance sheet.

3.5.6 Not only does the long-term growth assumption represent an embarrassing additional parameter in determining the initial budgeted contributions in any given year, we must deal also with the emergence of variance in our funding level and budgeted contributions in years when the 'short-term' (that is, actual) rate of growth does not coincide with our long-term assumption. Historically, the annual variance in this factor has been quite high. For example, over the last twenty five years the standard deviation has been 7% p.a. (which compares, for example, with volatility in real salary growth of only 2% p.a.).

3.5.7 Of course, from an accounting and budgeting perspective, such arbitrary growth assumptions do eventually come out in the wash. For a given actual rate of dividend growth on U.K. shares, our scheme funded on the 1% weaker growth assumption will book an experience gain or loss 1% worse than the other scheme, thus any difference in assumptions gradually unwinds. Furthermore, the position can be reconciled in true book-keeping fashion from year to year, by reference only to the change in dividends received over the year (a solid and familiar accounting number) and without having to worry about the progression of market values. The only real inconvenience arises when cash inflows or outflows result in assets being purchased or realised above or below their actuarial value; a familiar bookkeeping problem, although the method does also affect the *timing* of increases and decreases in contribution rates, an issue to which we return in Section 8.

3.6 *Homing in on a Target*

3.6.1 Finally, if we regard the funding methodology as a means of homing in our savings on a future liability commitment, we find another rather curious effect, as a consequence of the potential inconsistency with market values.

3.6.2 If, for example, we are funding for some index-linked lump sum in ten years' time using equities, we might find ourselves five years down the road with more than enough cash to buy a matching index-linked gilt, but the funding valuation might be writing down our equity assets so much that we are getting the message to put more contributions in. This is directly analogous with the situation which existed in September 1987. Now, our 'three ways' argument tells us that this scenario does not really matter in a world without transaction costs. If the shareholder wants to move to a matched position he can do so outside the scheme, and for every pound put into equities inside the pension fund he can, in principle, take another pound out.

3.6.3 However, from a transaction cost perspective, it seems rather a puzzling approach whichever way we look at it. If we believe that equities are going to return less than the risk-free rate over the remaining five years, then we are deliberately continuing to take cash from the business and allocating it to the scheme under the current policy, when we could, instead, cease further contributions, or even withdraw surplus, if we switch now to the matching assets. Given the low dealing costs of index-linked gilts (remember that we will need to sell our equities at some point anyway), even if we assume only a relatively small future cost associated with raising cash from the business, it would then seem worthwhile to match and pay in nothing more. On the other hand, if we still believe that equities have an expected return above the risk-free rate, this scenario blows a hole in the idea that the funding method aims to avoid building up excessive funds, because we already expect to have more than enough, and yet we doggedly continue to divert cash from the business into the pension fund.

3.7 *Conclusions*

3.7.1 The main issue to keep in mind when thinking about funding valuations is their purpose. This is particularly important when trying to defend some of the more obvious problems and arbitrariness associated with the method which we describe above. Funding is all about making sure there is enough to pay benefits, and that, if not, additional monies can be injected in a timely fashion.

3.7.2 In these circumstances, one might say that the funding method is most easily defended in applications where it does not really matter whether it is right or not. The consequence of getting the answer wrong is often only to shift contributions from one year to the next, which may have a small economic effect in the overall scheme of things. The only real puzzle here is really why so much detail and sophistication (and expense) is lavished on actuarial valuation systems which adopt the funding approach.

3.7.3 However, even when the answer does not appear to matter that much, some of our analysis above does suggest that, before identifying himself too closely with a particular method, an actuary should consider whether financial theory suggests a better approach.

4. MARKET APPROACHES

4.1 *Introduction*

4.1.1 In contrast with the actuarial funding approach, market approaches to valuation of cash flows have been developed principally by financial economists, although they reflect elements of investment analysis going back to Graham & Dodd (1934).

4.1.2 The starting point of this approach is that the market is already implicitly pricing future receivables from a vast number of alternative investment vehicles. The approach seeks to identify how a given series of cash flows would be priced by the market if securitised in the form of an investment. The key

concept is 'hedging', that is, comparing alternative financial transactions which have similar economic effects. The price of an untraded cash flow stream, such as a pension promise, may be taken as the estimated quoted value of similar cash flow streams, by comparison with traded assets such as bonds or equities.

4.1.3 In a market-based approach, it is, for the reasons described in Section 1.3, taken as axiomatic that the value of a traded asset is its market value. If we have a privately held view that a given asset is cheap or dear, we may trade on that view, but it should not cause us subsequently to account traded assets at other than market. Prudence dictates that we should only take credit for speculative investment gains after they have arisen. Similarly, if current market prices imply views on the future paths of interest rates, inflation or dividend growth, then we will use the market view for valuation purposes in preference to our own subjective estimates. The market is employed to calibrate the economic framework.

4.1.4 As we discuss further in subsequent sections, a valuation procedure which values gilts at market will not, in general, be consistent with a flat discount rate. Instead, appropriate term dependent discount rates would apply to fixed cash flows at future dates. This precludes, for example, the use of actuarial commutation functions to value cash flow streams. The more direct alternative, of projecting cash flows and discounting them, is still available, and has the added advantage of avoiding the confusing 'assessed value' concept. This is precisely what has now been proposed in IFAA (1997).

4.2 *An Example — Forward Contract Pricing*

4.2.1 By way of illustration we can consider a simple example where a strict application of the funding approach, described in the previous section, and this market, hedging, approach give rather different answers.

4.2.2 We consider a share with current market value 100, which, for simplicity, pays no dividends over the next year (but, of course, may do so thereafter). Current one-year interest rates are still 8%; the actuary still believes that the expected return on the share over one year is around 10% on a best-estimate basis.

4.2.3 A fund currently owns this share, but wishes to dispose of it one year hence to some counterparty. Furthermore, the fund wishes to agree today the price at which the disposal will take place — a so-called 'forward trade'. The question arises as to what is a fair forward price.

4.2.4 The funding approach to this question involves projecting asset returns on the 'best estimate' basis. Under this basis, the price of the share in one year is estimated as 110, which might, therefore, be taken as the fair forward price.

4.2.5 The market approach looks instead at 'hedges', that is, alternative ways of achieving the same effect. The desired effect is not to have the share in one year's time, but to generate a fixed lump sum instead. The easiest way to achieve this effect is to sell the share now for its known value of 100 and then put the cash on one-year deposit, earning 108 one year hence, which is, therefore, the fair

forward price. If a forward price in excess of 108 could be achieved, then nobody would bother putting cash on deposit — instead, we would all purchase this share today for 100 and sell it forward.

4.2.6 This market approach is almost universally preferred to the funding approach in the derivatives markets, where forwards and more complex structures trade in trillions of dollars. In such applications, of course, it is not intellectual purity which drives the use of this approach, rather it is a commercial survival instinct; if the same effect can be achieved in two ways, then the same price must be quoted, otherwise an arbitrage opportunity will be gifted to competitors. However, we suggest that this is also a good discipline for all 'clean break' financial decisions encountered by actuaries in real commercial situations, which is the basic theme of the economic value added approach to management. Sadly, this discipline does not yet appear to be universally accepted within the actuarial profession, although, as we noted in our introduction, it is has gained widespread acceptance elsewhere. For example, Larner (abstract of discussion of Smith, 1996) summarises a common view with "I see no reason why an appraised value, from the point of view of a proprietor, used as a management analysis tool, should necessarily take the viewpoint of a market trader". We hope that many such reasons will be revealed along the way in this paper and subsequent work.

4.3 *Purpose of Market Valuation*

4.3.1 This is the key difference between the two valuation paradigms; in contrast with funding valuations, market-based approaches are all about values of actual clean-break transactions in the market today. If the management makes a pensions promise, the shareholders will ultimately foot that bill — how do shareholders see this commitment in financial terms today? The pension liability is not traded, *but the company shares often are* — so real money can hang on pension valuations used for some decisions. Therefore, in stark contrast with funding valuations, market-based approaches tend to be most easily defended in situations where the answer *does* matter. The following are examples:

— Pension assets and liabilities are being transferred as part of a sale and purchase or other corporate restructuring exercise.
— Company management requires an estimate of the cost of its defined benefit pension scheme as part of a review of human resource and remuneration policy.
— An investor wants to evaluate his investment, having regard to the contingent liabilities added to a company by its pension promises.
— The board of a company seeks to separate share price performance between changes in the economic value of the pension fund and that of the business itself.
— Trustees wish to monitor the security of the liabilities in the event of winding up.
— Employees wish to measure the value of their pension promises as part of their remuneration bargaining processes.

— Members want to decide whether to exercise an option to take a transfer value, the value itself possibly calculated on a funding basis.
— The Government needs an assessment of the cost to the corporate sector of new pension legislation.
— The Government proposes a radical change to state pension provision which needs to be costed (see ¶3.3.6 for use of funding approach).

4.3.2 As can be seen, such questions have relevance to shareholders, company management, trustees, employees and Government. In each case, a calculated liability is being compared either directly with cash alternatives (for example, comparing the cost of providing pension benefits with the alternative of providing extra salary) or with other traded assets (for example the price of a matching gilt portfolio in the case of discontinuance valuation). In each case irreversible decisions with important economic consequences, rather than just the timing of cash flows or disclosure of information, may be based directly on the results.

4.3.3 This sharp distinction between the purposes of funding and market valuations is not helped by ambiguity in the word 'cost', which *The Little Oxford English Dictionary* defines as 'have as price' or 'involve payment or sacrifice of', which could cover both the economic or funding approaches respectively. Henceforth we will use the word 'cost' in this paper to mean an economic cost, of the type listed above, unless indicated otherwise.

4.3.4 However, all of the confusion over actuarial and market valuations, sadly, cannot be reconciled on the basis of dictionary definitions alone; at least not from an actuarial student's perspective. The following is taken from Lee (1986), the standard textbook for the pensions examination paper passed by many of today's practising pensions actuaries; "an employer contemplating the introduction or improvement of a pension scheme will ask for estimates of cost and will then decide...whether he and the employees can afford the new or improved scheme...The interested parties are therefore relying on the actuary to make as accurate estimate as he can of the long term cost of the scheme". So, on what assumptions, according to the textbook, should the actuary base this accurate estimate of cost?. Well, Lee tells students that "assumptions will have to be made about some or all of the following economic elements...(I)The average future dividend yield...(II)The average annual rate of growth...in the yearly amount of dividends...(III)The average long term yield on investments made in the future...". The actuarial textbook does not mince words here.

4.3.5 Similar ambitions for the funding method are echoed by Thornton & Wilson (1992), who cite the following three uses for their realistic approach to pension funding:

— "comparison of projected benefits [from defined contribution arrangements] with those from a 'final salary' scheme [which] needs to be made as objectively as possible" (we return to such comparisons in Section 9);
— "to set an appropriate level of [defined contribution] underpin and to cost the effect of such an underpin in a stochastic model"; and

— "transfers between occupational schemes...the reality is that any tendency for...bases to be too conservative results in excessive assets being transferred and too low a price being paid for the business".

Accordingly, it seems that we must pursue the above issues a little further to reconcile financial and actuarial theory on this subject.

4.4 *Another Example — Funding a Pension*

4.4.1 To pursue this distinction further, let us consider a human resource department which persuades the company management to set up a new pension scheme. They take employees aside, and offer them the choice of getting 110 next year, in return for 100 taken out of their pay packets today. The employees are happy to agree; this is better than they can get on deposit at the building society.

4.4.2 The management then invests the 100 in equities in a segregated fund. As far as the management is concerned, they appear to have broken even financially, because the actuary's funding valuation says that the scheme is 100% funded on a best estimate basis, assuming a 10% return on equities. The human resource department congratulates itself on its flexible remuneration policy.

4.4.3 However, the shareholders are annoyed. The nagging little problem they have is that, as the deal stands, one year down the line they will be responsible for the difference between the promised 110 and whatever the fund produces. Admittedly, this could cut both ways, and on average, they break even. The trouble is that using simple best estimates to derive prices is not really good enough, as, indeed, we saw in our first example. One way of reasoning why this is so is to see that, if the equity market plummets, the shareholders' personal portfolios perform worse than they otherwise would have done, because of the extra pension scheme deficit. The volatility of their personal portfolio has been increased, with no compensating return. Economic value has been destroyed.

4.4.4 The shareholders could have been perfectly happy with the deal made on their behalf if the promised pension benefits had not been quite so generous with their money. If the promised benefit were 108, for example, then the private debt involved in a pension promise is not very different from issuing debt on the capital markets. Such transactions do not destroy value, provided you get the market rate. If the promise had been struck at 108, this would have been acceptable, even if the fund had been invested in equities, as, on average, the fund would exceed the liabilities, and this extra source of earnings then compensates shareholders for the risk incurred. Incidentally, the price (of risk) is correct here, not because we are relying on market efficiency, but because it is exactly the same compensation which the shareholder receives for taking exactly the same risks elsewhere using replicating assets (equities and one-year cash deposits). Why should shareholders accept different prices for identical transactions?

4.4.5 However, if the company is investing in equities, shareholders would

like to be told about the mismatch, because they may wish to invest the rest of their portfolios more defensively to compensate for the gearing introduced by the pension scheme.

4.5 *Accounting for Risk*

4.5.1 It is clear that, in each of the above examples, the discrepancy between the funding and market approaches is of the order of 2% p.a., this being the assumed risk premium on equities relative to cash deposits. It is of interest to see how this emerges from the different economic perspectives.

4.5.2 A key concept behind funding valuation is that the assets and liabilities are projected within a consistent framework. Consistency is taken to force the use of a single rate of interest for discounting liabilities and the assets which are employed to fund them, irrespective of the risk profiles of the assets and liabilities. To the extent that the assets enjoy a risk premium in their expected returns, and the funding method discount rate reflects this, a lower valuation for any associated liabilities will result.

4.5.3 By contrast, the market approach would use different discount rates for cash flows of different risk. To value a set of liabilities, therefore, one first needs to identify a set of traded cash flows with similar risk attributes (the 'hedge portfolio'), and then observe the market price of the traded cash flows. The cash flows in the hedge portfolio may well arise from purchases and sales (at market) in addition to investment income. This construction ensures that the implicit discount rate accurately reflects a market reward for the risk assumed.

4.5.4 Under this market framework, the suitability of a hedge portfolio, for constructing values, is assessed on a symmetric basis. The possibility of the hedge assets outperforming the liabilities needs to be given equal weight to the possibility of underperformance. Such a convention is necessary to ensure that a promised cash flow stream is valued consistently by both parties. By the same token, it is inappropriate to insert arbitrary 'margins for prudence' in a market value calculation. Prudent for members may be imprudent for current shareholders, but at the same time prudent for potential investors.

4.5.5 Another convenient advantage which we can pick up here is that, when we use the market-based method, we do not need to worry about the choice between arithmetic or geometric means, medians or modes. The issue does not really arise. To take a simple example, consider a fixed payment of 100 in ten years. If we apply a funding valuation, and discount at historic rates of equity return, it is highly material whether we use 12% p.a. or 14% p.a., which might be a typical spread between various forms of average. However, if we use the market-based approach, and the payment is exactly matched by a ten-year discount bond, then the 'average' *historic* return on these bonds (mean, median, mode, etc.) observed in past data simply does not enter our calculations anywhere. If such bonds currently stand at 42, then this is our market price of the liability. We can express this result in a number of ways, for example we could express this as discounting both assets and liabilities at an average rate of

9.06% p.a., but the use of an average here is just a matter of presentational convention. As long as we use the same discounting convention on both sides, we will always arrive back at our answer of 42.

4.5.6 Establishing a hedge for market pricing purposes is, of course, a separate issue from portfolio selection. For example, portfolio selection in a funding framework might reflect the view (expressed by G. R. Farren in the discussion of Thornton & Wilson, 1992) that "failure would be disastrous and success merely fortuitous". Portfolio selection might also take account of regulatory restrictions, local customs, and the impact of essentially arbitrary accounting funding bases, for example as specified by the MFR. This contrasts with the hedge definition in the market approach, which is based only on liability cash flows.

4.5.7 Confusion of hedging with portfolio selection can give rise to bizarre conclusions — some appear to argue that equities are a hedge for any suitably distant cash flow on the grounds that, in the long run, equities are expected to outperform other asset classes. Such spurious arguments have been advanced, for example, in justifying equity-related discount rates for measuring the economic cost of pension liabilities. We will return to this issue in the following section.

4.5.8 In reality, perhaps the greatest beauty of the market approach is that, often, the risk premium, usually the most difficult parameter to estimate, does not have to be estimated at all for a value calculation. Yes — there may be a risk premium for holding equities, but in a discounted cash flow calculation, this should affect both projected values and also the discount rate. The overall effect should be zero. If market risk is the main form of uncertainty, then the market approach will result in less scope for judgemental input than the funding approach. However, where non-traded risks such as withdrawal rates or salary inflation are material, some subjective input may be required for either approach. A further element of risk, which may need to be incorporated in a market approach, is credit risk, that is the risk that the promised pension may not, in fact, be paid. These practicalities are discussed in later sections.

4.6 *The Link between Assets and Liabilities*

4.6.1 We highlighted, above, another major distinction between the funding approach and the market approach. The funding approach, in measuring the assets against the liabilities, concentrates on the assets actually held by the scheme. It is possible that the same scheme could be 100% funded either by 100 (by market value) of shares, or 102 in cash. This is not inconsistent — simply a reflection of different expected returns. The focus of the funding method is very much at the fund level. Any resulting accumulation of risk for shareholders and members, outside the fund, is not considered relevant.

4.6.2 On the other hand, the market-based approach to liability valuation uses as a reference point the 'hedge' that is, the portfolio of assets that most closely match the liabilities. A fixed pension liability of 110 payable in one year's time is unambiguously matched by a one-year cash deposit and not by equities.

Consequently, the liability should be valued with regard to current interest rates, irrespective of how the assets of the fund are actually invested or how much is currently held in the fund to meet the liabilities. The key economics occurs at the market level; the fund could be considered as an integral part of the underlying business.

4.6.3 In practice, pensions actuaries have become uncomfortable with the idea that switching asset portfolios should change the economic value of the liabilities, and the widespread use of 'notional portfolio' techniques within a funding calculation has provided a means of resolving this paradox (although it does introduce a new puzzle in a budget forecasting context, as to why the actuary should wish to project assets other than those actually held). These techniques involve pretending to reinvest the assets (at market value) into a 'suitable' notional portfolio for the purpose of liability valuation. The introduction of notional portfolios can, for example, be used to prevent schemes from being able to record low liability commitments by virtue of aggressive investment strategies. However, the use of notional portfolios can be viewed as an important half-way house between funding and market approaches.

4.7 *The Common Ground*

4.7.1 The notional portfolio described above is the closest we can get to a common concept linking our hedging portfolio and the funding approach. The market approach to valuation equates the value of the liabilities to the known initial market value of this hedging portfolio. If the hedging portfolio is a reasonable hedge, then asset and liability cash flows will correspond in a wide variety of economic outcomes. Any method of deriving a single projection, whether based on arithmetic or geometric means, medians or whatever, should produce similar projected cash flows for the liabilities and the hedging portfolio. A consistently derived 'best estimate' of the return on the hedging portfolio would be that rate of return at which the current market value is the present value of future cash flows, that is, the internal rate of return based on the current market price.

4.7.2 We have argued that:

— if the projected cash flows hedging portfolio is a reasonable hedge, then asset and liability cash flows on the hedge portfolio should be broadly similar to those of the liabilities; and
— the market value of the hedge portfolio is the present value of projected cash flows, discounted at a best estimate rate.

4.7.3 We can, therefore, deduce that the present value of projected liabilities, at the best estimate return on the hedge portfolio, will actually be the market value of the hedge, which is the outcome of the market-based approach. This is the key to reconciliation of the funding and market approaches. To put it simply: *The market approach will give the same funding level as the funding approach when the notional portfolio is the hedge portfolio.*

4.7.4 This also highlights some important differences. When applying the funding method, it would be unusual to take the notional portfolio as equal to the hedging portfolio. Instead, the notional portfolio would be one 'suitable' for the liabilities. This might mean that the notional portfolio lies on some efficient frontier, and so has the best level of return, given the level of mismatch risk versus the liabilities, although, given the *ad hoc* methods often employed to derive notional portfolios, such optimality is not always achieved. On the other hand, the hedge portfolio is that which minimises the mismatch risk. Typically, therefore, the notional portfolio will have higher risk and higher return than the hedge portfolio (although this is not inevitably the case, as the asymmetric risk definition often used for portfolio selection will not be the same as the symmetric measure defining the hedge). It follows that the funding approach will, other things being equal, often result in a lower liability value than the market approach.

4.8 *Conclusions*

4.8.1 In this section we have introduced the concept of market valuation of liabilities, associated with a hedging portfolio, and contrasted it with the funding approach. We have concluded again that the differences can only really be accommodated by an argument that funding values are just part of an algorithm used by actuaries to derive a contribution rate, and should not be compared with values used in corporate finance, business and investment.

4.8.2 We can identify a special case when the two valuations coincide. This occurs when the 'notional portfolio' for the funding calculation is the hedge portfolio. However, this construction also highlights the difference in approach; in most circumstances the notional portfolio is based on some idealised representation of the actual investment strategy, rather than being associated with hedging the liabilities.

4.8.3 Despite the different purposes of the two approaches, we have also seen that there are some turf battles in areas of overlap. For example, funding valuations can stray into the market arena in some of the applications listed in ¶4.3.1., as promoted in the actuarial textbook by Lee (1986). Our experience is also that the actuarial profession shows reluctance to adopt market valuation disciplines in such applications, as evidenced by many of the contributions to the discussion of Dyson & Exley (1995).

4.8.4 We, therefore, look to a successful and well-tested blueprint for the market pricing of pension liabilities which we can hold up as an example of the approach.

5. A BLUEPRINT FOR PRICING AND HEDGING LIABILITIES

5.1 *Introduction*

We have explained the difference between funding and market arguments for pricing. In this section we search out a successful blueprint of the market-

based valuation approach in action. We then ask, from the perspective of financial theory, why this same approach cannot be applied to pension schemes, and we address some of the conventional actuarial objections to the approach. The practicalities of implementation are deferred to Sections 6 and 7.

5.2 *A Blueprint*

5.2.1 The most illuminating blueprint for market-based valuation is the mark-to-market convention adopted by banks trading derivatives. At each daily close, a valuation is applied consistent with an open market valuation of all the deals on the book. Sensitivities to market parameters, known as greeks (so called only because the monitored parameters, such as deltas, gammas, sigmas and rhos all have greek letters!) are also computed; traders are required to contain these within agreed position limits. Capital gains are notionally put through the profit and loss account on a daily basis. No amortisation or smoothing is applied. Market volatility is fully reflected in the accounted number. Further details on this process are described in Kemp (1997).

5.2.2 In a pension fund context, the discipline of daily revaluation would seldom be imposed. Instead, the fund would typically be examined triennially, perhaps with annual reviews, unless there is some major upheaval (such as the sale of part of the business). Perhaps, of greater concern is that such valuations are generally carried out using the funding approach described previously, outside the discipline of market consistency. It is our contention that such consistency is achievable, and, furthermore, that it would be beneficial for the pensions industry as a whole if these disciplines were adhered to. However, we stress again that the pace of 'funding' or budgeting future contributions need not be coupled with these marked-to-market valuation procedures. This issue is addressed separately in Section 8.

5.2.3 If the greeks of a derivatives position are close to zero, then the book is said to be hedged. In this case the daily profit and loss movements are likely to be small. At most times most books will not, in practice, be fully hedged. Instead, a degree of volatility is acceptable when balanced against the transaction costs involved in improving the hedge. Traders may also use their judgement to select deliberate open positions, within the agreed limits, which would benefit if the trader's private market views were borne out. However, unlike the management or trustees of our saucepan manufacturer, the trader has high quality information as to the bets in place at any point in time. This does not, of course, guarantee that the bets are successful, merely that the bets actually in place were those intended.

5.2.4 The greeks implicitly measure risks relative to a short-term cash position. Nobody suggests that a derivatives desk should permanently have a net long position in, say, U.K. equities. Banks do not, typically, apply such exposure as an overlay at the corporate level, either. They would regard it as presumptuous to assume that shareholders should wish the bank to diversify on their behalf — in the same way as saucepan manufacturers are bought for exposure to the

manufacture of cooking utensils, banking shares are purchased in order to gain exposure to the banking sector, not to all markets at once.

5.2.5 Banks do, of course, borrow short and lend long in their *banking book*, but that is all part and parcel of the job done by the banking sector. Also, it may be noted that this banking (rather than *trading*) book may not, in practice, be marked to market itself. We would argue that such a discipline would, in fact, be valuable here as well, although most of the loan book is unquoted and highly individual. So, although desirable, this would be a somewhat more complex exercise than the application of the generic pricing models that can easily be draw upon for pension funds.

5.3 *Defining a Good Hedge*

5.3.1 Even if a position appears to be closely hedged, slippage in the profit and loss account is still likely, in either direction. This slippage arises because the pricing models are inevitably simplifications of the real world. Assumed correlations can break down, and assumed constants can move. Some exotic financial structures are one-offs, and contain exposures which are not traded in a liquid market — for example, products depending on the correlation between different markets are often impossible to hedge with liquid instruments. When such untraded exposures are revalued, the change falls straight through the accounts on that day. However, we would not accept that imperfection of hedging in practice makes modelling futile — merely that we must be aware of its limitations. In particular, we would note that apparently short-term hedging techniques have a good record of risk management, even for longer-dated structures — see, for example, the empirical work in Kemp (1996).

5.3.2 If even the best hedges produce some slippage, the question arises as to whether the best hedge is well defined — how can we test whether a hedge is optimal or not? In order to decide this, we list a number of key features of profit and loss account slippage of a best-hedge position. Changes in a hedged profit and loss account should be:

— uncorrelated with future price movements; otherwise, this would suggest that market movements in the future are reacting to information which has already been in the public domain for some time, which is implausible;
— uncorrelated with simultaneous price movements; if, for example, account movements were found to be positively correlated with bond yields, the hedge could have been improved by the inclusion of more bonds; the former hedge was therefore not a best hedge; and
— uncorrelated with past price movements; otherwise, we might, for example, be able to forecast that future account movements would be negative, given some historic data. If this were the case, then, arguably, the current balance sheet is overstated and the losses should be provided for.

5.3.3 Not only do these characteristics enable us to check whether a hedge is optimal, but they also indicate the direction in which a suboptimal hedge may be

improved. By trial and error, we can rearrange the hedge until the above three correlations are zero, which produces the best combination of price and hedge.

5.3.4 This process reveals the intimate relationship between hedging and pricing. The unique pricing basis which passes all these tests is the market related basis. We would argue that the main benefit of the hedging argument is that it enables us to put the market pricing concept on a firm footing. Hedging is a theoretical construction towards this end — but may or may not be a desirable investment policy.

5.4 *A Problem with Time Horizons*

5.4.1 So we have our blueprint; why is current actuarial practice so far away from it? Can we apply the same criteria to judge the quality of the apparent matching portfolios falling out of funding valuations?

5.4.2 If the same principles were to be applied to pension investment, the benchmark given to the fund manager would reflect a minimum risk portfolio which most closely hedged the liabilities. It would then be perfectly meaningful (although perhaps rather labour intensive) to monitor the fund manager's daily profit and loss relative to the benchmark.

5.4.3 However, the most common objection is that pension liabilities are long term, whereas banks' concerns are immediate and short term. Accordingly, pension fund investment benchmarks are rarely set in practice, even with an intention of attaining such an optimally hedged position.

5.4.4 Instead, the trustees will, in consultation with the company management, set a benchmark which deliberately incorporates some mismatch risk, usually in the direction of a greater concentration of equities on the asset side. This introduces a number of complexities, including:

— if a fund manager adopts a lower equity mix than the benchmark, he is increasing the risk of under-performance relative to the benchmark, despite the fact that the liabilities are in fact being matched more closely; and
— the superiority of equities is only supposed to emerge over the long term, so that, for example, whilst quarterly monitoring of investment manager performance is regarded as important, quarterly monitoring of the mismatch risks inherent in the benchmark is regarded as too frequent to be meaningful, although such apparent recklessness would be an anathema to most other areas of financial management.

5.4.5 There appears to be a widely held view that the long-term actuarial risks are, in some fundamental sense, different from the other financial risks borne by a company or its shareholders. As a profession, we have played heavily on the notion that there is something magical about large values of t which is beyond the comprehension of ordinary mortals. For example, in his Presidential Address, D.G.R. Ferguson seems proud to promote "the long-term view that only actuaries can provide". This lends some mystique to actuarial work, and discourages integration of pension risk within the general risk management

function of company treasury departments. To quote Ferguson again (Smaller *et al.*, 1996, abstract of discussion): "we should preserve a certain amount of mystique and avoid absolute clarity".

5.4.6 The mental separation of actuarial risks from other risks is reinforced by the use of actuarial assessed values and long-term assumptions — we have effectively invented our own actuarial currency, which is not freely convertible with other currencies more familiar to corporate risk managers. However, as investment banks and other financial engineers turn their attention to the longer dated market risks, the prospect of a more transparent and liquid market in actuarial currency is now looming on the horizon. The profession needs to prepare itself for the possibility that the *de facto* market rate bears no resemblance to our official rate, and any resulting dislocation in our advice to clients. More seriously, if employees have a choice between defined contribution and defined benefit arrangements, then we already have the possibility of such a market rate spoiling the best laid plans of companies acting on the basis of long-term actuarial values. In particular, as we discuss further in Section 9, the thorny issue of selection needs a firm grasp by management.

5.4.7 At the heart of this approach is, we believe, a faith in the principle of *time diversification* of risk. This masquerades under the same banner as portfolio diversification, where you hope to reduce your exposure to risks by holding a large number of them. The difference, which is being glossed over, is that we are hoping that exposure to a lot of time periods is as good as holding a larger portfolio of risks. Using an insurance analogy, we hope that exposure to one ship for a hundred years is as good as exposure to one hundred ships for one year.

5.4.8 However, it may not be quite as straightforward as that. For example, if we numbered our ships from 1 to 100 in the second example and five ships sank, we could renumber our policies so that the sinkers are allocated numbers 1 to 5 and the floaters get numbers 6 to 100. This paper exercise has no economic impact and economists will endorse the mathematics suggesting that risk reduces as the number of ships increases. Indeed, it might be argued, rather cheekily, that Markowitz, Miller and Sharpe earned a Nobel prize by applying this actuarial principle to financial markets. It is, though, more debatable whether this same paper renumbering exercise has no economic impact when we expose ourselves to the risk of one ship per year for one hundred years. This would require the insurer not to mind whether all his losses were incurred in the first five years or were scattered evenly over the next hundred years.

5.4.9 We therefore feel the need to investigate this issue quite closely, if only because some rather subtle complexities and a few paradoxes immediately arouse our suspicions over the rigour of this similarity. If nothing else, the financial theories developed in the previous sections have taught us that inconsistencies are often a very good sign that something, somewhere, has gone amiss.

5.5 *Time Diversification of Risk*

5.5.1 A key feature of the hedging process in our blueprint is that it does not

only work at some terminal time horizon — it has to work all the way along at daily intervals. Monitoring of daily profit and loss accounts is an essential part of the control of a derivatives operation, because the account movements provide important indications if a pricing basis has gone wrong or if a trader is misbehaving.

5.5.2 Actuaries, by contrast, seem to regard such discipline as an unwelcome short-termist intrusion into the long-term management of funds. For example, according to Field (Mehta *et al.*, 1996, abstract of discussion) "up to the minute information is actually misleading, because it has too much of the current minute in it". The root of this defensiveness is that much long-term actuarial folklore, for example the universal superiority of equities to meet long dated liabilities, manifestly does not work all the way along, as a proper hedge ought. Instead, the hope seems to be that, in the long run, the equity risk premium will lift the position clear of any short-term troubles. In the meantime, we use long-term valuation as an actuarial method which conceals the deficit and prevents our clients from getting nervous.

5.5.3 Barings, a London investment bank, recently got into difficulties following large losses run up by a derivatives trader, a Mr Leeson, taking long positions in Nikkei futures. If the equity position had been held open for longer, then the long run upward drift of equities would have cleared the paper loss. A long-term actuarial argument could easily have been constructed to revalue the position off-market, and thus smooth out any troublesome short-term volatility. This would have been consistent with the traditional actuarial arguments against unwelcome intrusion of short termism, as described above.

5.5.4 Although the bank was criticised for its slowness in acting against Leeson (according to the Bank of England, 1995: "the systems and controls put in place must include mechanisms for ensuring that weaknesses are rectified promptly"), the delay was a mere blinking of an eye by comparison with actuarial time scales. It is our view that fast action in such cases is highly desirable — and only a market-based accounting system can make this possible.

5.5.5 It could be argued that the long-term superiority of equities will not, and cannot, be captured using only the short-term risk measures that we have advocated. Perhaps we have missed the whole point of long-term investment? This assertion, although fallacious, deserves some more detailed investigation, because it is so widely held within the actuarial profession.

5.5.6 It is, therefore, worthwhile to describe first some established actuarial portfolio selection theories which associate equities with long-term pension fund investment strategies, and thus, via the funding approach, link equities with model portfolios for the valuation of assets and liabilities. According to Clark (1992): "although the theoretical development of matching and immunisation is sound, the results are ... of little practical help in investigating the interaction of the assets and liabilities of a U.K. pension fund". Both Clark and Lockyer (1990) suggest strategies which, instead, minimise the 75th percentile outcome for the contribution rate at some chosen horizon. This prompts Lockyer to observe that:

"over the medium term, the preferred asset is index linked, even though it provides a lower expected return than equities or fixed interest. During this time the correlation between the growth of the liabilities and the return from this asset class is the key factor. Over the longer term *the higher return from equities* means that this asset class dominates" (our emphasis in italics).

5.5.7 Thus, using what we assume to be one of the "(actuarial) techniques for identifying assets which best match the liabilities" with "extensive use of stochastic modelling" cited by IFAA (1997), Lockyer effectively argues that the likely outperformance of equities in the long run *strengthens* the argument for their inclusion as the higher return from equities supposedly becomes more important than any 'medium term' correlation between index-linked gilts and the liabilities. However, the ability to trade off certain risks against the prospects of much higher returns from equities must be a portfolio selection issue, and should not, we maintain, be confused with hedging. By contrast, the investigation into the Barings affair (Bank of England, 1995) concluded that the extraordinary profits reported by the Singapore office were just as conclusive as evidence of hedge failure as major losses would have been ("the size of profits being generated should have alerted Barings' senior management to the greater risks involved").

5.5.8 The nub of the long-term argument is this principle of time diversification of risk. It suggests that, as returns grow like t and risk grows like $\sqrt{t}$, then, in the long run, the expected return is all that counts. For example, when funding for a fixed cash flow in the distant future, an equity portfolio, using the methodologies of Lockyer and Clark, for example, can be constructed which is 'highly likely in the long term' to provide more than enough to honour the bond, while the initial outlay required to purchase the equities is less than the market price of the bond. This near-arbitrage occurs, supposedly, because the market is dominated by short-term investors who are blind to the long-term benefits of equities. But how good is 'highly likely'?

5.5.9 We should, by now, be highly suspicious indeed of such intuitive reasoning. Our simple example of forward contract pricing in Section 4.2 showed how use of the 'best estimate' outcome might be intuitively appealing, but wrong. We were 2% adrift over one year in that example. We are now looking, not at best estimate outcomes, but at outlying percentiles. However, we are still hooking up this formal mathematical argument onto the same 2% drift which led us badly astray over one year, and hoping that it pulls us clear of trouble in the 'long term'. Put another way, we are relying on the fact that outcomes bunch around the expectation in the long term, but the expectation itself proved to be a bad steer in our simple example.

5.5.10 We can, of course, see practical evidence that this 'highly likely in the long term' argument breaks down in the real world. It manifestly fails to explain why anyone would be prepared to purchase long dated bonds at their market price, if they can be synthesised for so much less. The key must lie in the unlikely event where the equities fail to be adequate. Although the probability of

this event may be small, it bears heavily on the minds of investors as a whole. We can see why — a promise which holds fast when everything else has collapsed all around is potentially very valuable. If investors were prepared to accept the 'highly likely' outcome delivered by equities instead of the level of certainty provided by Government bonds, say, then bond prices would fall, and long-term interest rates rise until the level of certainty offered by gilts looked attractive against the return offered. The price which investors are prepared to pay for different levels of certainty over different time periods is already reflected in bond prices, without the actuary adding his own ha'penny worth of professional opinion on the matter. When actuaries fiddle with the message from these bond yields and disregard the unlikely (but possible) event of an equity collapse, they are effectively saying that their particular client does not place such a great weight on the relatively unlikely meltdown scenarios.

5.5.11 The trouble is that we do not really know how much weight to place on these outliers. Worse still for our formal t and $\sqrt{t}$ trick, we have another nagging little mathematical problem. As noted by Exley & Mehta (1996), although the outcomes do indeed bunch around the expectation for longer time horizons, there is always one outlier such that the probability of this outcome or worse is highest for the longest time horizon we consider. For example, suppose we model real equity total returns using a Gaussian geometric random walk with geometric mean return of 6% p.a., with a 5-year horizon. Then the probability of being below 70% of the starting value, or worse, increases as time moves towards the 5-year horizon.

5.5.12 Clarkson (1996), illustrates well the confusion over exactly how much weight we should place on such rare, but catastrophic events with two apparently contradictory statements: Firstly: "avalanches in ski-ing, major natural disasters, and exceptional capital market movements are all examples of very unlikely events. To suggest that they should be given zero probability is so utterly ridiculous from a common sense perspective that I shall use this axiom as the cornerstone of my 'unintelligent' or type-B behaviour". This is followed by the observation, in comparing two different statistical distributions, that: "the two distributions intersect at such a strongly negative value of return, and at such an infinitesimally small value of probability density function, that for all practical purposes it is indeed reasonable to say that one distribution lies to the right of the other".

5.5.13 Taking the shareholder perspective, there might be some rationale for ignoring the meltdown scenarios, but not because shareholders place a small weight on such highly unlikely events. In fact, quite the reverse. The shareholder might take the view that, in this scenario, the company will have gone bankrupt anyway, and he can just default on his debt. If the pricing of corporate bond spreads is anything to go by, investors seem to put quite a high weight on the option to default in such circumstances.

5.5.14 From the members' viewpoint presenting the time diversification effect as a long-term *benefit* gained from equity investment would then seem very odd

indeed. It relies on ignoring long-term meltdown scenarios, on which other representative investors in the market seem to place significant weight, if long-term bonds are anything to go by. This is all the more surprising, given that the ostensible purpose of a pension fund is to provide security to members in the event when everything else goes wrong. It would seem to be little comfort to a pensioner without his promised benefits for him to be told that, in the 95%, or 99% of cases when his employer would have been solvent, the fund would have been in comfortable surplus!

5.5.15 Taking the members' viewpoint, there could, we suppose, be a completely different rationale for ignoring meltdown scenarios. If the company is highly creditworthy, then, perhaps, members might be prepared to rely on the backing it provides in such circumstances. If members also had some element of participation in surplus, then they might be quite happy to take a ride on the risk premium on equities, since a significant element of this premium might be attributable to the potential losses of equity value in meltdown scenarios, from which they believe they are insured (see Exley, Mehta & Smith, 1996). However, this argument cuts the other way from the shareholder's perspective, he is effectively underwriting a deep option from which members are deriving benefit. Following this explanation, it would then be rather curious if the shareholder saw the effect as a desirable feature of equity investment!

5.5.16 Accordingly, we simply cannot accept that the shareholder and the member can both simultaneously gain *overall* from these two explanations of the effect, because the gain to one is always a loss to the other. For both to gain would require the member and shareholder groups to place different values on the gains and losses in each circumstance, so that shareholders were beguiled by the first explanation and prepared to ignore the second, whilst members ignored the first in favour of the charms of the second. Given the overlap we have highlighted between these two groups, this interpretation of the universal desirability of equities owing to time diversification benefits seems to be a non-runner.

5.6 *The Prominent Role of Gilt Yields*

5.6.1 The second main objection to market-based approaches is the prominent role of gilt yields, both conventional and index-linked, in the valuation process. In particular, the manner in which conventional gilt yields may appear to loom large in the calculation of price or salary inflation linked liabilities can be queried, as can the effect of the various risk premia in these assets.

5.6.2 We have already answered elsewhere the argument that gilts are inappropriate because U.K. pension funds invest in equities rather than gilts. Although, in the case of a funding valuation, assets and liabilities may be intimately linked, there is (apart from a few subtleties such as credit risk) no link at all between the valuation of the liabilities and the assets held under our market discipline. We are concerned only with the assets which allow us to hedge the liabilities and unravelling a price from this. If it turns out that equities do match some feature of the liabilities (which we return to in the next section) then

equities would appear in the pricing of the liabilities *regardless of whether the fund is invested in equities.* Equally, if index-linked gilts match pensions in payment, then these form the pricing basis regardless of whether the fund invests in gilts, or whether the supply of such gilts is sufficient for all funds to invest in them (seen from this perspective, the directly traded market in index-linked bonds is really just the tip of an iceberg).

5.6.3 In fact, the reason for the appearance of conventional gilts in the market valuation framework, is, in many instances, much more subtle than simply arguing whether conventional gilts or equities provide a better hedge for the liabilities. Under many actuarial portfolio selection models, portfolios of conventional gilts would not even lie on the efficient frontier, whereas equities would no doubt appear somewhere on the frontier, if only because of their risk premium, whether or not they are a better match than index-linked gilts for salary (rather than price) inflation related liabilities.

5.6.4 However, let us set aside, for the time being, the arguments for including equities in the hedge for such salary related liabilities. Suppose, instead, that we just assume we can make some fixed assumption for real salary growth. Market valuation should then consist of identifying and valuing the appropriate portfolio of index-linked gilts to match the salary and retail-price-index-linked liabilities. This involves, broadly, projecting our salaries using our assumption for real wage growth and then discounting at real yields on index-linked gilts. For *presentational* purposes, this is often represented as a projection of nominal wage growth and discounting at a total return. The key, usually unstated, ingredient in this calculation is that *future inflation should be estimated by reference to the spread between conventional and index-linked gilt yields.*

5.6.5 The conventional long dated gilts used in this calculation are often supposed to have a yield premium of around 1.5% in excess of cash. Current gilt yields are an upwardly biased estimate of future average cash returns. By the same token, the implied rate of inflation from gilt yields is not an unbiased estimator of future inflation, but, rather, is contaminated by various term premia which exist both in the conventional and index-linked gilt markets. The beauty of using yield-based inflation estimates for valuing index-linked cash flows is that, when discounted at gilt yields, they reproduce index-linked gilt prices. All the various term premia cancel out, as indeed they must, for index-linked gilt prices were one of the calibrating ingredients. If conventional gilt yields were to rise by, say, 2%, but real yields remained constant, it would not make one iota of difference to the valuation of inflation-linked pensions, because the higher implied future inflation is cancelled out by the higher discount rate. The focus of conventional gilt yields for discounting is, then, a red herring. The key economic assumption is the congruence between wages and index-linked gilts. In the U.K., where we have an index-linked market, this translates into a gilt-based discount rate, combined with using an inflation estimate equal to the difference between conventional and index-linked gilt yields.

5.6.6 A more formal development of the marvellous way in which interest

rates and inflation and their associated risk premiums all mesh together is provided in Section 7, when we consider more complicated liability features such as limited price indexation (LPI).

5.6.7 What then of countries where there are no index-linked gilts? One must then approach inflation estimation from a more fundamental perspective, such as economic or time series analysis. However, the theory of such estimation, would normally regard *unbiasedness* as the key property of valid inference. In particular, inflation estimates based on economic fundamentals arrive 'clean', without the various term premium biases that beset yield-based estimates.

5.6.8 This means that, when discounting, the marvellous cancellation of term premia which occurs for yield-based estimators will not occur for unbiased estimators. This is a neat turn around, given that the existence of unknown risk premiums in 'market implied inflation' is sometimes cited as a reason for *not* using this measure for valuation purposes! If unbiased inflation estimates are to be discounted at gilt yields, then the appropriate term premium adjustment needs to be carefully considered.

5.6.9 It is, perhaps, a little ironic that bond-based discounting, as an accounting device, is widely accepted in many countries without an index-linked market, where it is least defensible. However, this is all relative — the effect of the term premia would be relatively modest compared with the equity risk premium, for example, especially in economies with stable inflation rates. Gilt related discount rates still emerge as preferable to equity related rates.

5.7 *The Importance of Accounting Numbers*

5.7.1 A third objection to our blueprint is the importance which supporters of funding valuations assume to be attached by shareholders and management to disclosed actuarial valuation numbers in decision making. Fears are expressed that a move away from stable long-term 'funding' valuations of defined benefit liabilities and the associated assets being invested 'long term' to meet them, especially for expensing numbers, will lead to short termism by investors and a reluctance for shareholders to support companies with long-term defined benefit commitments. For example, Gerry Acher, head of audit at a big six accountancy firm, was recently quoted in *Accountancy Age* (January 1997) as claiming that "the proposals (IASC, 1996) would hasten the demise [of final salary schemes] and cause existing ones to move their investment policy away from equities". We believe that sponsors would be ill-advised to make such fundamental changes to their business simply on the back of an accounting convention.

5.7.2 Such criticisms appear to give 'accounting' numbers a status which they do not really deserve at all. There is considerable academic evidence from the U.S.A. that manipulating accounting numbers which can be altered at the stroke of a pen, without altering the underlying value of the business, such as reported earnings per share, does not enhance market prices. Rather, sophisticated investment markets look through to the underlying economic reality, exactly as we have proposed.

5.7.3 This is discussed in detail by Stewart (1990). For example, he presents research which demonstrates that companies switching from FIFO accounting to LIFO accounting see a reduction in reported earnings per share (as one would expect), but, on average, share prices rise by an amount in direct proportion to the present value of taxes saved by making the switch (Sunder, 1975). As another example, Hong, Kaplan & Mandelker (1978) analysed share price performance following acquisitions using either purchase price accounting (which requires subsequent reported earnings to be adjusted for amortisation of goodwill) and pooled accounting (which requires no adjustment to future earnings). Their results suggested that the method of reporting earnings has no impact on share price performance.

5.7.4 We would therefore suggest that, contrary to the view that market-based approaches to costing and expensing run across the grain of investor behaviour, focus on the importance of funding valuations in such applications appears inconsistent with much empirical research. Furthermore, there may be some positive economic gain from market-based approaches if management is encouraged to recognise that, for example, our 'three ways' of gaining equity exposure are equivalent. Attention can then be devoted to arranging the capital structure of the firm to maximise shareholder value (by better harnessing management skills, for example, or exploiting taxation benefits), rather than to exploit perceived accounting benefits.

5.7.5 In this context, we are puzzled at the reaction in some quarters to the recent accountancy exposure draft IASC(1996). At a superficial level, it should not really matter how accounting numbers are presented (provided that they are accurate). Indeed, if the way in which a benefit is accounted does not fundamentally affect its economic cost, then accounting numbers could even fall conveniently into the category of actuarial calculations which do not really matter at all and for which funding valuations may be well suited. However, our earlier analysis, in Section 3, rationalised funding valuations as a way of *budgeting* future cash flow requirements for the scheme. In a normal trading situation, budget forecasts would not be pulled through the revenue account; instead accountants insist on stating what actually happened. However, in the opaque world of pension accounting, the temptation to insert budget forecasts instead seems almost irresistible, because they are so smooth. For example, the amortisation of pension profits and losses in SSAP 24 results in a weighted average of actual and budget being reported, with the weight heavily in favour of the budget forecast.

5.7.6 It is, of course, a common and quite justifiable business practice for divisions of an organisation to manage their affairs to a target budget or business projection. It is wasteful of resources and confusing for managers to keep moving goal posts, so business plans tend to be left untouched for periods of a year or more. Budgets are only revised if some major event changes the entire economic landscape to such a degree that managing to the previous budget would be totally unrealistic. By the same token, we can accept the arguments for stability of

pension funding bases. The desire to revise budgets only after a large move is encapsulated in the FASB corridor concept. However, it is undeniable that the actual business does diverge from the budget on a daily basis. If we want to measure the actual business movements, rather than simply rediscovering our own budget forecast, we must accept the volatility this entails. It is our contention that, in common with other business areas, measuring actual versus budget is rather more useful than measuring budget against last year's budget.

5.7.7 We would therefore take issue with the use of funding values to report pension costs to shareholders. What is most important for accounting is not smoothness, surely, but disclosure of relevant information to investors and potential investors. If this is the case, then the basis with the highest information content is the most valuable to readers of accounts. Furthermore, it is difficult to see what conceivable decision any investor could make on the basis of an actuary's own funding value without converting it to a market comparison. Given that the actuary probably has access to the best information to facilitate this conversion, it would seem preferable for him to disclose on this basis in the first place. It is, therefore, our contention that market-based numbers meet the requirements of investors better than funding values and are a more efficient means of disclosure, especially if funding valuations are allowed to be clouded by undisclosed actuarial opinions which cannot easily be unwound out of the numbers provided.

5.8 *Price Volatility*

5.8.1 A final criticism is that the mark-to-market convention leads to volatile prices. For example, a liability 'costed' as £100 million at some time might change to £120 million or £80 million shortly afterwards. The implication is that 'funding' values acquire more professional credibility simply because they are more stable numbers (see, for example, Parsons in the discussion of Dyson & Exley, 1995).

5.8.2 This appears to us to be a favourite theme of actuarial examinations. Examiners regularly expect students to make the point that falling market values are only a problem if one has to realise assets. A mark-to-market analysis would suggest that, if assets fall in value, you always have a problem, unless the liabilities fall as well. However, if the liabilities do fall, then realising assets at their market value is not a problem. However, the issue is the fall, not whether assets are realised or not.

5.8.3 By way of example, suppose that a risky asset initially stands at 100, but over one time tick it falls to 50. A wise investor who initially delayed purchase of the asset will still have 100 in his pocket, with which he can now buy the same asset and still have 50 in change. To argue that someone who bought at 100 is no worse off, we need to assign zero 'value' to this remaining 50 in cash. However, rather paradoxically, our wise investor can now use this money, if he wishes, to go out and buy *another* holding in the same asset, which is supposed to be still 'worth' 100. So our poor actuarial student must decide

whether the 50 in cash is worth nothing at all, or 100. The obvious answer that it is worth 50 is not, apparently, open to him!

5.8.4 This paradox, and much supposed wisdom on short-term volatility, highlights another actuarial problem with time; in this case *continuous* time. The argument that someone buying at 100 is no worse off as a result of the fall to 50 can only wash if we insist that portfolios cannot be rearranged on a tick by tick basis. Rather, once investors have made their initial choices we must insist that they all stick with them to some ultimate horizon, when they are then allowed to realise their assets. We will return to the issue of removing this unconvincing constraint in the next section.

5.8.5 We will also leave aside, for the moment, the issue of whether the reflection of such tick-by-tick price volatility is desirable in setting the pace of funding of a scheme. There may be strong arguments for stability and predictability here, and we will discuss this issue in Section 8. Instead we will consider now only the use of funding numbers to calculate 'costs' to shareholders when compared with market related methods.

5.8.6 There appears to be no direct evidence that clients place more credibility on numbers which remain consistent and stable over time. For example, even rather unsophisticated individual annuitants accept that the cost of £1 p.a. of pension, like the cost of a block of aluminium, can vary significantly over short time periods. Of course it can be argued that the price of aluminium should be more stable, reflecting the true worth of the effort expended in extracting and smelting it, rather than the vagaries of supply and demand. The trouble is that the price of aluminium, whether or not it offends our personal appreciation of the value of the work done in producing it, can be enforced by arbitrage. Attempts to impose an alternative 'fair' value, whatever its social or intellectual justification, cannot be enforced without rigging the rest of the economy. Attempts to impose such fair prices have generally been rather unsuccessful and arguably lead to inefficient allocation of resources. This is the basic thrust of some of the arguments presented in Section 2. If companies are to run pension schemes, they need to know that this is an efficient use of management and other resources. It is our contention that market-based valuations provide the most reliable guide for such corporate decisions.

5.8.7 To take another example, suppose that our saucepan manufacturer holds equities against its pension liabilities and actuarial values and prices initially coincide at £100 million. Suppose, also, that during a particular year the price of the matching portfolio, for the sake of illustration, a portfolio of gilts, rises to £120 million and the equity portfolio at market prices falls to £80 million, but for his expensing and ongoing funding basis the actuary continues to assign stable funding values of £100 million to both.

5.8.8 The £40 million shortfall is the true representation of the underlying economic position from the shareholder's perspective. Whatever the actuary's personal beliefs of 'value', it is rather difficult to explain how a shareholder could conceivably believe that £80 million of equities might at a given point in time

have a 'price' of £80 million when he holds them directly, but, because an actuary solemnly tells him so, have a long-term 'value' of £100 million, when he holds identical assets indirectly within the pension fund. Sadly, whatever the actuary might wish, only an extremely altruistic purchaser would give shareholders £40 million credit for the difference between the 'long-term' funding position and the underlying market equivalent.

5.9 *The MFR Hedge*

5.9.1 We have now defined what we mean by a good hedge and considered some of the criticisms of applying the approach to the valuation of defined benefit pension schemes. In the light of these ideas, it may be worthwhile just to pause here and have a closer look at some of the characteristics of a funding basis with a high public profile, namely the basis prescribed for the MFR. After all, there may otherwise be a tendency to run with the idea that our blueprint is a nice idea, but existing methods work well enough.

5.9.2 The main elements of the MFR basis, in particular the equity element, were eventually prescribed by Government. It is however an 'actuarial basis' to the extent that the Government gave the profession responsibility for prescribing the detailed application (GN27). It is not exactly clear how the Government arrived at the ideas which it imposed on this basis. However, the idea seems to be supported by IFAA(1997) (at least for use as an accounting measure of value), which states that "equity investments are typically regarded by investors as essentially the only investments of sufficiently long-term and acceptable marketability which are available...In countries where the term of the liabilities is longer than that of the assets which are readily available, or when the nature of the liabilities is such that assets are not available with which to immunise the risks, the use of historical long-term real rates of return, which reflect investment in long-term real investments, such as equities, should be required". This focus on the 'long term' appears to skate over the key feature of a hedge which, we argue, is that it works *all the way along*, not just at some ultimate time horizon. We have, however, conceded that it might be unreasonable to expect a perfect hedge. We will, therefore, consider how the MFR basis stacks up against our test of a good hedge and, crucially, assess the significance of any failings.

5.9.3 The idea behind GN27 is that the liability is valued on a stable basis, but is then multiplied by the ratio of an assumed long-term yield to the current yield on the FTA All-Share Index. In this way, if the market collapses, and the yield rises, the liabilities are written down, but revert back to the long-term discounted cash flow basis as the yield returns to its long-term value. If on the other hand, dividends fall, and the market falls correspondingly, this may represent a more permanent loss, and so it would seem appropriate to take the hit immediately, as the method does, rather than attempt to amortise the deficit.

5.9.4 The MFR is sufficiently prescriptive that we can back test it to see how it would have worked. However, we must immediately inject a note of caution. The MFR basis was prescribed using knowledge of the U.K. history for

most of this century. If we back-test the parameters on the same history, we are unlikely to obtain much insight into whether the process will work well in the future, where, with the benefit of perfect foresight, completely different parameters might be selected. It would be more instructive to examine what the result would have been if we had used only the information available before the valuation date to estimate our valuation parameters.

5.9.5 The logical process ostensibly employed to derive the MFR parameters is discussed in Wilson (1995). However, the long-term inflation assumption of 4%, the long-term bond yield of 8% and the long-term dividend yield of 4.25% are all remarkably close to the actual market conditions at the time the formula was proposed. A cynic might suggest that, far from being based on a long-term view, these assumptions might have been influenced by the short-term (that is, actual) conditions at a point in time. Of course, this is quite reasonable if that point in time is also your valuation date, but, arguably, less so if it is not. Indeed, the dividend yield is currently so low that we are in danger, already, of encountering the nonsensical situation described in Section 3.6.

5.9.6 When reconstructing historic MFR valuations, we have therefore attempted to recreate the basis which might have been used since 1930. In the absence of index-linked gilts, it is rather hard to guess at exactly what contemporary inflation expectations were. However, the gap between inflation and the return on short gilts has been reasonably stable over time, so, for a first guess, we were prepared to accept a constant gap between the discount rate and the inflation assumption. We were less able to accept that a long-term estimate of equity yields would always have been 4.25% (and, indeed, an examination of actual bases used within one of our firms confirmed this suspicion). Instead, actuaries have tended to use a weighted average of recent past history, although not always rationalised as such. In our investigation, we therefore adopted the following recursive formula:

$$\text{long-term yield } (t) = 25\% \times \text{actual yield } (t) + 75\% \times \text{long-term yield } (t-1).$$

Anyone believing that the equity yield of 4.25% is a universal constant may wish to revise from the actuarial textbook by Lee (1986), which states quite clearly to students that "immediate yields have *always* tended to return to a mean level of around 5 per cent" (our emphasis in italics). A less dogmatic position was adopted by Thornton & Wilson (1992) who advise that "it is possible to suggest that for the future average yields might lie anywhere in the region of 4.25% to 5%, and our preference is to assume 4.75%"

5.9.7 The above formula, as well as corresponding broadly to historic practice, does conveniently produce answers around 4.25% for the last few years. It also hits 5.0% neatly at the end of 1985, just as Lee (1986) was going to print. We need to address one further problem before we continue. The MFR basis was designed to measure the value of accrued benefits on a cash equivalent or deferred pension basis. It does not attempt to forecast future salary

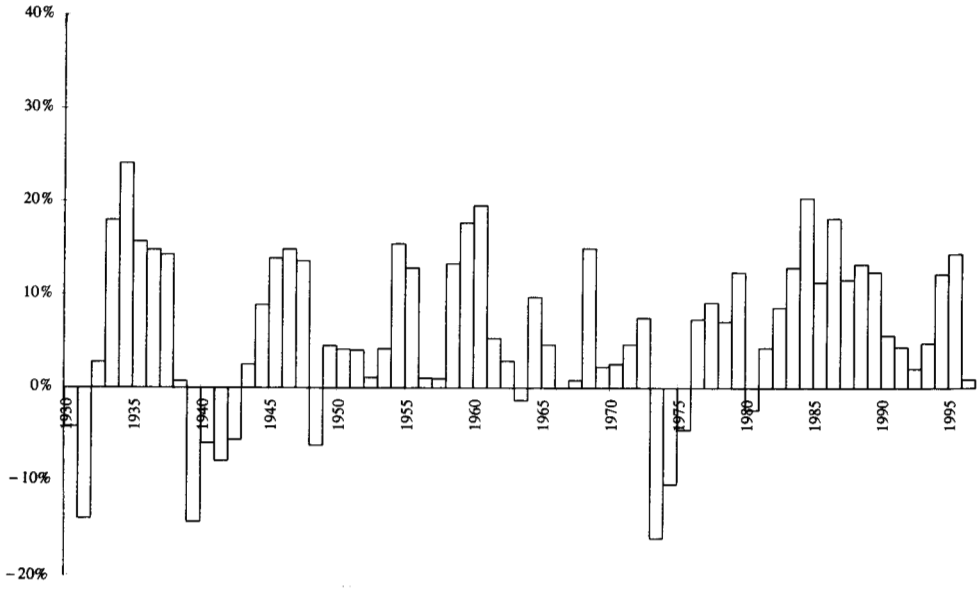

Figure 5.9.1. Surplus emerging in each year, on MFR basis, expressed as a proportion of the liability value on the valuation date

inflation, but instead assumes revaluation according to the statutory minimum based on RPI. If we follow the valuation through time, we must expect some losses to the extent to which actual wage increases exceed retail price inflation. We have therefore amended the MFR valuation for ongoing purposes allowing for an additional 2% growth of real salaries. We have assumed 100% equity investment, consistent with the liability adjustment.

5.9.8 Figure 5.9.1 shows the surplus emerging in each year, assumed distributed immediately, expressed as a proportion of the liability value on the valuation date. It could be noted that this chart is rather less volatile than would have been achieved if we had not applied the dividend yield adjustment. Perhaps this provides some demonstration that this valuation basis is meaningful and the equity hedge works? But before we jump to such a conclusion, let us apply some of the hedge criteria presented in Section 5.3. In particular, we are interested in whether we can predict the surplus in advance — if so, of course, we should allow for the predictable component in our valuation basis. One obvious predictor to try is the write-up (or down) applied to the liabilities at the start of the year. This is plotted in Figure 5.9.2.

5.9.9 This is beginning to look suspicious. It does seem that surplus tends to emerge after the liability has been written up, while losses appear when liabilities have been written down. The correlation is 57%, which is significantly different

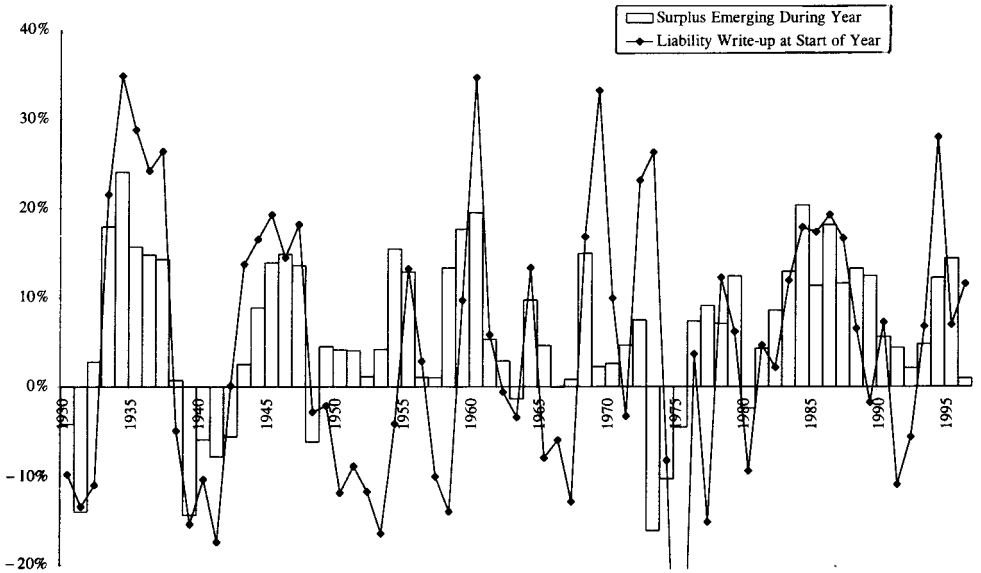

Figure 5.9.2. Surplus emerging in each year, on MFR basis, and liability write-up at start of year

from zero. Of course, this is what we might expect — if we insist on writing down the liabilities using an over-optimistic basis, we can expect to feel the pain as that basis unwinds. It is perhaps alarming that it unwinds so quickly, blowing a hole in the long-term nature of the equity related valuation. If we provide in advance for the predictable component of future deficits, this undoes our carefully derived yield adjustment and puts the liabilities back onto a discounted cash flow basis.

5.9.10 Another way of looking at this is as follows. Dividend-based valuation methods tend to lead to surplus emerging when dividends grow, and deficits when dividends fail to live up to the assumptions. However, it seems odd to suppose that actuaries are better at forecasting dividends than the rest of the market. Indeed, the above evidence shows that the market, using a forward looking consensus and past data, has been a better guide than the actuary's statistical average of historic experience alone. If, therefore, one wanted to immunise against falling future dividends, a sensible way to do it would be to sell equities. This would result in a more bond-based investment strategy than is currently popular within U.K. pension funds. Surplus would then be more stable, anyway, without the need for an *ad hoc* dividend yield adjustment.

5.9.11 Of course, this is not looking a long way forward, our analysis has simply looked a long way back. Given the amount of effort put into the MFR, it might be hoped that the market would oblige by respecting our cherished long-

term basis for a bit longer. Unfortunately, the dividend yield assumption is already looking a bit shaky. However, there is no reason to suppose that actuaries will rework the basis on such short-term signals (or that the Government, in prescribing the equity link, expected the profession to do so). Instead, they are likely to wait until a substantial body of evidence amasses over some period of time. We predict that this will give rise to what we call the Canute effect.

5.9.12 There is a danger in giving the MFR constants the status of unassailable physical facts, on a par with the speed of light or the charge on an electron, simply because they have been hard-coded into legislation. Wilson (1995) warns that "this assumption [the expected equity yield] will need to be closely monitored and the whole process kept under review". Under this process, new information may not be factored in immediately, but instead could be allowed to build up while the profession maintains a long-term view. When the tide comes in up to the neck, then those prescribing the basis are finally forced to admit that some form of adjustment is required, and everybody's pension basis is realigned with a catastrophic jump in the basis. The message of the Canute effect is that the unwinding of the perverse dividend adjustment cannot be deferred for ever, but it can be deferred for a few years, during which the surplus emerging on an actuarial valuation basis may appear quite stable. All the volatility is then saved up until the basis is suddenly realigned with reality. It is not clear to us what beneficial outcome is achieved by such step changes either in the MFR or in accounting bases as proposed by IFAA (1997) — it adds considerable complexity to asset-liability modelling and could upset cash flow planning at the business level. If the MFR basis is also used in the calculation of cash equivalents, any tardiness in updating assumptions creates valuable options in favour of members leaving the scheme. Such a situation is reminiscent of the difficulties experienced by some unit-linked insurers when allowing policyholders to trade on historic prices.

5.10 *Conclusions*

5.10.1 Traditionally, a sharp distinction has been drawn between asset and liability management by banks, where the mark-to-market convention is second nature, and the valuation and management of pension liabilities, where infrequent monitoring using funding bases is the norm. Our analysis suggests that there is no good reason why *in theory* the same mark-to-market blueprint cannot be applied in both cases, and we contend that this approach would lead to positive improvements in corporate management of pension schemes.

5.10.2 The remaining objections to our blueprint are, we believe, much more practical and we discuss these further in the next section.

6. STANDARD TECHNIQUES IN MARKET PRICING

6.1 *Introduction*

So we have our blueprint and, from the viewpoint of financial theory, we

cannot see any convincing reason why this should not be applied to the management of defined benefit corporate pension schemes. The final objections motivating resistance to the methods described above may be quite practical in nature. Our simple examples are facile, how could an actuary in the field apply financial theories to value complicated liabilities? We will address these concerns in the next section. However, some of these problems will turn out to be quite hard to crack, and we may encounter a few false trails looking superficially quite appealing, unless we are armed with a selection of standard techniques. These techniques are, therefore, set out below before we launch into the practical issues.

6.2 *Consistency*

6.2.1 The first basic principle of market pricing is that, whatever complications are thrown at us, we must always ensure that if liabilities do have equivalent traded assets, the pricing is consistent. This is known as the 'Law of One Price'. If two cash flows are identical, then they should have the same price at a given point in time, otherwise we have a simple arbitrage.

6.2.2 If we intend to obey this elementary law, then abandoning the use of market rates of interest in favour of a funding basis for pricing vanilla deferred pension liabilities, because we encounter problems getting an exact answer from the market for salary growth expectations of active members, seems not only rather eccentric (much like abandoning your car and walking to work in the rain because you cannot quite decide which cassette tape to play in your stereo), but rather short sighted. If the client subsequently asks for the cost of a benefit improvement applying only to deferred pensioners, for example, then we lose our excuse for arbitrariness in our assumptions, and have to recompute the additional liability on a market related basis.

6.2.3 Furthermore, in case a market does eventually develop in such assumptions, it might be wise to have a stab now at how the market *would* price them, to minimise the risk of an enforced step change in our assumptions as market sophistication increases. For example, if we used the yield on equities to discount inflation-linked liabilities in a country where inflation-linked bonds do not exist, we might be faced with the problem of explaining why the liability had suddenly increased if the government subsequently issued such bonds. Similarly, it is sometimes suggested that, while bonds are an acceptable match within the term of the yield curve, some other long-term asset class, such as antique furniture, or more usually, equities, should fill the abyss beyond the end of the yield curve. Such conventions inevitably lead to large jumps when a new long dated bond is issued.

6.2.4 We would, therefore, argue that these practical objections are only really a motivation for searching out techniques which can infer the pricing of more complex liability features from available market prices, rather than proceeding with a purely judgemental approach in the absence of a perfect match.

6.2.5 By contrast, the popular arguments against volatility of actuarial

valuation numbers, discussed in the previous section, appear to argue in favour of an actuarial 'law of one price', applied along the time axis. It is, apparently, considered to be of particular importance that the pension liabilities of our saucepan manufacturer should have the same or similar values at *different times*, regardless of the lack of consistency with the market price of the identical traded cash flow (the portfolio of government bonds for example) which would be demanded by financial economists. The economists' price of such traded cash flows will certainly fluctuate quite markedly through time; consistency across identical cash flow 'space' and time cannot be achieved simultaneously. Faced with this choice, consistency across identical cash flows at a given point in time wins hands down from the economist's viewpoint, not least because it does not leave his cherished theories open to the sort of conjuring tricks presented in Section 3.

6.2.6 In the context of this paper, a particularly important aspect of this principle is consistency with term structures of interest rates and, in particular, the importance of the law of one price when applied to combinations of bonds. The concepts involved are fundamental to many aspects of arbitrage pricing. We will encounter them again and again when marking to market the liabilities of a defined benefit pension scheme, so they deserve some special recognition here.

6.2.7 Term structures have been a major stumbling block, both for financial economists and for actuaries, in the second half of this century. However, while economists have now largely resolved the major issues, confusion still seems to reign in some actuarial circles.

6.2.8 The concept of a term structure arises whenever a stream of cash flows is to be valued. Standard special cases are: the valuation of bonds, the valuation of index-linked bonds, and the valuation of equity dividends. Cases of particular interest to us include, in addition, bonds linked to wages and bonds linked to limited price indexation.

6.2.9 It turns out to be of particular importance, given an overall market value, to decompose that into the value arising from each cash flow. This is of interest, for example, if we are evaluating liabilities which depend on some, but not all, if the income flows from a specified asset. These single cash flow constituents are sometimes referred to as a STRIP, which is an acronym for Separate Trading of Registered Interest and Principal.

6.3 *Flat Yield Curve Models*

6.3.1 Perhaps the simplest approach is to assume that the sequence of strip values form a geometric progression. The value of the first payment, divided by the market value of the total is then the *running yield* (expressed as a discount). Plainly, in order for the geometric progression to sum to unity, the strip values must decrease by a factor of (1 – running yield) each term.

6.3.2 In the context of fixed income modelling, the geometric progression concept is sometimes described as a 'flat yield curve' model. As the model is

driven by a single parameter, it is natural to consider the sensitivity of assets and liabilities to this parameter. This gives rise to the concept of *immunisation* as developed, in the U.K., by Redington (1952).

6.3.3 As Redington noted, the flat yield curve model does give rise to some curious investment strategies. It would appear to be optimal always to hold a mixture of very long and very short strips, and, if possible, take short positions in medium dated strips. It is then, apparently, possible to arrange one's affairs in such a way that, whichever way the yield moves, a profit arises.

6.3.4 Nowadays, the apparent arbitrage from immunisation would usually be regarded, not as a wise investment policy, but rather as an indication that something is wrong with the flat yield curve model. A number of more robust arbitrage-free alternatives have been described, and some of the finest minds in the economics profession have been applied to these problems.

6.4 *Empirical Work on Yield Curves*

6.4.1 Rather than rely on an apparently arbitrary choice of geometric progression, which, in any case, leads to economic inconsistencies, market practitioners often prefer to employ many bond prices simultaneously to determine implied strip prices. For example, a price of a one-year deposit might be available; this is already, in effect, a strip. If one then has a price for a two-year bond with a coupon payable in one year's time, the coupon can be valued using the one-year strip price, and subtracting this from the two-year bond price we have the price of a two-year strip. This process continues inductively to determine strips at all terms. The resulting strip prices are then consistent, not just with a single bond, but with all bonds used in the calibration.

6.4.2 The practicalities of this calculation vary in complexity from one market to another. In the U.S. treasury markets, for example, there are only four days of the year on which interest is paid. At least out to about 10 years or so, there are sufficient bonds to calibrate strip prices to each of these dates by a process of linear elimination.

6.4.3 In the U.K., the mechanics are rather more awkward, given that interest payment dates are scattered throughout the year. Some form of curve fitting is then required to reduce the degrees of freedom to a manageable level. However, the IFAA (1997) has proposed that implied strip prices (either in the conventional and index-linked markets) should be used for discounting pension liabilities. We fully support this proposal, but it will require actuaries to become proficient in some new term structure modelling techniques. An algorithm suitable for use in the U.K. is outlined in Evans (1997). This will all become a lot easier when the U.K. strips market starts to trade.

6.5 *How Term Structure Models can Benefit Actuaries*

6.5.1 Term structure models can benefit actuaries in several ways. They provide:

— a more robust model of the relationship between income and capital values,

which avoids the arbitrage of the geometric progression-based discounted income method;
— a continuous spectrum of instruments, covering both the long and short term in a consistent fashion;
— a means of reconciling *forward* projections of assets, based perhaps on random walk ideas, with *backward* valuation of liabilities based on discounted cash flow;
— a consistent arbitrage-free methodology for pricing interest-rate contingent cash flows, such as caps and swaps, consistently with underlying bond markets; and
— for students, a relief from the tedium of commutation functions!

6.5.2 There has been some resistance in actuarial circles, even to the simple immunisation concepts proposed by Redington. For example, Coutts (1993) declares that 'immunisation is dead'. Coutts & Thomas (1997) then illustrate the effects of eschewing term structure models, proposing instead an asset model in which bonds do not mature at 100% and equity prices are statistically independent of equity dividends.

6.6 *Characteristics of a Good Term Structure Model*

6.6.1 Term structures are therefore important, because they tell us a great deal about the cost of hedging defined payments in the future. Accordingly, it should come as no surprise that they loom large in our pricing of defined benefit pension liabilities. However, these models demand slightly more mathematics than the compound interest with which actuaries are familiar when using a few gross redemption yields.

6.6.2 The important point to note here is that the mathematical complexity of these term structure models arises from the fact that we must model (in theory and pretty well in practice) a continuum of bonds of different durations.

6.6.3 Actuaries may be familiar with the idea of adding all sorts of different risk factors in their models, but even if we just assume a single source of risk to interest rates, unless we rig things properly we open the possibility of synthesising the same exposure to this single factor using different combinations of bonds. We therefore need to ensure that if we take long and short positions in these different combinations of bonds to eliminate the risk exposure, we only earn the risk free rate — otherwise we have an arbitrage machine. So the law of one price must be policed rigorously within the model.

6.6.4 This concern is not mere sophistry. If we are pricing liabilities by arbitrage, as described above, a model of term structures which is riddled with arbitrage opportunities is about as useful as a chocolate fireguard. Of course things can get a lot more complicated still if we have more factors driving our interest rates. A bit of elementary linear algebra suggests that we will always have the same problem of a potential arbitrage machine as long as we have more bonds than factors. If we like things to be complicated we can also consider making the volatility structure of our stochastic drivers more exotic, but again,

with added complexity comes added complications when squeezing arbitrage out of the mathematics.

6.6.5 As a consequence of these difficulties, some term structure model assumptions may seem rather simplistic, by comparison with the 'bells and whistles' attached to many actuarial models based on time series analysis of historic data. Equally, these actuarial models do not generally include full term structures. Presumably this is because it is anticipated that actuaries will rely on funding, rather than on market methods of valuing cash flows, otherwise the bells and whistles would be little compensation for this omission.

6.6.6 Wilkie (1995b) commented that; "unfortunately, to my mind, they [arbitrage-free term structure models] are usually based on an assumption about how they ought to behave rather than being based on how they actually do behave". However, term structure models should not necessarily be rejected outright on account of the underlying simplicity of the interest rate processes or their superficial inconsistency with actuarial analysis of past data, for the following reasons:

(1) The calibration disciplines (discussed in Section 6.7) ensure that we do not go too far wrong with our model, despite our simplifying assumptions. For example, we will calibrate the model to ensure that it initially prices all available bonds correctly. We will then calibrate the volatility structure of the model against vanilla bond options and maybe interest rate caps. This means that, if our liability is a bit like a mixture of these assets, then the principle of interpolation will see us through. Despite their complexity, many standard actuarial models fail even to get past the first hurdle here, and it is a non-trivial exercise to incorporate initial yield assumptions for available bonds without messing up all the other assumptions carefully constructed from historic analysis.

(2) Term structure mathematics slips into a forward neutral world at quite an early stage. By contrast, most actuarial models stay in the real world. This forward neutral world has several slippery features if we try to grasp it. For example, it may be observed that interest rates are mean reverting in the real world. However, a model which displays no mean reversion in the forward neutral world is not necessarily inconsistent with this observation. Of more relevance is the range of feasible outcomes (rather than their probability). As a consequence, there may be little to choose between the real world equivalents of two models which can both generate negative interest rates, even if such an outcome appears much more likely in one model than in the other. More important is the richness of the volatility structure allowed by different models. Since, as noted above, few of the standard actuarial models have explicit term structures it is difficult to compare this richness.

6.6.7 In fact, we will encounter almost immediately, in the next section, an example where the simpler term structure models (such as the beautifully simple model of Ho & Lee, 1986) are not adequate. However, this issue is subtle and unlikely to be picked up by funding valuation techniques. Furthermore, we will

show that we only need to step up one gear into an off-the-peg general term structure model of Heath, Jarrow & Morton (1992) to accommodate this subtlety.

6.7 *Market Calibration (Interpolation)*

6.7.1 As explained by Smith (1996), a key feature of market-based pricing techniques is the use of the 'controlled experiment' principle. First, a model is built which is calibrated to ensure that it correctly prices traded cash flows at a given point in time. As noted above, a term structure model will be fitted to the initial real and nominal interest rate term structure as well as the pricing of caps and other interest rate options.) The same model will then be turned onto similar (but not traded) cash flows to derive an estimate of the price. Provided that this perturbation away from traded cash flows is small (the cash flows exhibit similar characteristics to those used to calibrate the model), any error in this 'interpolation' is likely to be small.

6.7.2 This interpolative discipline is fundamentally different from the extrapolative actuarial principle of calibrating funding 'values' against history. For example, the latter results in the use of a smoothed price based on some average set of market returns and inflation rates. This funding approach to valuation (as proposed, for example, by Pemberton (1996) as a method of pricing options) involves statistical analysis of how assets have behaved in the past and then using this information to discount future cash flows, regardless of any inconsistency with the current market prices of cash flows which can be used to hedge the liability.

6.7.3 We therefore find it somewhat surprising that those objecting to the application of financial economics in actuarial work should choose statistics as a battle ground. Without the use of the calibration techniques we describe, unfettered statistical analysis can, indeed, sometimes result in answers which lack robustness. The following criticism by Paterson (Clarkson (1996), abstract of discussion) seems particularly puzzling in this regard, since it seems to us that reference to financial economics could easily be replaced with reference to equity-based funding valuations when compared with market valuations: "Much of the trouble with financial economics comes from putting too great an emphasis on statistics, which, in reality is of little use. It is not unreasonable to say that what happens in the world is determined by realisations of probability distributions. Probably it is. The trouble in the investment field is that you only get one realisation of any distribution. Every year's investment return in, say, the U.K. equity market may be a realisation of a probability distribution, but if next year's is a different probability distribution from this year's, and last year's was a different one again, how do you expect to get much value out of statistics?".

6.8 *Dynamic Optimisation*

6.8.1 As we will see, market-based pricing has an actuarial counterpart which has many features in common — the concept of matching, as constructed by Wise (1984, 1987). The latter theory forms the basis of most actuarial work in

asset-liability studies and portfolio selection. Wise was also one of the first to suggest that the economic value of a set of liabilities might best be assessed by reference to the market value of a 'best match' portfolio. However, as well as similarities there are also important differences between the development of this concept by actuaries and financial economists.

6.8.2 In all applications, the basic concept of matching, or hedging, involves choosing asset portfolios which behave in a way which is 'close' to a defined set of liabilities. Various types of asset portfolios might be included as candidates for this process, including;

— *static portfolios*: this means a constant mix of investment classes, perhaps rebalanced at intervals to maintain constant proportions by market value;
— *time varying portfolios*: this means portfolios which are invested in one asset mix and then, at a defined point in time, sold and switched into a different asset mix; and
— *dynamic portfolios*: this means portfolios whose composition changes over time as a function of current or historic market levels, the future switches are not known at the outset, because they depend on future information not yet available.

6.8.3 Common practice, as described, for example, in Clark (1992) or Kemp (1996) chooses simply between static portfolios. These approaches have the advantage that 'efficient' portfolios, that is, maximum return for a certain level of risk, can be solved by simple matrix arithmetic — see, for example, Lockyer (1990).

6.8.4 The original papers by Wise (1984, 1987) did also consider time varying portfolios. Wise presents an ingenious method for considering such portfolios, which enables the matrix methods still to be applied, albeit with much larger matrices. Consideration of time varying portfolios introduces a number of subtleties relating terms and cash flow amounts. We can no longer rely on traditional notions of matching by mean terms, as exemplified in IFAA(1997) (as we have already quoted in ¶5.9.2). For a contrasting illustration of the new approach, we observe that a five-year unit-linked policy may be matched by a portfolio, say, of equities or a portfolio of cash, according to the link selected by the policyholder. Any apparent mismatch between the mean terms of the assets and liabilities is compensated by the fact that cash flows themselves depend on market values. In Section 7 we will show how these concepts can be applied to the pricing of salary-linked liabilities.

6.8.5 The inclusion of dynamic portfolios complicates the mathematics to a considerable degree. Simple matrix methods are no longer up to the job, and, in general, it is difficult to solve explicitly for optimal investment mixes more than one step ahead. The mathematics, which is unfortunately rather complex, is contained in Smith (1993).

6.8.6 It is important to distinguish between the concept of dynamic matching (or hedging, as it is more often called) and particular models which make use of

the technique. For example, the Black & Scholes (1973) option pricing formula can be derived as the price of the best matching dynamic portfolio involving just cash and the underlying share. The model assumes, among other things, a diffusion model for the share price. If the share price fails to perform a diffusion, the supposed hedge may break down. Of course, the problem here was an assumption of a diffusion model, not the principle of trying to hedge.

6.8.7 To get an idea of some of the issues involved, it is illuminating first to consider the effect of looking only at static portfolios on the outcome of asset/liability studies. The simplest examples might consider a deferred pensioner who receives price inflation in deferral and a guaranteed 5% increases in retirement. If the analysis, unusually, includes time varying portfolios, then the best match would be a portfolio holding index-linked gilts prior to retirement and conventional gilts after vesting. However, the more common technique of static analysis would produce some mixture of conventional and index-linked gilts. As the portfolio matures, the static portfolio moves towards an even higher concentration of conventional gilts. The recommended mix is always more heavily into conventional gilts than would be suggested from a time-varying investment strategy.

6.8.8 Perhaps, if the effect of ignoring time varying strategies is simply one of some unwanted averaging, the overall impact might be seen as rather benign. However, in the case of establishing portfolio selections with supposed 'long-term' matching characteristics at some ultimate horizon (of the type described by Lockyer (1990) and Clark (1992), as discussed in ¶5.5.6, for example), we contend that major discrepancies can arise. The problem originates in the use of lagged structures to analyse financial returns, as, for example, proposed in Wilkie (1995b). For example, historical evidence is sometimes claimed in support of effects such as:

— if there is an inflation shock, equities tend to fall, but subsequently rise to catch up in real terms; or
— equities tend to perform well 5 years after a burst of salary inflation.

We would question the statistical basis of these statements, as the significance tests applied to demonstrate the results appear to be based on a normality assumption. However, the data points which provide the main justification for the conclusion arose in the early 1970s, and, by the standards of the normal distribution, are extraordinarily extreme events. Indeed, the extreme nature of these events arguably casts doubt over the normality assumption, and hence over the validity of the statistical results themselves (see, for example, Huber, 1995).

6.8.9 Nevertheless, if we accept the above results as being valid, a static asset/liability study might typically suggest that (in terms of the likelihood of shortfall, say), although extremely risky over the short term, increasingly large fixed allocations to equities supposedly offer increasingly attractive risk versus return characteristics against both price and salary-related liabilities over longer horizons (Clark, 1992).

6.8.10 However, the apparent optimality of these large fixed allocations to equities is seen to be illusory if we allow for dynamic portfolio selection and the conclusions change quite radically. In particular, we find that:

— if you want to protect against unexpected inflation, you should go short of equities, and then buy them back when the market has collapsed; furthermore

— you can use salary inflation over the last five years as a switching rule, to make sure that you get the benefit of any equity rise while avoiding being in the equity market when it falls!

6.8.11 So, here we can see that static asset/liability modelling gives totally different results from dynamic modelling. Furthermore, these results do not appear to be robust to a change of model. The rather odd results that we have just obtained are due to the way asset prices respond tardily to new information, rather than difficulties with the principle of dynamic optimisation. Fixing this problem by disallowing dynamic policies by *fiat* leaves us with significant arbitrariness in our answer, and seems a highly unsatisfactory way of proceeding.

6.8.12 Hence, in the case of portfolio selection the optimal solution can vary greatly, according to whether dynamic strategies are allowed or not. Conventional actuarial omission of dynamic strategies does not simply result in bypassing strategies that were silly anyway. We would claim that an actuarial restriction to static optimisation has resulted in the focus on distributions only at some terminal time horizon. This paves the way for the time diversification of risk fallacy, which, in turn, forms the basis of the actuarial long-term view. In particular, a static analysis would appear to offer a pre-eminent role for permanent long equity positions, which is completely squeezed out when dynamic alternatives are available.

6.8.13 If we now consider our process of hedging, rather than portfolio selection, we find that, as noted earlier, the mathematics of dynamic hedging is involved, but not impossible. Some results of particular importance, derived in Smith (1993), are that the conditions for dynamic optimality imply:

— the characteristics of a hedged profit and loss account, described in Section 5.3; and

— a hedge should not just work at a terminal time horizon; it should work all the way along, as noted in Section 5.5.

These requirements can now be seen, not simply as our blinkered attempt to generalise derivative practice, but as a consequence of more advanced mathematics applied to the matching problem widely discussed in the actuarial literature. In this context, it is, perhaps, also interesting to note that when it comes to identifying such a hedge, the Wilkie model, for example, gives a result for matching price and salary-related liabilities which is significantly different again from any of the portfolio selection results described previously, and much more robust with respect to changes in the model. In the absence of index-linked

gilts, it turns out that the *hedge* consists almost entirely of cash plus some irredeemable stocks!

6.9 *Forget Arbitrary Constraints*

6.9.1 As noted above, the conventional long-term actuarial asset/liability studies for pension funds, as described above, have been carried out in the context of portfolio selection rather than hedging. It might seem a simple procedure, having identified an appropriate portfolio of assets, to take the value of the liabilities to be equal to that portfolio of assets, as suggested in Wise (1987). However, there are a number of reasons why portfolio selection does not easily translate into our concepts of hedging or matching. These boil down to the basic principle that the portfolio of assets held to meet the liabilities is only part of the total portfolio of assets held by an investor. Therefore, if we are to have an answer which is robust with respect to paper reallocations of these assets, the result must be *independent* of this portfolio, so we must learn to forget about it.

6.9.2 For example, a natural constraint of an asset-liability study aimed at portfolio selection is the initial amount of cash in the pot. The scope of the advice will cover how these existing funds should be invested — the level of funding being a separate exercise. In particular, the lower the amount of cash available, the higher the likely recommended equity proportion, as the greater the degree of risk which must be taken to stand a reasonable chance of meeting liabilities. This translates into the assertion that, for example, equities are a better match for inflation than index-linked gilts, because index-linked gilts have too low a return.

6.9.3 However, from a pricing point of view, this constraint on the initial investment value is unhelpful, if not useless. It fails to satisfy our independence principle, because it is clearly dependent on the arbitrary decision to earmark a particular set of assets to meet the liabilities. A pricing investigation should value the promise that has been made, the amount notionally set aside today to meet part of that promise should not be part of the input to this calculation. This turns on its head the conventional application of asset/liability modelling — that one starts by inventing a valuation basis and then watching how it behaves over time. Instead, we regard the identification of economic value as the most valuable *output* of asset-liability modelling.

6.9.4 Another constraint which is commonly applied in the context of portfolio selection is a restriction on short positions or on gearing within the asset portfolio. This may be sensible for portfolio selection purposes, but in the context of market-based pricing, where the cash flows being priced are part of a larger shareholder picture, such restrictions do produce rather odd effects.

6.9.5 For example, suppose that we have a company with cash assets whose liabilities increase when the FTSE falls, and vice versa. This company would have the characteristics of a FTSE tracker fund irrespective of whether the regulatory framework allowed it the freedom, in principle, to take an offsetting short position on the asset side.

6.9.6 A particular case in point relates to cash flows beyond the reach of the current yield curve. In order to avoid a large jump in the liability value when new bonds are issued, it would seem sensible to price liabilities consistently with where we think new bonds are likely to be priced. For example, we might take the yield on existing long-dated bonds as a guide. Hedging this liability would then involve taking a geared position in long-dated bonds.

6.9.7 If, however, gearing was not permitted, then some other longer-dated asset class, such as equities, might appear, instead, to be a good match. This would tend to underprice the liability, with a sudden correction when new bonds are issued. It also gives rise to some peculiar nonlinearities in valuation; for example, if a set of long-dated and short-dated cash flows are valued separately and then added together, these may produce a lower value than if they were valued in aggregate. This is because a hedge for the aggregate may be achievable without gearing, while matching of the longer-dated cash flows in isolation may require some gearing; if this falls foul of our artificial constraints, then some other less matched asset, such as equities, may appear instead.

6.9.8 In fact, following the principles described above, this definition of gearing within pension funds strikes us as a rather curious anomaly anyway. If a scheme follows a mismatched investment policy by way of being overweight in equities, it is using the member liabilities to gear its equity exposure. This is common practice, and is not generally held to be imprudent and inconsistent with the fiduciary role of trustees. By contrast, using equities or bonds to fund a bank debt is gearing, and therefore held to be imprudent and speculative, even if liabilities are more closely matched as a result.

6.10 *Conclusions*

These techniques will prove extremely useful in the following section. We now give concrete examples of these techniques at work in solving some of the practical objections to market based methods.

7. PRACTICAL APPLICATIONS OF MARKET PRICING TECHNIQUES

7.1 *Introduction*

7.1.1 Even the most patient reader should by now, we hope, be eager to use our proposed approaches to have a crack at a couple of 'chestnuts'.

7.1.2 The basic practical problem which actuaries face is, of course, that, although simple defined benefits, such as fixed or U.K. price inflation linked pensions in payment, from a government-backed institution, have an unambiguous matching asset, the market does not give us an immediate price for:

(1) real salary growth (see Greenwood & Keogh, 1997) as well as demographic assumptions such as withdrawal decrements — we still need to nail the question of whether equities have a role in valuation here; and
(2) features such as fixed increase caps and no decrease collars applying to many

price-indexed pensions (see comments from S.J. Green in discussion of Dyson & Exley, 1995).

These problems may have given rise to some comfort that actuarial practice in the pensions field is safe from the disciplines of market pricing. We shall see.

7.2 *Pricing NAE Bonds*

7.2.1 Most of the controversy raised by the application of market-based valuation methods to pension schemes appears to surround the treatment of salary inflation within financial pricing. Actuarial thought has set a great deal of emphasis on the claim that equities match salaries, as evidenced by Lee (1986), Thornton & Wilson (1992) and IFAA (1997). This conviction is not restricted to pensions work; for example the notes prepared by the Actuarial Education Service for the general insurance paper of the Institute of Actuaries examination in 1994 tell students that "index linked gilts (ILG) provide a real return linked to RPI. Historically, claims have increased due to court award inflation and national average earnings. Hence, Employer's Liability claims are expected to increase in real terms, thus equities are likely to be a better match than ILGs." The commentary then adds further that "ILGs may be over-valued due to demand from other institutional investors".

7.2.2 However, an examination of the past few years in Britain gives an indication that this traditional actuarial logic can often fail to manifest itself in reality. The years since the early 1990s have seen the following features:

— a recovery from recession driven substantially by foreign investment — the benefits of economic growth being reflected, presumably, in the dividends of the foreign companies who invested in the first place;
— low inflation and temperate wage awards; and
— increasing unit productivity in the U.K., with a U.K. equity market rallying on the back of it.

This is hardly consistent with a chain of logic which links U.K. wages to U.K. equities!

7.2.3 As observed by Greenwood & Keogh (1997), the reason why NAE is difficult to price is that there is no obvious traded asset which replicates it. We would ideally like the market prices of index-linked bonds linked, not the RPI, but to the national average earnings index (NAE). Unfortunately they do not seem to exist, at present. Thus, it is indeed fair to observe that the immediate route of equating the price of our salary-linked liability with the price of a hedging bond portfolio is not open to us.

7.2.4 One of the attractive features of studying national average earnings is, however, the large volume of historic data available, spanning several centuries. Accordingly, it is very tempting to trawl these data, and we have seen actuaries resort to some rather curious devices to derive the cost of final salary related

liabilities via this route. If we look at the prices thus derived for salary related lump sums, then these should roughly equate with the price of an hypothesised NAE-linked bond. To clarify the issues involved, it is therefore instructive to consider how we would price such a bond using these techniques. The advantage of this parallel approach is that we can more easily identify methodologies which cannot possibly work for pricing bonds, whereas some of these howlers may be less obvious if we think directly in terms of pension liabilities.

7.2.5 One approach, for example, might be to make comparisons between the capital values (or total returns) of shares and growth in NAE. The difficulty here is that the observed NAE growth is, effectively, the ratio of the maturity value of two different zero coupon NAE bonds at different times, while the equity return is the growth over time in the market value of a single asset. These results can, therefore, be rather hard to interpret when we try to unravel our bond prices from them.

7.2.6 We could alternatively try to start by pricing an NAE-linked perpetuity (instead of a zero coupon bond), but then a comparison of NAE growth against equity returns is a comparison of *income* on one asset class with the *capital value* of another. This line of logic would be equivalent to the suggestion that, in order to assess the effectiveness of a gilt portfolio to hedge a set of cash flows, one should calculate the correlation of the market value of gilts to the cash flow amounts. This would 'prove' that gilts cannot match their own fixed cash flows, as the gilt market value does not stay constant until an instant before maturity, jump up suddenly and then collapse to zero.

7.2.7 Therefore, to summarise the position so far, we cannot compare capital values with capital values for the lack of existing NAE bonds. It is meaningless to compare income to capital values. The only remaining alternative is to compare income to income. Again, we can only really do this in the context of perpetuities. This might lead us to compare:

— income on perpetual index-linked gilts, that is the RPI;
— income on perpetual salary-linked bonds, that is the NAE; and
— income on (perpetual) equities, that is a suitable dividend index.

In fact, it makes for a more transparent comparison if, instead of showing inflation, we show inflation plus an additional 2% p.a. for real productivity gains.

7.2.8 Since the primary quantity for analysis is salary inflation, it is interesting, initially, to express salaries as multiples of dividends and of retail prices plus 2%. Our figures, which are similar to those shown in Thornton & Wilson (1992) are plotted in Figure 7.2.1.

7.2.9 It is striking from this graph how closely linked prices and wages have been over this period. Data shown in Wilkie (1995) confirms that this level continues more or less without interruption back to the early 19th century. Furthermore, similar patterns seem to hold internationally. Figures 7.2.2 and 7.2.3, adapted from IFAA(1997), show corresponding data for France and Germany. This reference also provides further examples of the close link between salary and

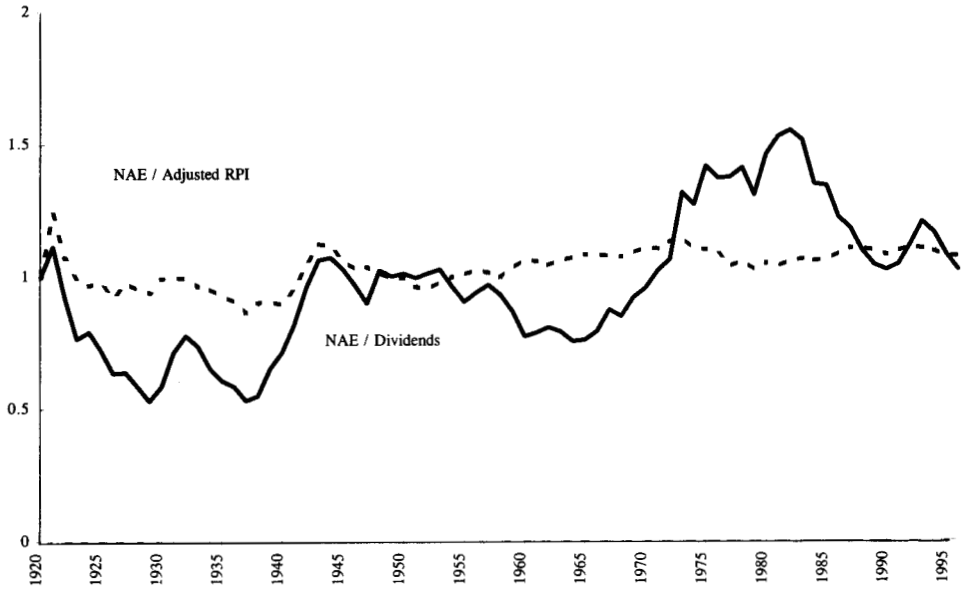

Figure 7.2.1. Comparison of national average earnings growth against adjusted retail prices index and dividend index (U.K.)

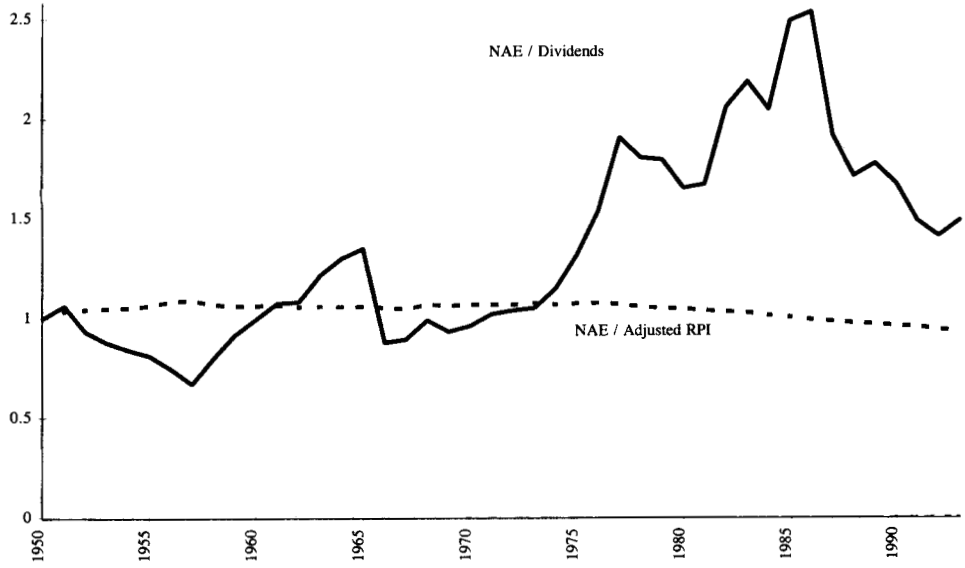

Figure 7.2.2. Comparison of national average earnings growth against adjusted retail prices index and dividend index (France)

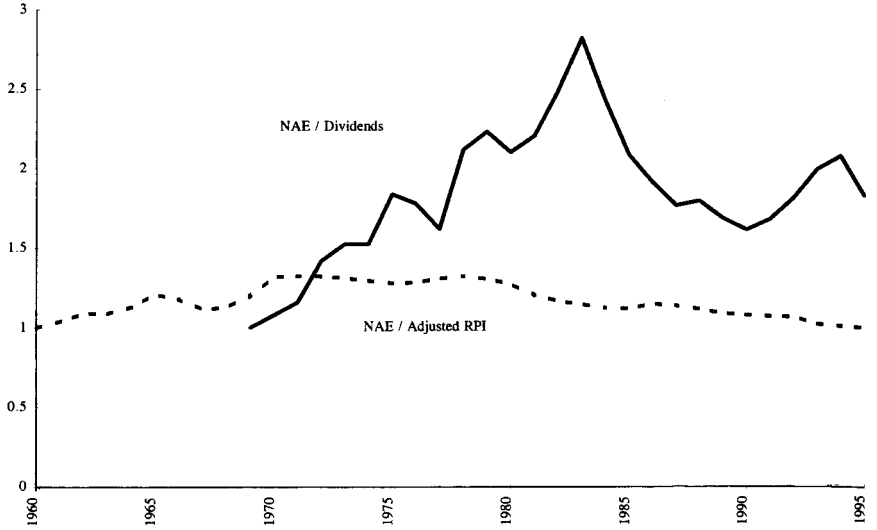

Figure 7.2.3. Comparison of national average earnings growth against adjusted retail prices index and dividend index (Germany)

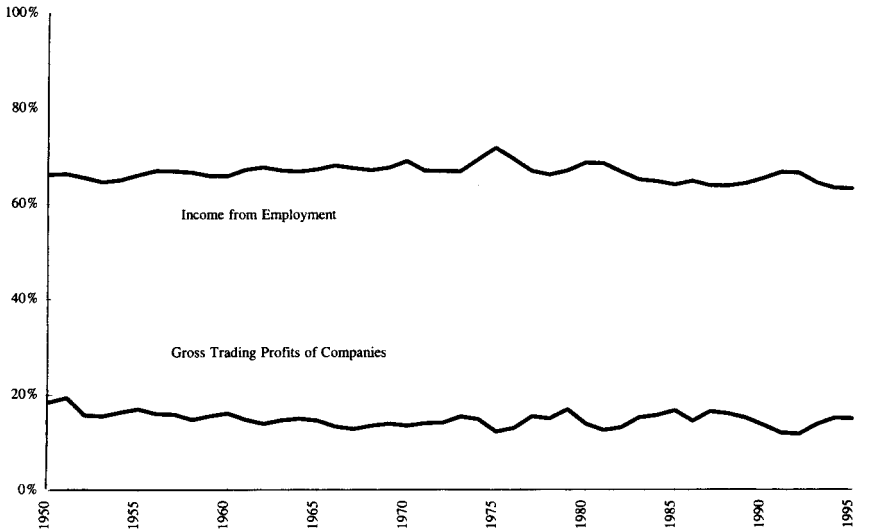

Figure 7.2.4. Variations in components of gross domestic product
Source: Central Statistics Office

price inflation (and the unreliability of the link with dividends) for several other countries.

7.2.10 By contrast, the link to dividends is much less clear. From these data, we would find it very difficult to justify any match between equities and salaries if index-linked bonds were available as an alternative.

7.2.11 On reflection, this result is perhaps not so surprising. The theoretical thread from which the link between equities and salaries is supposed to hang is based on high school economics; the profit of industry is allocated between capital and labour according to proportions which allegedly stabilise in the long run (although nobody seems prepared to hazard a guess at what these proportions should be). Against this amateur economics, Figure 7.2.4 reproduces the statistics provided by Dyson & Exley (1995). The basic problem with the quasi-theoretical argument is that, although company trading profits and income from employment are carved out of the same cake (so both will tend to grow as the cake grows), the percentages in each slice can vary antagonistically over time, reflecting the balance between capital and labour. Whereas these variations are proportionately small in the case of employment income, they are quite substantial in the case of the smaller slice allocated to profits, which does not seem particularly stable at all. This goes some way to explaining the observed large variations in Figure 7.2.1.

7.2.12 In fact, we would suggest that the economic argument which actually hits us from Figure 7.2.4 again supports our preferred alternative approach of starting with a market framework for retail price inflation and then adding an assumption for real salary growth on top. Given that, at around 70% of GDP, real salary growth is pretty well constrained by the level of GDP growth, it seems to us to make more sense to try and back out market numbers for GDP expectations (some investment banks already make a market in GDP derivatives) and then latch on to the link between salaries and GDP, rather than trying to back out a salary growth expectation from equities.

7.2.13 More generally, the relationship between wages growth, unemployment and financial market variables such as interest rates does not appear to be clear cut. To illustrate this, we obtained a number of simulation results for the Liverpool University Macroeconomic model of the U.K. economy. A monetary shock, for example a rise in real interest rates, has a modest negative effect on real wages and only a marginal effect on long-term wages growth. An unexpected decline in the money supply causes financial market prices to decline and wages growth to fall. On the other hand, a supply side shock, for example an increase in unemployment benefits, increases real wages, but also gives rise to higher short-term interest rates after a temporary initial fall. Although this does not address the question of the relationship between equity returns and wages, it does give an indication that links may vary according to the nature of extraneous shocks. An increase in wages is not necessarily associated with an increase in equity earnings or dividends, nor vice versa, as the chart shows.

7.2.14 Admittedly, if, in a portfolio selection context, the return on index-linked gilts was deemed too low, some equity may increase the expected return.

However, it does seem that the widely claimed match of equities to wage inflation is completely spurious. In particular, Thornton & Wilson's claim that the theoretical link between equities and wage inflation "does provide a convincing rationalisation of the results found from the inspection of the historical figures" seems hard to interpret, except in the rather negative sense that, given that the theory is in doubt, it is unsurprising that the data fails to support their contention either.

7.2.15 We note, in passing, that, even if a link between equity dividends and wages could be demonstrated in the future, this does not necessarily help us to hedge our NAE-linked bonds anyway. The problem which arises is that, whereas in the index-linked gilt market we can effectively trade future RPI-linked cash flows separately, there is no such thing (yet) as an equity strips market, except for very short-dated cash flows where the forward market is liquid. Any putative dividend link to wages would only help us if we had the same number of members retiring every year into the future. This extra degree of freedom, embedded within an equity term structure which we can neither observe nor hedge, does inject an unwanted degree of arbitrariness into any equity-based valuation methods.

7.2.16 However, index-linked gilts, our preferred starting point for pricing NAE bonds, have only become available since the early 1980s. Prior to this point, perhaps equities would have featured in a matching portfolio? Having established the close historic match between NAE and inflation, this question is now much easier to answer. Arguably, an NAE-linked bond should behave very much like an RPI-linked bond. Therefore, effectively, we have market price data for NAE-linked bonds based on index-linked gilt prices. It is now a simple exercise in regression to determine the asset mix which have best hedged these bonds using data from the period after the issue of (RPI) index-linked gilts. In order to take proper account of the term structure issues, we analysed separately the long and short index-linked indices using monthly total returns since 1986 (when the indices started). These were regressed against indices of one-month certificates of deposit, short gilts, medium gilts, long gilts and equities, all on a total return basis. The results are relevant, we contend, not only as an exercise in U.K. economic history, they also give some guidance as to the appropriate hedge for wages (and inflation) in overseas territories which do not, currently, have an index-linked market.

7.2.17 Interestingly, the best hedge for the short index-linked gilt index contained 30% cash and 70% short gilts. The longer-dated index-linked gilt indices can be hedged most closely by a short position of 45% in cash, a long position of 135% in short gilts and the remaining 10% in U.K. equities. The fact that these figures are different for short and long-dated commitments confirms the importance of using time-dependent hedges. However, these results are remarkably robust to changes in the time window investigated, suggesting that, in this case, the additional sophistication of a fully dynamic hedge is unlikely to improve significantly on the time dependent hedge discussed in the previous section.

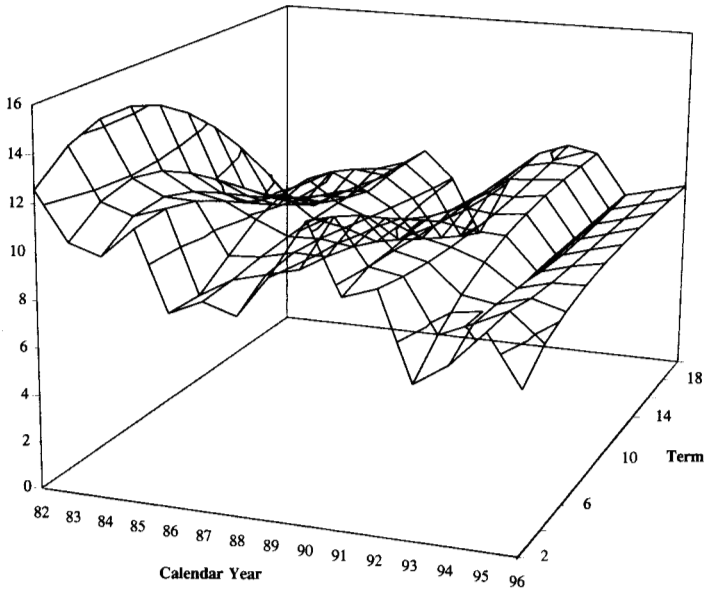

Figure 7.2.5. Forward rates on conventional gilts (1982 to 1996)

7.2.18 When using these results in practice, we are not, of course, faced with a constant maturity index, but rather a bond which matures on a known date. In order to replicate this bond, we need to simulate the effect of being in the long index for a period of time, rolling gradually into the short index and finally into cash. In this way, our essentially static analysis of the constant maturity indices delivers the optimal *dynamic* hedge for the bond with a fixed redemption date.

7.2.19 There are three features of these regression results which require comment. The easier one to explain is the low concentration of equities. The fact that they appear at all suggests that some aspects of inflation are captured by equities and not by gilts. However, equities capture an awful lot of other noise as well. The moment the equity mix rises, the extraneous noise grows quickly, and soon comes to make the wages hedge worse rather than better. We would argue, also, that most of the risk premium is associated with this extraneous noise rather than the salary inflation risk, so it would be wholly inappropriate to take credit for the full equity risk premium when assessing wage growth.

7.2.20 The hedge for short-dated index-linked gilts is, perhaps, not too surprising. The main point to note here is that, over the period studied, there has not really been such a thing as unexpected inflation. Instead, the market has anticipated the actual inflation fairly accurately within the real and nominal yield curves up to around 2 years ahead. It follows that a 2-year index-linked bond

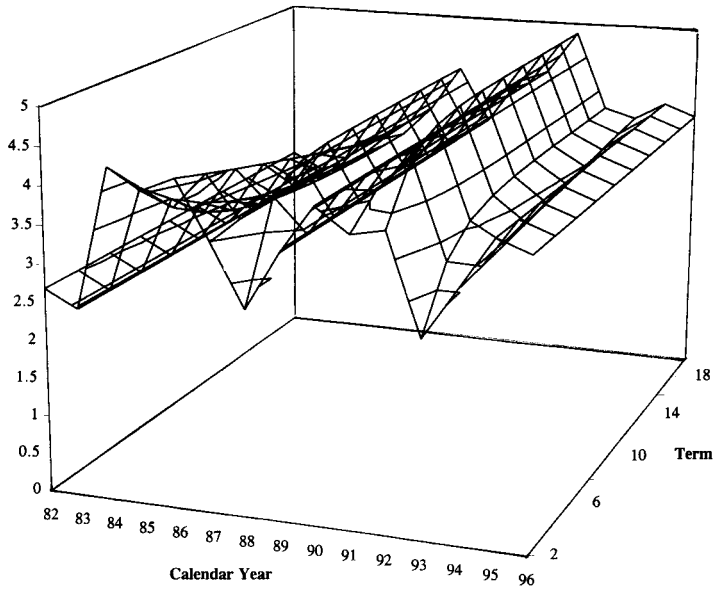

Figure 7.2.6. Real forward rates on index-linked gilts (1982 to 1996)

behaves very much like a 2-year conventional bond, as the maturity value is essentially known in each case.

7.2.21 The more subtle feature to explain is the failure of long or medium gilts to feature in the hedge, even when trying to replicate a long-dated index-linked bond. This feature is subtle, because most of the simple one-factor term structure models in common use would produce long gilt returns, which behave very similarly to geared short gilt returns. The fact that there is a difference at all requires some explanation.

7.2.22 We plainly need to move to a multi-factor framework in order to get a better grasp of the behaviour of our NAE bonds. Perhaps the most suitable general framework for understanding such issues is contained in Heath, Jarrow & Morton (1992) (HJM). These construct an integrated arbitrage-free framework around the forward rates. Forward rates on conventional gilts throughout the period concerned are shown in Figure 7.2.5.

7.2.23 It is clear from this diagram that the nominal yield curve has taken a variety of different shapes during the period studied. Furthermore, some of the effects produce significant curvature in the forward curve, even out as far as 20 years. By contrast, the real forward curve has been rather simpler. This is shown in Figure 7.2.6.

7.2.24 Although the short end has been rather volatile, and there has been

some change of shape, the longer dated end is pretty flat. We do not observe any curved volatility functions out in the long end, in contrast to the case of nominal forward curves. This data set looks to be adequately described, for our purposes, by a one-factor model. Therefore, the use of geared short-dated index-linked gilts to replicate longer-dated index-linked gilts is rather effective. As short-dated index-linked gilts behave rather like short-dated conventional gilts, we find that geared short-dated conventional gilts behave much more like long-dated index-linked gilts than long-dated conventional gilts.

7.2.25 It is instructive to go a little further in analysing the various volatility functions within this HJM framework. The factor applying to index-linked gilts can pretty readily be identified as real returns. This has a steeply decaying volatility function, which suggests that the effect of an initial shock in required real returns is soon extinguished by an underlying mean reversion.

7.2.26 This real return factor should also apply to conventional gilts. The remaining volatility function which creates the curvature at the longer end of the nominal forward curve must then relate to the other ingredient of nominal returns — inflation expectations. Now this volatility function will be small for short durations, reflecting the narrow funnel of doubt for future inflation out to a small number of years. The inflation expectations volatility function then gets larger, and goes out longer than the real return volatility function. A burst of inflation away from the long run mean takes years, even decades, to sink without trace.

7.2.27 The use of geared short gilts to replicate long index-linked gilts can, therefore, be thought of as a sort of high pass filter — we capture the high frequency real yield moves, but, by avoiding the longer-dated gilts, we avoid getting caught up with the market's estimates of future monetary inflation, which should not be relevant for assessing real liabilities anyway.

7.2.28 As noted in Section 6, even the Wilkie model produces results along these lines, although the lack of a proper term structure does limit the resolution provided by the model. This result appears to confirm the robustness of our approach. So our analysis does generate some quite interesting and useful results from the perspective of market pricing salary related liabilities. The main message is, however, that starting with price inflation index-linked gilts, and then making an assumption for real salary growth, which, in practical terms, must be quite close to GDP growth, has much to commend it. Unfortunately, our overall verdict on the supposed link between equities and salaries is much less lenient. It is our assertion that the viability of linking equity price movements and the associated risk premium with changes in the salary growth expectations embedded in NAE bonds (or, equivalently, market related final salary pension liabilities) in reality ranks somewhere alongside the extraction of grapes from wine.

7.3 *Pricing Caps and Collars on Price Indexation*

7.3.1 The second objection which we will address is that inflation-linked pensions, for example, participate only in annual increases (and not decreases) in the price index level, hence index-linked gilts (with no such floor) are not a

perfect hedge. Further complications are introduced by limited price indexation (LPI), which additionally imposes a cap on the annual rate of increase.

7.3.2 There is, therefore, some slippage between underlying securities available in the market and common pension liabilities. Does this mean that we can ignore market pricing techniques in favour of traditional actuarial 'funding' methods of valuation?

7.3.3 As an example of the standard actuarial approach, the basis prescribed by the Pensions Board for the Minimum Funding Requirement (GN27) adopts a fixed assumption for 'long-term' equity backed liabilities that full inflation increases will be 4% p.a., and LPI increases will be 0.5% p.a. below this. For gilt backed liabilities, reference is made to the difference between fixed-interest and index-linked gilt gross redemption yields ('market implied inflation'), but in a step wise manner, so a fixed 0.5% p.a. margin is added to the index-linked gilt yield if implied inflation is below 5.5% p.a. whilst the fixed-interest gilt yield less 5% p.a. is used otherwise.

7.3.4 This approach has a number of curious implications. For example:

— The 0.5% p.a. margin added to the index-linked gilt yield is exactly the same whenever implied inflation is below 5.5% p.a., whereas one might have expected the margin added to the index-linked gilt yield to increase as implied inflation increases. On the other hand, once implied inflation exceeds 5.5% p.a., there is no allowance at all for the possibility that inflation might fall below 5% p.a. again.
— The approach ignores the 0% floor on pension increases applying to most pensions in payment.
— There is no recognition of the dependence of the margin upon the *volatility* of implied inflation. One would expect the cap to be more valuable to the sponsor in more volatile conditions.
— The same 0.5% margin is applied independently of the *term* of the liabilities.

7.3.5 In fact, the final observation highlights a more general problem with just reading off an 'implied inflation' number by differencing a couple of specified fixed-interest and index-linked gross redemption yields and then assuming that this applies for all durations. Even if we expected the actual rate of inflation to remain constant through time, we would expect an upward tilt in forward rates to reflect the term premium associated with greater exposure to 'rate risk'. A cap on this rate would serve to reduce risk, and would again tend to vary with duration. By ignoring both of these features, we are, in effect, hoping that two wrongs make a right. Sadly, in this case they do not, except by chance. The same criticism applies to the level 'long-term' assumptions of the equity-backed part of the basis.

7.3.6 However, it turns out that abandoning market-based valuation because of the slippage between underlying index-linked and fixed-interest gilts and our pension liabilities may be a rather hasty response. With a cool head and a little perseverance we can call upon the full power of the term structure modelling

techniques more usually applied to bond derivative pricing to pin down our answer. As the reader might expect by now, these techniques eliminate the curious inconsistencies which creep into the funding valuation of the liabilities.

7.3.7 Several investment banks are now, in fact, actively prepared to make a price in derivatives linked to LPI. The mathematics of pricing such derivatives contingent on the future level of the RPI are discussed in detail by Bezooyen, Exley & Smith (1997). We do not intend to repeat the mathematics here, but we will highlight a few important results. We should start by noting that the 8-month lag in indexation is something of an inconvenience, but this can be worked around, as described by Evans (1997), and we will ignore it for our purposes here.

7.3.8 Subject to this caveat, the first important result is that, if we assume that the instantaneous inflation *rate* follows a Brownian motion, so that the very short-term variation in the index *level* is of insignificant order (as assumed, for example, by Dyson & Exley, 1995), then it follows immediately, by simple arbitrage between dead short index-linked and fixed-interest bonds, that the instantaneous inflation rate must be equal to the difference between the instantaneous nominal and real interest rates. This is a rather important result. It means that there is a basic duality between any process for the 'instantaneous' inflation rate and the 'implied inflation' taken from differencing the processes for our instantaneous nominal and real interest rates. That is, we have an eternal triangle between the three instantaneous rates; any one can be defined from the other two.

7.3.9 The neat trick arising from this duality is that we can then use standard term structure models, described in the previous section, for the development of nominal and real interest rates to price liabilities dependent upon the RPI as if they are just bond derivatives. In other words, we can equate the price of any retail price indexation rule with the expected value, under the forward neutral measure, of the benefit projected using our process for instantaneous 'implied inflation'. This produces a price which is, as required:

(a) dependent on initial forward nominal and real interest rates;
(b) dependent on the volatility of interest rates, as calibrated from traded interest rate options; and
(c) dependent on the term to payment.

7.3.10 Furthermore, the approach, as usual, generates a portfolio of index-linked and fixed-interest gilts which can be used to hedge the liability, thus enforcing the price by arbitrage (give or take a few model assumptions). Bezooyen, Exley & Smith (1997) show that the composition of this hedge portfolio is quite robust under alternative term structure models calibrated to the same initial conditions.

7.3.11 Things become a bit more complex if we assume that the price index level itself is subject to Brownian uncertainty. We can, for example, assume that there is another source of additional risk in the price index level and that expected inflation is greater (or indeed, but unlikely, less) than that implied by

the difference between instantaneous nominal and real interest rates (which it can be, once we prevent simple arbitrage by introducing this extra risk). However, as noted by Wilkie (1988), it turns out that, in the same way as the expected stock return falls out of the standard Black & Scholes formula, to be replaced by the risk-free rate, so our expected inflation parameter falls out in favour of the rate implied by the difference between the two instantaneous interest rates.

7.3.12 To see why this is so, we can consider the limiting case where the instantaneous nominal interest rate is assumed to be constant and the RPI *level* (rather than the *rate* itself) follows a Brownian motion with some drift μ. The slight problemette is that our underlying investment will not be this index, but an index-linked gilt offering a real interest rate r, so the total expected return on such a gilt is $\mu + r$. From this it can be seen that (as observed by Smith, 1996) our real interest rate is really just a convenience yield, paid for the convenience of being able to consume retail goods.

7.3.13 If we then skip through the standard (constant interest rate) Black & Scholes (1973) option pricing formula for stock options, replacing the process for the stock price with our index-linked gilt, we will find that, as with stock options, our drift of $\mu + r$ falls out, to be replaced by the risk-free rate i. Or put another way, the drift μ for our RPI level is replaced by $i - r$ (the 'market implied inflation' rate).

7.3.14 This is a simple, but rather profound result, confirming again more formally our assertions in Section 5.6. The result suggests that actuarial debate over what the average inflation rate should be is really rather futile. Whatever drift we slot into the Brownian motion for the (logarithm of the) RPI, it drops out of the pricing formula, and arbitrage enforces the use of 'implied inflation' taken from the difference between our nominal and real interest rates.

7.3.15 More generally, this duality between risk-neutral processes for inflation and interest rates have potentially led to a few crossed wires between the development of actuarial theory and market pricing techniques over the last decade. The U.K. actuarial profession has devoted a great deal of resources into constructing models of inflation and making 'long-term' assumptions for the U.K. inflation rate and, implicitly or otherwise, the right price for inflation risk. However, as with the price of our block of aluminium, debate within the profession as to what the price of inflation linkage *should* be is interesting, but the answers generated by this approach are as unenforceable as they are varied.

7.3.16 Rather ironically, the issue of inflation-linked bonds in the U.K. parallels this extensive work by the profession. Crucially, the emergence of a market in such bonds allows a market price of inflation linkage to be enforced by arbitrage and, as we describe above, wires up inflation models with the powerful mathematics of term structures.

7.3.17 We have considered two special cases for the pricing of LPI bonds — with special constraints on either the inflation rate or the term structure. Unsurprisingly, when we take account both of unexpected inflation moves and stochastic term structures simultaneously, the mathematics becomes rather more

complex. We will not go into the mathematics here, but, instead, we will look at some answers based on Bezooyen, Exley & Smith (1997).

7.3.18 As for the case of NAE bonds, it is simplest to start pricing zero coupon bonds and then construct streams of payments using several zero coupon bonds of differing maturities. One of the subtleties of pricing LPI bonds is the special role of the annual fixing date, on which the gain in the RPI is observed and applied to the LPI calculation. The pricing of LPI bonds is much simpler if the valuation date happens to be a fixing date. We investigate this case first.

7.3.19 The pricing of LPI bonds can be expressed in a number of ways. For ease of comparison, we express the pricing as in GN27. However, unlike GN27, our interest rates and implied inflation are derived from market zero coupon rates, rather than gross redemption yields. Given an implied (spot) rate of inflation implied from gilt prices, we then need to come up with an appropriate annual assumption for LPI. This will, of course, vary according to the term of the bond. A suggested general shape for these assumptions is shown in Figure 7.3.1.

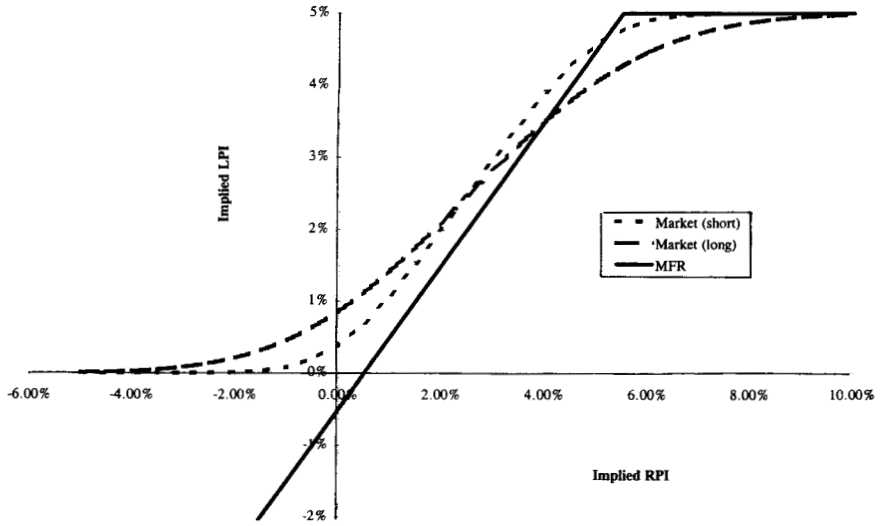

Figure 7.3.1. Comparison between LPI assumption obtained from derivative pricing techniques and prescribed MFR calculation method

7.3.20 If we take these prices as read for the moment, we can use them to construct a hedge, from the perspective of someone who has issued such a bond. However, annualised forward growth rates are not the easiest point to start from. Instead, we would like to work with prices, and possible instantaneous changes in price at time zero. Now, the discount factor to be applied to the LPI bond will

be the price v of the zero coupon conventional bond of the same term. The implied forward RPI will be a function of the price ratio of a conventional zero coupon bond v to an (RPI) indexed zero coupon bond w. Thus, the price of an LPI indexed bond can be written as:

$$\text{LPI bond price} = h(v,w)$$

for some suitable function h. It is also plain from the construction that h is first-order homogeneous, that is, for $\lambda > 0$ we have:

$$h(\lambda v, \lambda w) = \lambda\, h(v,w).$$

Now the construction of the hedge involves holding quantities of bonds such that, for small movements in prices, the hedge immunises against the bond price movements. Thus, we would want to invest in a quantity A of conventional zero coupon bonds and B of index-linked bonds, given by the partial derivatives:

$$A = \partial h/\partial v \quad B = \partial h/\partial w.$$

The cost of this hedge is $Av+Bw$. In the normal run of events the difference between this and the liability value h would have to be invested in cash. However, in this case it is a consequence of the homogeneity of h that:

$$h = Av + Bw$$

so, in this case, the hedge is particularly simple, containing only conventional and index-linked zero coupon bonds of the appropriate term. The hedge can be specified uniquely by the value of the index-linked bonds as a proportion of the whole; it gives rise to the results in Figure 7.3.2.

7.3.21 Having constructed a hedge that works along the space of the asset dimension, we now follow the putative MFR hedge through time to see why it does not work. The least subtle failure of the implied MFR hedge applies when forward inflation moves around the 1% to 4% range. Here, the MFR hedge is 100% index-linked bonds, but, unfortunately, this 'hedge' slips by exactly 50 basis points (bp) p.a. Therefore, consistent losses will appear to come through as the hedge progresses. To reconcile with a market basis, one ought to provide for these future valuation strains and add it to the initial provision. That is why our proposed results show a cost in excess of MFR for the central range.

7.3.22 There is also some subtle behaviour in the hedge around the MFR kink at 5.5%. Let us suppose, initially, that the forward rate of inflation is 5.0%. We are 100% invested in index-linked bonds. Now suppose the forward inflation rate jumps up to 6.0%. We now want to switch into 100% conventional bonds. Moreover, a simple compound interest calculation shows that we have more than enough in the kitty to make the switch. Some surplus emerges on the hedge.

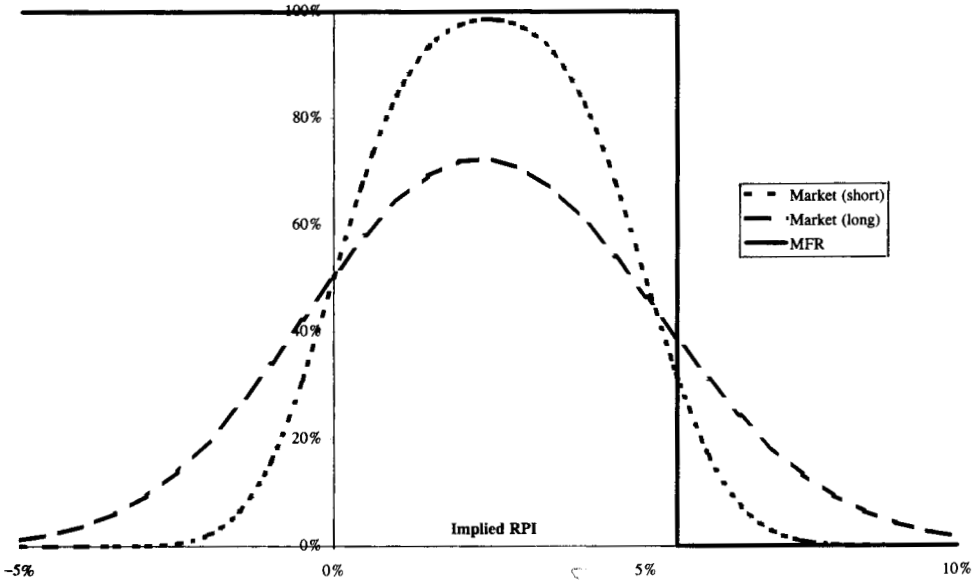

Figure 7.3.2. Comparison between allocation to index-linked gilts in LPI hedge obtained from derivative pricing techniques and prescribed MFR calculation method

7.3.23 Now suppose the forward inflation jumps back to 5% again. We might expect that there would be a loss which soaked up our previous profit, and we would be back where we started; but, in fact, the reverse is the case. A profit emerges here too. Every time the forward inflation rate crosses 5.5% we make a small profit on the hedge relative to the MFR liability. A market-based value would deduct the present value of these hedging profits from the initial cost estimate. That is why our pricing results give a cost lower than the MFR cost in this range.

7.3.24 The MFR basis appears even more curious for inflation around 0.5%, where a strict interpretation of GN27 would seem to allow us to value on the basis of negative nominal increases, in spite of the fact that scheme rules would not normally permit the effect of deflation to be passed on to pensioners. However, applying a lower limit of zero on the assumed nominal growth for MFR purposes would not entirely fix this problem, because whenever forward inflation crosses 0.5%, the MFR hedge slips a bit and more cash needs to be injected to finance the asset switch. Again, on a market basis, the present value of these hedge slippages should be provided for in advance, increasing the cost above that provided by the MFR.

7.3.25 Although the mathematics behind the pricing of LPI bonds is complex,

following the MFR hedge through time has enabled us to explain the major qualitative features. One loose end now remains. We have explored LPI bond values as at the fixing date. We now consider the situation between fixing dates. Things are now much more complex. Some additional information will have arisen during the year as to the likely position of the RPI relative to the cap and floor on the next fixing date. This short-term forecast will have a significant effect on the value of the LPI bond, but the information will be contained in the short end of the yield curve. Thus, the simplification of a hedge, which only contains zero coupon bonds of the same term as the LPI bond, breaks down between fixing dates. The hedge then becomes much more complex intra-year, but, needless to say, all the messy positions in short-term bonds vanish again as the next fixing date approaches.

7.3.26 The pricing of LPI bonds illustrates the importance of a dynamic hedging arguments. These are not only required in the mysterious world of derivatives, but also in the apparently more mundane world of limited price indexation. Once again, the complexity of the mathematics introduced by the new techniques seems a small price to pay for the removal of arbitrary guesswork and the effectiveness in risk management that hedging affords.

7.4 *Complexities of Combination*

7.4.1 In the preceding sections, we have established how both NAE and LPI bonds can be priced within a market framework. The benefits provided by pension schemes do not, however, correspond simply to a mix between these two. Rather, the NAE indexation applies prior to vesting and LPI indexation subsequently.

7.4.2 One apparently logical way forward would be to start from the price of an NAE bond paying out on retirement, and also the forward price of an LPI annuity starting at 1 p.a. on retirement. Multiplying these two together should give an indication of today's cost of an annuity linked to NAE prior to vesting and LPI subsequently.

7.4.3 To consider the efficacy of this approach, we construct the hedge implied by it. We purchase the NAE linked bond, in a quantity determined by the forward annuity price, and annuities in a quantity determined by the forward value of NAE. Now let us follow the fortunes of this hedge. Suppose first that NAE turns out at exactly its forward value. Then the forward purchase of annuities has insulated us against changes in LPI annuity prices, and the hedge performs perfectly. Similarly, if annuities turn out to be exactly at their forward price, the NAE bond delivers the appropriate resources to exercise the forward and to purchase (or sell back) any additional annuities in the market. The hedge works well if one source of uncertainty dominates.

7.4.4 The difficulties arise if, for example, NAE ends up above the forward, and annuity prices also end up above the forward. Then, not all of the required annuity purchases are covered by the annuity forward contract, and, unfortunately, purchase in the open market is more expensive than we had

thought. Similarly, if NAE ends up below its forward value and annuity rates have also fallen, then the annuity forward overhedges the purchases required, and even though we obtain some satisfaction from selling back the excess in the open market, we do so at a loss.

7.4.5 Fortunately, the more likely event is that NAE and annuity prices move in opposite directions. This is because, if inflation rises this is likely to cause a rise in NAE and also in interest rates. Conversely, lower inflation will restrain NAE growth, but lead, probably, to falling interest rates. In such situations the hedge outperforms. This correlation effect means that the hedge is overly generous, and probably overstates the cost of LPI-linked annuities.

7.4.6 There are also some subtle complexities associated with the combination of withdrawal decrements and salary growth assumptions. It is our contention that these cannot be regarded as independent. We will revisit this issue in Section 9.

8. Consequences for Funding and Investment Strategies

8.1 *Introduction*

8.1.1 In the paper so far, we have analysed the cost of pensions from a shareholder value perspective. This has focused on a financial analysis of pension cash flows. As the cash flows paid by the sponsor are precisely those received by the member, the economic cost of the pension to the sponsor is precisely the economic value to the member.

8.1.2 In particular, we have argued that the economic cost of a pension promise depends principally on the promised cash flows, not on the pace at which they are funded, nor on the assets in which the fund invests. We have rejected traditional notions that, for example, investment in equities simultaneously reduces economic cost to the sponsor and enhances the value of benefits to the members.

8.1.3 All of these issues were considered within a somewhat idealised world of no transaction costs. We have obtained the first order results, and these are illuminating. We know that, for example, optimal investment policies cannot be expected to emerge from plotting efficient frontiers of risk and return, because, if carried out correctly, all the risk premia will cancel and all portfolios will look equally suitable. Preference for one asset mix over another will only emerge in this context if there is an error in the calculation or misconception in choice of objective function.

8.1.4 However, ignoring transaction costs and other second order effects does smack of unrealism. In this section we consider the most significant of these cost items. Although the frictional costs may be relatively small in the overall size of the scheme, their importance far exceeds their magnitude. The reason for this is that, having proved the irrelevance of first order effects, the optimality of one funding or investment policy over another hinges entirely on the second order terms.

8.2 *The Price of Credit Risk — Insights from Annuity Markets*

8.2.1 As noted earlier, there is a risk that a pension will not be paid as promised. While it is widely accepted that credit risk reduces the value of benefit to members, there is less clarity on why it reduces cost to sponsors. One helpful parallel exists in the annuity market. Annuity providers typically invest in A or AA rated corporate bonds. These bonds provide a yield of, say, 100 basis points in excess of a similar government gilt. Historically, the actual cost of defaults has been of the order of 30 bp. The annuity writer wishes to withhold 20 bp as profits for themselves. This results in the issue of annuities at a yield (after allowing for expenses and mortality) of gilts + 50 bp, roughly equivalent to AA+ rated bonds. This funding argument for pricing may appear to lead to profitable business over a number of years. In addition, we would observe that it gives rise to the same annuity basis for all annuity providers.

8.2.2 A shareholder value analysis gives a rather different picture. If the insurer is AAA rated, it is effectively raising funds at AA+ rates in order to play the credit spread. If it believes that it can make money from credit speculation, then it would be cheaper to raise funds in the wholesale market in order to do so, because then credit would be obtained for the AAA rating. Shareholder value is destroyed by the annuity transaction.

8.2.3 If, on the other hand, the insurer has an A rating, then it has created an A rated liability, but received a AA+ premium for doing so. This creates shareholder value; such transactions should be maximised to generate cash and pay off existing capital market debt, thus taking advantage of the arbitrage between wholesale and retail debt markets.

8.2.4 This illustrates the point that, even taking account of credit risk, it is the strength of the issuer which determines the economic value of a promise, not the assets in which the issuer tries to invest, except insofar as these assets affect the creditworthiness of the issuer.

8.2.5 Crucially, we have used shareholder value concepts to reconcile the credit cost, as seen by beneficiaries, to value added within an issuer. To the extent that the value of a benefit is reduced by credit considerations, economic cost to the issuer is also saved. It is not unreasonable to suppose that these considerations are taken into account, at least subjectively, within the general process of wage negotiations. It is not, therefore, necessarily in the interest of sponsors to reduce the creditworthiness of their pension promise if that simply results in higher wage demands.

8.3 *Credit Risk of a Pension Promise*

8.3.1 In the context of pensions credit risk, the issues become more complex, because two events have to go wrong at once. Firstly, the sponsor must become insolvent. Secondly, at that point in time the pension scheme must have inadequate assets on a discontinuance basis. Even if reference, for example, to corporate bond yields could give us a market-based measure of credit cost, the interaction with the quantum of loss is subtle and requires further assumptions to

be made. The extent to which the value is reduced will depend on, among other things, the financial strength of the sponsor and the level to which the scheme is funded.

8.3.2 To take a simple example, let us suppose that a fund invests, quite improperly, wholly in the debt of the issuer. The situation here is, in effect, an unfunded scheme, but the formulation as a debt is helpful. The yield on this debt will be higher than government bond yields, to reflect the credit risk. This yield enhancement will enable to sponsor to reduce the cost of the pensions promise below what would otherwise have been the case. However, should the sponsor become insolvent, the value of the pension scheme assets fall dramatically, creating a large deficit which the sponsor has insufficient resources to make good. This loss then falls on the members of the scheme.

8.3.3 Let us suppose, instead, that the scheme invests in other corporate bonds, of broadly similar credit quality (and hence similar yield) to the sponsor. In the event where all bonds go into default, we are back where we were before. However, there are now two more alternatives:

— If the sponsor goes bust, but the bonds do not go into default, then there may be plenty of assets in the pension fund, and members get paid as promised. This leaves members better off than they were under the previous arrangement.
— If, on the other hand, the bonds default, but the sponsor remains solvent, then the sponsor needs to make up the shortfall in the pension scheme. Thus the fundamental point that the sponsor stands behind the scheme kicks in — the yields on the corporate bonds actually held give a false steer for the cost of the pension scheme, they fail to deliver the goods in some important scenarios, leaving the shareholder to make good the deficit on his own.

These results suggest that moving away from self-investment improves credit quality, and thus simultaneously increases both member value and shareholder cost. The extent will be smaller if the assets held are highly correlated with the credit risk of the sponsor.

8.3.4 This, therefore, enables us to identify the first area in which the assets held within a scheme *do* affect the economic cost of a pension. For example, the point of the economic cycle at which insolvencies are maximised may also be one where equities are at a cyclical low. This can occur for several reasons; for example, the trading position of the company itself may be highly geared to activity in the economy as a whole, or, even when this is not the case, fraud is statistically more prevalent in recessions. If sponsors invest in equities or other cyclically responsive assets, this reduces pensions cost and increases credit risk.

8.4 *Corporate Insolvency Risk created by Pension Shortfall*

8.4.1 So far we have examined credit risk from the perspective of looking at the likely assets in the fund when the sponsor goes bust. However, there is an additional complication here, which has become much more significant as the MFR begins to take effect. The complication is that contributions under the MFR

may actually trigger the bankruptcy of the sponsor. We have already highlighted, in ¶2.4, that bankruptcy can be costly to both management and shareholders. We should add here also that it is also likely to be expensive to employee members, who will face losing their employment and may be unlikely to receive much by the way of compensation. It is, therefore, likely to be in the interests of all parties, shareholders, management and, at least, employee members of the scheme to avoid circumstances where the MFR cash injection triggers the bankruptcy of an otherwise (just) viable business.

8.4.2 Exley & Mehta (1996) suggest that, in this framework, shareholder and management interests are best served by trying to ensure that the scenarios, when the MFR is breached, form a subset of the scenarios when the core business activity is certain to be bankrupt anyway. This fatalistic approach does not, however, offer much comfort for members.

8.5 *Implications for Valuation*

8.5.1 As can be seen from the above sections, the evaluation of credit risk is not a trivial objective. Undoubtedly, the existence of credit risk reduces the economic cost of the pension scheme below where it would otherwise have been. In a valuation, this may be reflected in a higher discount rate, which would depend on funding level, sponsor creditworthiness, matching policy and various other correlation effects. The one ingredient which does not seem to be remotely relevant is the risk premium on equities, except to the extent that a default premium is embedded somewhere. This is somewhat ironic given that many actuaries regard this risk premium as a key determinant of pension cost.

8.5.2 Given the complexity of evaluating credit risk properly, it may be the case that the beneficiaries do not, in fact, take account of credit risk in a strictly logical fashion. Now, from the shareholder's perspective, enhancing credit is not simply a matter of acting decently and properly. Credit enhancement imposes an economic cost on shareholders, and so may not be seen, universally, as a good thing. Ideally shareholders would like some form of apparent credit enhancement which would fool the members, but, in fact, is illusory and has a low economic cost. A cynic might suggest that this is where actuarial valuations with their 'realistic' funding bases taking advance credit for the equity risk premium come in.

8.5.3 As a footnote to this analysis, and following on from the points we made in ¶5.7.5, it is arguable that the use of AA rated bonds (instead of gilts) to discount, as suggested in IASC (1996), takes some broad brush account of the credit risk associated with a particular scheme. Again, it does not imply in any way that pension funds actually invest in such bonds. However, if we pursue our analysis above, it is clear that the true credit spread above gilts ought really to take into account funding level, strength of covenant, maturity, investment policy and other features.

8.6 *Leakage of Investment Performance*

8.6.1 We have, so far, taken the pension promise as wholly defined by the

member's employment history, except for credit risk. There are, however, some circumstances in which the benefit received could be more than promised. These would occur if the scheme was in surplus and, either the surplus was used for discretionary increases, or the sponsor went bankrupt and could not recover the surplus. This effect would suggest that scheme surpluses do not always flow through in full to shareholders. Instead, some may leak out as better-than-promised benefits. This eventuality is more likely to occur if the assets are more volatile, for example if there is a higher equity mix.

8.6.2 We can now see a conflict between two second order effects on investment. If the equity exposure of the scheme is increased, this will tend to increase the credit risk, but will also increase the likelihood of future leakage. The former would benefit shareholders, the latter members. Unfortunately, these aspects do not, in general, cancel out. If the sponsor is financially strong and the covenant good, then the credit risk aspect is reduced and the benefit leakage argument will tend to dominate.

8.6.3 The pricing of this member participation in surplus clearly depends on being able to specify some rule for the circumstances which trigger it and the amounts involved. However, if we can get over this hurdle, we should be able to apply our market-based pricing techniques, and the benefit will be akin to a call option on the assets of the scheme. As noted in Section 2, where there is this element of discretion, based on investment returns, part of the liabilities can be directly related to the assets and assume the characteristics of a defined contribution scheme. In this case there may be a role for some element of equities in the matching portfolio.

8.6.4 This latter result appears to be confirmed immediately if we apply standard option hedging techniques. Furthermore, if this surplus participation is reflected in discretionary pension increases, then financial theory also supports the actuarial principle of making a stronger assumption for guaranteed increases than for 'targeted' discretionary pension increases. If the target is withdrawn in adverse scenarios, it is correct to adopt an increase assumption which is below true expectation for mark-to-market pricing purposes.

8.6.5 However, if we wish to compare the market value of these discretionary increases against the potential loss on bankruptcy, there are further complications because of the order of priority in a wind-up situation. In the event of discretionary increases being awarded, the most likely beneficiaries are pensioners. On the other hand, active members bear the brunt of the credit risk. Active members are, therefore, likely to favour a defensive, low equity position while deferreds and pensioners would gain from an increase in equity mix — which, from the members' perspective, seems to be completely the other way around from currently fashionable wisdom on matching.

8.7 *Implications Outside the Pension Scheme*

8.7.1 Thus far, even our second order arguments have influenced cash flows symmetrically — if the pension goes into default, then the sponsor does not pay

and the pensioner does not get. If the benefit is improved, the sponsor pays and the member receives. Provided these contingencies are factored into the wage bargaining process, there is not necessarily any gain to shareholders in reducing economic pension cost, or to members in increasing it. Arguably, this even applies indirectly to pensioner benefits, because, although they are no longer actively bargaining for wages, current members are likely to interpret the treatment of current pensioners as an indicator of their likely treatment when they come to retire.

8.7.2 Although second order effects have forced us to soften our stance on whether the investment held affects the value of benefits, we have not yet got much of a handle on any optimal funding or investment policy. In order to do this, we must seek to drive a wedge between members and sponsor, to find cash flows which affect one and not the other. One such example was the common interest in avoiding circumstances where pension shortfall itself triggers bankruptcy, as mentioned above. Several more follow below.

8.7.3 All of the issues below involve some cash flow to third parties, be it administrators, bankers or the Inland Revenue. As noted in Section 2, given that the foregoing analysis of credit risk and benefit leakage form, broadly, a zero sum game, it is in the interests of both shareholders and members to minimise this leakage to third parties. Having done so, any consequences in terms of the factors considered previously can be compensated by rearranging other items in the employees remuneration.

8.8 *Effects of Raising and Distributing Capital*

8.8.1 The raising and distribution of capital within a company both incur some costs — raising of capital via investment bank fees and distribution via the timing of advance corporation tax. This means that companies are reluctant to pay a large dividend, only to recoup it via a rights issue a few years later, which would favour holding some form of cushion against a future temporary downturn. On the other hand, investable securities held on the balance sheet would tend to attract tax, and so excessive capital on that balance sheet also destroys shareholder value. Some modern financial instruments such as letters of credit and standby loans provide more tax efficient capital resources.

8.8.2 However, it would be rather handy to have a tax-exempt fund into which profits could be squirrelled in times of positive cash flow and which could be raided to support new projects when cash flow was tight. This would avoid both the tax issues and other transaction costs associated with frequent recourse to the wholesale markets. The pension fund seems an ideal vehicle for this purpose, and the reduction of transaction costs can then be split for the joint benefit of shareholders and members.

8.8.3 This starts to give us a hint of an optimal funding policy. Transaction costs can be reduced by stuffing up the pension scheme when cash is plentiful and running it down when cash is tight. Arguably this would also adversely affect the credit risk, but, as we mentioned previously, the credit risk aspect is

in essence a zero sum game which can be compensated by other aspects of the remuneration package. The only asymmetric feature is transaction costs, whose reduction benefits both shareholders and scheme members.

8.8.4 However, this optimal policy seems as odds with the way typical actuarial funding valuations are presented to clients. The discounted income equity valuation revises budgeted contributions upwards when dividends from the corporate sector generally are growing slowly, and downwards when these are growing rapidly. Rather inconveniently, for this common valuation method, these same dividends are regarded by corporate financial theorists as a measure of spare cash being generated by businesses, for which the management cannot presently find more productive internal investment opportunities. Thus, if company management sought, quite sensibly, to minimise transaction costs, it may not be desirable to apply an actuarial algorithm which reduces the pace of funding when cash is generally plentiful and then accelerates the pace again when cash is generally scarce, unless the company is particularly contra-cyclic.

8.8.5 In addition, a consideration of transaction costs leads to the establishment of an optimal band of capital, as described, for example by Smith (1996). Economic circumstances and perverse valuation bases may conspire to force the sponsor to inject more spare capital into the pension fund than would ideally be held in the firm as a whole. This then rebounds out of the pension fund and floods the business with an unwanted cash pile. An example of such a situation was highlighted in Section 3.6.

8.8.6 However, perversely, such considerations could lead us to understand the only advantage of the discounted income method — its great flexibility. Many actuaries, in practice, are not blind to the synergies available to companies that wish to take into account the cash needs of the business when planning their pension fund contributions. As a result, although actuarial funding methods may be designed, for example, to produce a stable contribution rate as a proportion of salary, the scheme actuary may well reduce transaction costs by being more accommodating, and the greater degree of flexibility in the funding method, the easier it would be to achieve this. We certainly would not propose that an objective market-based approach to pricing should result in a schedule of contributions which is more rigid than current applications of existing methods. However, we do not see why an actuary who, quite reasonably, has taken account of the short-term cash flow of the sponsor when reaching a recommendation, should feel obliged to rationalise the process in terms of a change in his view of long-term dividend growth.

8.9 *Asymmetries in Taxation*

8.9.1 Against a policy of matching, one motivation for preferring to hold particular assets within a pension fund, apart from the possibility of 'second order' factors, described above, would be the existence of a significant taxation gain to shareholders. This comparison needs to take into account, not only the relative merits of different assets within the fund, but also the comparison with

different means of investing. We follow through the three methods of investing, discussed in Section 2.3, but this time allowing for the tax impacts.

8.9.2 Let us consider, first of all, an investor who is cash flow positive. He wishes to invest regularly. The simplest way to do this would be to purchase investments directly. An alternative would be to accept a lower dividend, leaving the funds with an existing company. The company could either invest the money in securities on its own account, or it could make a large contribution to the pension scheme. In either case, we assume that the investment is liquidated one year later (in the case of the pension scheme, by way of a lower contribution) and passed on as an enlarged dividend.

8.9.3 To clarify the tax issues, it helps to notice some initial simplifications:

— The shareholder's personal taxation basis is only relevant in assessing the direct investment. In the other cases, the investment return is received as a reduced dividend followed by an enlarged dividend. The return on the transaction is the extent to which the enlargement exceeds the reduction. Plainly, this gives the same answer whatever the rate of dividend taxation (or credit), provided that the rate does not change between investment and realisation.

— The rate of corporation tax is not relevant for assessing the investment in the pension scheme, as tax relief is obtained on actual contributions made. Again, providing the rate of relief is the same at the date of both contributions, the actual rate does not matter.

8.9.4 Our most favourable case, then, should be the return achieved by investing in the pension scheme — because this results in a gross return to shareholders. We use this as a benchmark against which we measure other alternatives. Any of the other routes may trigger some tax, and therefore would be less advantageous. Of course, the Inland Revenue has already spotted this, and the surplus limits were largely devised to make sure some investment still takes place in a taxed environment.

8.9.5 In view of the clear tax advantages to shareholders, it is perhaps surprising that so few schemes, in fact, fund up to the revenue limits.

8.10 *Taxation of Cash Deposits*

8.10.1 The simplest tax effects to compute relate to one-year tax deposits. Here the rate of interest is known in advance, so the amount of tax payable at the year end is known. By discounting tax proceeds at the gross rate, we can, therefore, decompose the initial investment into the proportion that benefits the investor and the proportion taken by the tax authorities. Based on an interest rate of 6.5%, we have the following table:

Investment in cash deposits	Benefits to investor	Tax
	%	%
Non tax payer or inside pension scheme	100.00	0.00
Basic rate tax payer	98.78	1.22
On company balance sheet	97.99	2.01
Higher rate tax payer	97.56	2.44

In each case, and in our consideration of equities, below, this is a marginal rate, assuming full use has already been made of tax efficient vehicles such as TESSAs.

8.10.2 Ideally, everyone would prefer investments to be in the pension scheme, by this calculation. However, capacity here is limited by the surplus rules. By contrast, capacity for the individual or the company balance sheet is effectively unlimited (except to the extent that the individual moves between tax bands). Under current rates, it would seem that basic rate tax payers would prefer to invest cash on their own account, while higher rate tax payers would rather assets were held on the company balance sheet.

8.11 *Taxation of Equity Investments*

8.11.1 Investment in equities is rather more complex, not least because we now need to consider risk as well as return. As noted by Mehta (1992), taxation results in a sharing of both risk and return with the tax man; however, we will show how the arbitrage arguments, with which the reader should now be quite familiar, can pull us through this problem also.

8.11.2 For simplicity, we will assume a known prospective dividend yield of 3.5%, so the only element of uncertainty relates to capital gains. The total (gross) return of investing in equities can, therefore, be expressed as a fixed amount, 3.5%, plus a multiple of 100% of the capital gain factor.

8.11.3 The net return can also be expressed in this form — the multiple of the gain will depend on the rate of capital gains tax, while the fixed amount relates to the dividend and also the purchase price relative to which the gain is measured. The capital gains tax rules are now rather complicated — indexation relief is available to reduce chargeable gains, but not to increase losses. As a rough compromise, we suppose that the capital gains tax is measured relative to 102% of the purchase price.

8.11.4 Thus, for example, a basic rate taxpayer may be paying tax 20% on (gross) dividends, and 23% on realised capital gains. His net return can then be expressed as a constant of 26.26% = 80% x 3.5% + 23% x 102% plus a multiple, 77%, of the capital gain factor.

8.11.5 To value this outcome from a gross perspective, we construct a mixture of equities and cash deposits which would have the same outcome, whatever the capital growth. We can start by investing 77% in equities, but this would give a fixed cash flow of only 77% x 3.5% = 2.70%. The gap, of 26.26% – 2.70% = 23.56% has to be made up from cash deposits, with an initial cost of 23.56/1.065 = 22.13%. Adding this to the 77% equity investment, the total cost of the hedge for the net amount is then 99.13%. The remaining 0.87% is the value extracted by the Revenue.

8.11.6 Perhaps the most interesting aspect of this argument, from an actuarial perspective, is that it did not involve guessing the expected return on equities. Instead, we were able to construct a hedge with identical risk characteristics, which works wherever equities end up.

8.11.7 We can perform similar constructions for various other tax perspectives, as for the cash investment, and this gives the following table:

Investment in equities	Benefits to investor	Tax
	%	%
Non tax payer or inside pension scheme	100.00	0.00
Basic rate tax payer	99.13	0.87
On company balance sheet	99.03	0.97
Higher rate tax payer	98.31	1.69

8.11.8 Again there is a mild preference for basic rate tax payers to invest privately, and higher rate tax payers to invest within companies. However, the much more striking effect is that equities are universally less heavily taxed than cash investments.

8.11.9 Investment in index-linked gilts turns out to be very similar to equities, in that indexation relief is available against capital gains tax.

8.12 *Comparison of Bonds versus Equity*

8.12.1 Now, suppose that a shareholder wishes to hold a mixed portfolio of equities and bonds. Even though the total assets of the pension scheme are restricted by surplus rules, there is some latitude as to what assets the investor holds on his own account and what he holds within the scheme. As privately held cash instruments are more heavily taxed than privately held equities, it makes sense from a tax perspective to hold equities in private portfolios and bonds within pension schemes. Pension schemes, therefore, maximise shareholder value by investing 100% in bonds.

8.12.2 This practice would be very unusual in the U.K., but, interestingly, is much more widespread for schemes in the Netherlands (where the final salary liability structure is very similar to the U.K.). If anything, the tax incentives in the Netherlands are even stronger. However , many Dutch schemes appear to be in the process of adopting the equity-based approach to funding, encouraged by the use of ALM developed in the U.K. These issues are discussed further by Bezooyen & Mehta (1997).

8.12.3 There are number of loose ends here, regarding the details of the tax assumptions. Some of these, for example the ability to defer tax on equity capital gains until realisation, serve to reinforce our conclusions. Moreover, our general conclusion is robust to varying the assumptions we have made. Those assets most beloved of ALM experts, namely equities and index-linked gilts, should sit outside the scheme, while the scheme itself should concentrate on getting the maximal tax relief from bond investments.

8.12.4 So far we have also considered only the position of investors with positive cash flow, and money to invest. The perspective of an investor who holds equities for the income may appear to be a little different. In particular, the deferral of dividends by maximising pension surplus may not be attractive if

dividend income is required. However, arguably, these shareholders also benefit from tax efficient pension scheme investment, as the enhanced shareholder value would be reflected in the greater capital value of the shares, which can then be realised in tranches to provide a higher income.

8.13 *Administrative Cost*

8.13.1 As noted in ¶2.1.6, there may be some expense efficiency advantages to corporate pension provision. The availability of optional rider benefits, such as FSAVCs, does add to the administrative complexity of defined benefit schemes, and arguably makes them less attractive, from an expense perspective relative to defined contribution plans, than would otherwise be the case.

8.13.2 By contrast, a group personal pension would seem to entail far greater administrative effort, associated with the pension provider having to reconcile his individual pots of money. The provision of individual choice between investments may also complicate matters, both in terms of having to provide advice, but also in restricting the fund manager's flexibility over timing. This may result in a higher proportion of trades taking place the 'wrong' side of the bid-offer spread.

8.13.3 Personal pensions might seem, at first sight, to involve no additional expenses over those of group personal pensions. However, group personal pensions do seem to gain, to a small degree, from economies of scale, particularly for larger employers. The main differences arise, not in administrative inefficiencies, but in the sales cost, including the provision of legal documentation and the payment of commission.

8.14 *Utility Gaps*

8.14.1 By now, the reader will not be surprised to learn that we reject the notion that defined contribution plans 'cost more' because they are less likely to invest in equities. However, there are some rather more subtle points which do affect asset mix preferences, which are discussed below.

8.14.2 We immediately need to recognise the complexities involved in ascribing utility functions to pension scheme members. As an example of this, consider evaluating alternative defined contribution strategies by reference to utility functions. We restrict ourselves to two simple alternatives. A member is currently aged 45 and expects to retire at 65. He has been told of the merits of matching annuity rates to avoid exposure to interest rates, but is also aware of the potential gains to be had by investing in equities. He has decided to compromise, matching the annuity basis for ten years, and investing in equities for the other ten. He therefore chooses between:

— investing in a long gilts fund for the first ten years, then in equities until retirement; or
— investing in equities for the first ten years, then in medium and finally short gilts in the run up to retirement.

8.14.3 Most utility-based approaches would favour the first of these alternatives. Both provide an equally good match to annuity rates, but long gilts provide a better term premium than mediums and shorts. This conclusion would, of course, contradict current practice of life style switching.

8.14.4 A closer examination reveals the flaw in the utility approach. If assets underperform, the likely consequence is not only a reduced pension, but a need to inject additional contributions in the meantime. Plainly, the shorter the time scale over which a given market loss must be made up, the greater the inconvenience and impact on consumption. This argument would favour the current practice of matching more closely as retirement looms. Incidentally, the idea of consumption-based utility has been widely studied by financial economists (see, for example, Duffie, 1992). It would behove actuaries designing DC schemes to study some of this literature in greater depth.

8.14.5 An additional feature, which would influence investment in less volatile assets towards retirement, is the consideration of early retirement, and the management of the risk that annuities may be purchased at a date other than originally planned.

8.14.6 Other aspects of members finances may complicate their preference for pensions. For example, many individuals find themselves simultaneously saving for pensions and paying off a mortgage. Given that dealing spreads apply to both sides of these deals, there would seem to be a gain to be had from using pension fund contributions to pay off the mortgage first, and then using the cash which previously would have gone on mortgage interest to save for a pension. Unfortunately, revenue limits on DC pension contributions militate against such a reduction in transaction costs. It would be better for members if any unused portion of the revenue limit could be carried through for use in later years.

8.14.7 As noted in Section 2, pursuing this issue further, member preference for equity exposure will be influenced by the other investments held. In particular, a member paying off a mortgage using a personal equity plan already has a substantially geared exposure to the equity market, and may not welcome additional exposure to the same market in his pension provision.

8.14.8 Having taken the complexities of utility on board, we now tackle the ways in which utility preferences of members and sponsor may differ. The key to this understanding is the realisation that portfolio optimisation involves adjusting asset classes until marginal utility is equal to market value (or at least, lies within the bid-offer spread). The mathematics behind this statement is contained in Smith (1996).

8.14.9 The trouble with the marginal utility approach is that, for many members, the pension is a large lump of their savings which they cannot switch in small bits. The valuation of a pension saving would, therefore, need to move away from calculating the local gradient to consider, instead, the higher order terms.

8.14.10 We would note that, for certain key risks, such as interest rates and equity exposure, the member can change the exposure in small bits by moving the rest of his portfolio. However this may be costly; in particular, it is much more

difficult for individuals to *remove* equity exposure via their personal portfolio than it is to *add* it. This would favour a low equity exposure within the pension benefits, as is the case, for example, with pure defined benefit arrangements.

8.14.11 The higher order terms in the utility function really come to play for risks that are not hedgeable in the market. The concavity of typical utility functions would tend to penalise variability in non-hedgeable risks, when the quantum of the risk cannot be varied. On the other hand, for a shareholder, much of this risk may be laid off via diversification, and, although a pension entitlement cannot be traded in bits, shares can.

8.14.12 This leads to a *utility gap* between sponsor and member, whereby the disutility of the member to non-hedgeable variability exceeds the cost, on a marginal basis, as seen by shareholders. This would seem, in particular, to apply to credit risk, where members may attach a greater disutility to the risk of default than the market price of making benefits more secure. This argument goes some way to explaining why we do have funded pension schemes at all.

8.14.13 A further area which does not fit easily within our hedging arguments is the exercise of discretion, either by the sponsor or the trustees. In many cases, from the members' perspective, such discretion (for example, over dependants' benefits) may appear to be something of a lottery. As the member cannot diversify this discretion to the same extent as shareholders, he may well place lower value on such discretionary benefits than the economic cost to shareholders of providing them. This would suggest that, in general, the provision for significant discretion (above the minimum required to obtain tax-exempt status) is not cost effective.

8.15 *Conclusions*

8.15.1 The above analysis has picked up a number of themes introduced in Section 2 and analysed them more closely. Although this has added further insight, it only serves to reinforce the subtlety of the issues involved in finding optimal solutions.

8.15.2 However, we will carry away a few important features of defined benefit schemes which seem worth trying to preserve, when we look to the defined contribution alternative:

— The flexibility over timing contributions is valuable in terms of reducing the costs of raising and distributing capital.
— There are tax advantages to shareholders from pre-funding up to the limits imposed by the Inland Revenue.
— There are also tax advantages associated with shareholders being able to invest in bonds via the pension fund vehicle.
— The administrative costs of defined benefit arrangements should be lower than those of defined contribution arrangements.
— Since it is easier for members to add equity exposure (rather than remove it) from their personal portfolio, the provision of defined benefits is supported.
— There is a possibility that, because of non-diversifiable risk, members, in fact,

might also place a value on security which is slightly higher than the credit spread seen by shareholders, and also a lower value on discretionary practices, supporting provision of a matched and well funded (well) defined benefit arrangement.

8.15.3 Many of these advantages to the shareholder and member are lost by defined contribution arrangements. However, the recent trend in the U.K. has been towards greater provision of defined contribution schemes. The possible reasons for this trend and new ways of addressing it, to recapture the advantages of defined benefit arrangements, are discussed in the following section.

9. INTEGRATED MODELS OF EMPLOYMENT COST

9.1 *Introduction*

A dominant theme of this paper so far has been the benefits of integrating actuarial management of a pension scheme into the financial risk management of the firm as a whole. However, the pension scheme is not only a financial instrument; it is also part of the means by which human resources are remunerated. In this last section of the paper, we consider how pension scheme dynamics interact with the labour market.

9.2 *Pension Schemes in Relation to the Core Business*

From the pensions actuarial perspective, one of the benefits from looking through to the underlying employment policy is a greater insight into withdrawal rates. The actuarial practice of treating withdrawals as a statistical decrement, similar to mortality, for example, may give the impression that leaving employment is a matter of chance. However, in contrast to mortality, there is a great deal employers can do to influence employee retention. For example, if an employer is generous with salaries in contrast to his peers, we might expect that employer to have a lower than average withdrawal rate. Employees may change jobs for a number of reasons, some of which are not directly financial, for example health or family reasons. However, nobody voluntarily moves jobs solely for the purpose of receiving a pay cut. By contrast, plenty of employees move in order to go to a higher paid job elsewhere. This example suggests that there may be some benefit to be gained in probing in greater depth the subtle relationships between employment cost and staff turnover.

9.3 *Means of Trading Goods*

9.3.1 In order to clarify the concepts, we borrow some terminology from commodity markets. A quantity is said to be traded spot if the quantity is delivered and cash received instantly the deal has been done. A forward trade is one where the price is fixed now, but the cash and goods are exchanged at some future date. A derivative trade means one whose cash flows are calculated by reference to the market price of some underling asset, however no physical assets

need change hands at all. Of course, it is quite reasonable (even usual) for the market spot price on a particular day to be different from the market prices of forward trades for various future settlement dates.

9.3.2 In many ways labour is a commodity which can be traded in a market like any other. Until recently most labour markets traded spot. However, now this is rarely the case. The provision of pensions and the growing volume of employment legislation means that, in many cases, cash is transferred even when labour is not being delivered, and, in addition, the provision of defined periods of notice includes an element of forward trading. One feature of spot markets is easy comparison of prices. By contrast, salaries quoted in today's market are agreed on a number of trading bases, and the figure stated typically excludes a number of fringe benefits. This complicates the econometric analysis of wages to a considerable degree.

9.3.3 Although the analogy between labour and other commodities can be instructive, there are also some important differences. The labour market is fragmented between many different skill sets which are not readily substitutable. Furthermore, employees who have stayed with one employer for an extended period of time often acquire knowledge (such as familiarity with legacy computer systems or internal politics) which is useful to that employer, but of little use to other employers, even in the same industry. There are also a number of less tangible effects; an individual may have a positive or negative influence on the working environment; in some cases the financial impact of such indirect effects may exceed, by several fold, the economic value of the labour supplied by contract. As an additional complication, governments world-wide have tended to impose tax burdens on the trading of labour which exceed by far the stamp duty payable on other commodity transactions. Political interference is also widespread, with additional rights often conferred on one party by statute part way through a contract of employment.

9.4 *The Value of an Employment Contract*

9.4.1 The simplest possible employment contract would provide for the worker to be paid a wage negotiated daily, with no fringe benefits and instant notice on either side. This is in essence a strip of spot labour trades. Such a contract is similar in nature to a mandate to a securities firm to dispose of a stock portfolio over a period of time at a market price. Viewed as a derivative, such a mandate has no financial value at any point of time before execution, as all future transactions are at market prices.

9.4.2 Recent times have seen more complex employment deals. It has been common for pay awards to be agreed some months or even years in advance. In one recent well-publicised deal between Blue Circle and the GMB and TGWU unions, employees agreed to accept pay rises for 5 years linked to inflation plus 25 basis points, in return for a promise from management of job security. Unlike a spot trade, such deals involve prices agreed in advance, so bear some similarity to forward trades.

9.4.3 One complex feature of forward trades which distinguishes them from spot trades is that they can have a non-zero market value. For example, let us suppose that a share trades today (28 April) for 98p. I might agree to purchase that share for 100p, under a forward trade settling on 30 September. However, if, tomorrow, the share price rockets to 160p, my forward trade will become an asset to me, being worth just over 60p. At the same time, it will become a liability to my counterparty.

9.4.4 By the same token, a fixed-price employment deal may become a liability to an employer if the market price for labour falls subsequent to the deal being struck. The employer is then faced with the opportunity cost of having agreed to employ the workforce at a higher price than the replacement cost which would apply were the fixed price deal not in place.

9.5 *Nature of the Pensions Deal*

9.5.1 In the context of commodity markets, final salary pensions are without parallel. A commodity (labour) is provided today, but some of the settlement is deferred until between retirement and death. The price paid is not fixed on the date the labour is supplied, but, instead, linked to prevailing wage prices at the retirement date.

9.5.2 In practice, pensions deals involve significantly more complexity even than this. The majority of scheme members do not remain with the same employer through to retirement, but, instead, take either a transfer value or a deferred pension when they leave service. The amount of the transfer value or deferred pension can be expressed as a multiple (or fraction) of salary at the time of leaving service.

9.5.3 The complexity of defined benefit schemes can be contrasted with the financial simplicity of defined contributions, at least from the perspective of the employer. That is not to say that either arrangement is necessarily superior to the other. Employees who value simplicity may well regard a defined benefit scheme as more transparent because they believe they understand the benefit structure.

9.6 *Difficulties with Measurement of Cost*

9.6.1 One of the strengths of a defined contribution scheme from an employer's perspective is that the cost of the benefit in respect of a given year's service is known. Accounting for defined contribution schemes is uncontroversial. One can actually look back and measure the extent to which each year of service contributed to the total pot. Typically, this will not correspond to the distribution implied by any of the standard funding methods for defined benefit schemes.

9.6.2 By contrast, we would argue that, quite apart from the choice of *basis* (funding versus market), as discussed earlier, the standard actuarial *methods* of apportioning cost between years of service in a defined benefit scheme currently involves some degree of arbitrariness. We suggest that the way in which this arbitrariness is dealt with is unhelpful when trying to understand underlying employment and labour market issues.

9.6.3 For example, the projected unit method is now almost universally accepted for accounting the cost of a defined benefit scheme. This method involves, effectively, allocating to each accounting year the cost of the benefit accrual during that year. The 'cost', therefore, takes into account likely future salary rises on past service liabilities, but not the effect of future service accrual. The argument for ignoring future service accrual when valuing pension promises is that such accrual is, ultimately, at the discretion of the employer, who could, potentially, cut the future accrual rate to zero with immediate effect. By contrast, future salary growth is fully budgeted. This does raise some inconsistencies, as, arguably, future salary rises are just as discretionary as future accrual rates, if not more so.

9.7 *Implied Spot Prices*

9.7.1 If all labour is purchased spot, then it is easy for us to measure the cost of producing saucepans. A simple calculation establishes whether a profit has been made on sales, and how large that profit is. As discussed above, the existence of a defined benefit pension scheme introduces a large number of complexities to this process.

9.7.2 The ideal which we are aiming for is to derive an implied spot price, that is, given an employee with a complex remuneration package, we want to identify a spot package with an equivalent effect on shareholder value. This implied spot price must be meaningful for use in the assessment of cost of sales. Intuitively, we can decompose the implied spot price as the actual salary paid plus some measure of pension cost during the year.

9.7.3 As we have stressed on many previous occasions, it is important to avoid confusing economic cost with a pace of funding. To a large degree, the pace of funding is at an employer's discretion. A creditworthy employer could, in principle, fund the future pension in a single lump sum the day an employee joins, or not fund at all until the day before the employee leaves. This choice of funding could be made independently of the benefit structure promised. However, it would be wrong to suggest that the economic cost is incurred only when the actual cash flows take place. Instead, leaving aside the complicating issue of credit risk, the value of the package to an employee (and hence its cost to the employer) will depend on the benefit conditions, and not how it is funded. As noted in Section 8, this flexibility in the pace of funding is, though, a potentially valuable characteristic of a defined benefit arrangement from the perspective of minimising tax and the cost of raising and distributing capital.

9.7.4 We also need to avoid confusing the economic cost with various accounting conventions. For example, SSAP 24 *requires* that projected reported pension cost should constitute a stable proportion of salaries. IASC (1996) suggests an alternative based on uniform spreading of future benefit across years of service. Neither of these standards are categorically wrong — but both are, to some degree, arbitrary. When we maintain that an implied spot price can be calculated, it would not follow except by chance that projected salaries are a

constant proportion of implied spot, or that the difference between implied spot and actual salary is uniformly spread over years of service in future value terms.

9.7.5 Instead of projecting future pensions and then arbitrarily allocating the cost across years of service, we follow McLeish & Stewart (1987), whose defined accrued benefit method or DABM attaches much great significance to benefits for early leavers. Arguably, McLeish and Stewart were before their time, proposing a method which, at the time, involved prohibitively high computational expense. Nowadays, calculations far more complex than the DABM are required by law.

9.8 *Features of Implied Spot Prices*

9.8.1 In order to illustrate the principles, we consider a highly simplified example.

9.8.2 We want to equate the cost of a final salary defined benefit scheme to an equivalent defined contribution scheme with equivalent benefits. In effect, this means that the defined contribution scheme must be so arranged that the amount in the pot at any point is equal to the transfer value available from the defined benefit scheme. The rise in the transfer value comes, broadly speaking, from the unwinding of the low salary growth assumption on the past service liability.

9.8.3 Thus, as the past service accrues, this unwinding becomes more dramatic. The equivalent DC contribution to keep pace with the transfer value, therefore, starts out at a modest level, but can rise at higher ages well above the pension cost expensed for accounting purposes. Here again, the concept of a hedge working all the way along, not just at maturity, comes into play to remove the need for any decrement assumptions.

9.8.4 Figure 9.8.1 shows our concept of pension cost (that is, implied spot price minus salary) for a range of different ages. There are a number of different curves according to the age at entry (assuming no past service credits on entry). Also, for comparative purposes, we show the standard contribution rate under the projected unit method (which is shown dotted).

9.8.5 This concept of implied spot prices shows a number of interesting features. Firstly, the economic cost slopes much more steeply with age than the projected unit method standard contribution rate. This means that, if an employer were to use existing methods of pension expensing for accounting purposes as a means of comparing the cost of employing different employees, he is likely to overstate the cost of younger employees and understate the cost at later ages. He is also likely to understate the cost of long servers versus recent joiners.

9.8.6 The increase in the spot price with service requires the rate of salary increase to exceed a 'break even' rate associated with the revaluation of pensions in deferment. If these pensions are simply linked to price inflation, then this break even rate is trivial. More generally, a break even rate is delivered by following through the unwinding of the hedge discussed in Section 7.3. Usually, the rate of salary increase will be above this break even rate. However, in times of negative real salary growth, longer serving employees can suffer an effective cut in their overall remuneration. An employer using current methods of costing

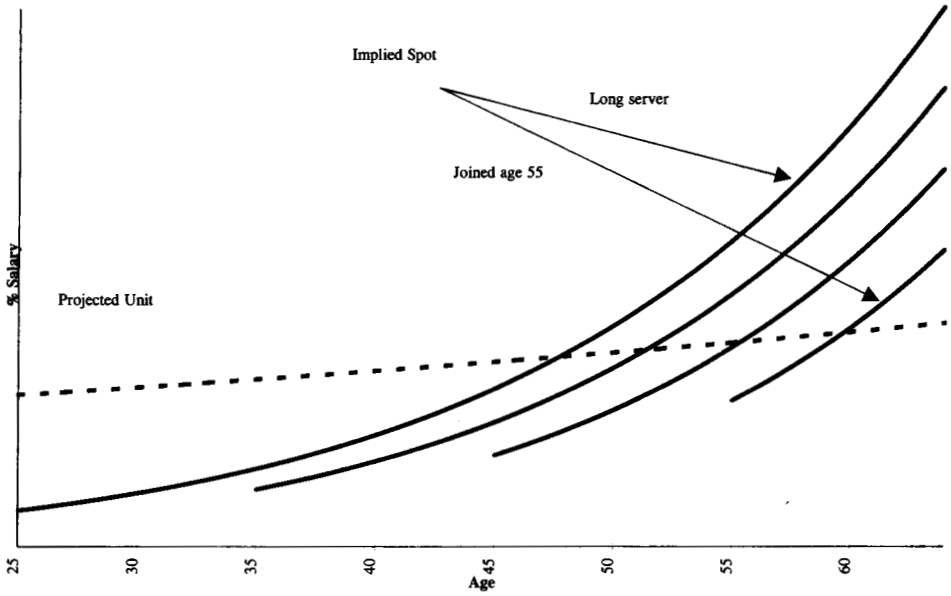

Figure 9.8.1. Pension cost variation according to age and service

pensions would underestimate the savings made by constraining pay in such an environment, when compared with our implied spot approach, whilst underestimating the costs of longer serving employees in more normal circumstances.

9.8.7 In addition, the analysis raises some questions with regard to anti-discrimination law. We have argued that, for two employees of the same age and on the same salary, the one with the greater past service usually incurs the greater economic cost. Now suppose that, for a particular employer, and for employees of a particular age, female employees had, on average, a lower past service credit. Then, even if the salaries were equal between the sexes, the economic employment cost would not be. The female employees could, on the strength of our analysis, argue that they were victims of unfair discrimination because their implied spot rates were lower than those of equivalent male employees.

9.9 *Asymmetries in Employment Practice*

9.9.1 We have now developed a consistent concept of implied spot price which identifies the economic cost of labour. We might naturally suppose that, having calculated this cost, employers would decide only to provide employment to individuals where this cost still allowed them to make an economic profit in

production. By the same token, employees will seek, when selecting employment, to maximise the implied spot price rather than their salary alone.

9.9.2 In practice, employers may not seek to be this draconian. Getting rid of employees can be costly, involving greater compensation than if the employee had left voluntarily. Furthermore, in many industries, the structure of pay scales may make it difficult to remunerate each employee consistently with their contribution to the firm — some cross subsidy is inevitable.

9.9.3 These cross subsidies do not mean that employers are necessarily always the victims of adverse selection. There are also significant costs to the employee of moving jobs, particularly if geographic relocation is involved. Employees will not necessarily resign in order to achieve only a modest pay increase. However, it is generally easier for an employee to resign than it is for an employer to get rid of an unwanted member of staff.

9.9.4 This asymmetry gives rise to some interesting features. If an employee's market rate of pay should fall relative to his current salary (or, more accurately, if his market equivalent spot should fall relative to his current equivalent spot) then employment legislation offers him some protection from redundancy. On the other hand, if the market implied spot rises above his current package, he may switch jobs to lock in the gain, or at least use the possibility of such a switch to bid up his existing package. In effect, the employer has granted an American style option to the employee. The value of this option may be lost if the employee voluntarily leaves service; a substantial rise in salary will be required from the new employer in order to compensate for this.

9.9.5 The value of this option will often be higher in the context of DB schemes than DC schemes. This arises because of the steeply rising equivalent spot in the case of DB schemes, which equates to a rising strike price in the put option. In addition, the contribution rate for a DC scheme is not interest rate dependent, whereas the implied spot rate for a DB scheme will be. This injects additional volatility, further serving to increase the value of the option for the DB scheme.

9.10 *Investment Risks associated with Defined Benefit Schemes*

9.10.1 An often cited reason for companies moving away from defined benefit arrangements towards defined contribution instead is the level of investment risk associated with the former.

9.10.2 However, the implied spot rate approach we describe allows us to see more clearly the nature of this risk. As the reader knows by now, the reason why we can calculate these spot labour rates is because we can hedge them. Also this hedge works all the way along, so we can dust off our blue print again and monitor the hedge if we wish on a daily basis.

9.10.3 We do not need to know how salary will grow, or make assumptions about withdrawal rates, the defined accrued benefit is well defined in terms of current salary and the revaluation rules (possibly linked to LPI, which we can hedge, as described in Section 7). The cost and hedge can be calculated from

current bond prices when the labour is delivered. Accordingly, if a company wished to hedge the risks of a defined benefit scheme, this provides a methodology for doing so.

9.10.4 Once the risks associated with past accrual have been hedged out, the distinction between defined benefit and defined contribution arrangements becomes much more blurred. The nub of the difference boils down only to the greater variation in the implied spot rate in the former case. However, in theory only the variation in interest rates (as noted above) is outside the company's control. Variations in the spot rate with age and service can be managed, as we discuss below.

9.10.5 We should, of course, stress again that the shareholder may not necessarily want a hedged investment strategy to be adopted, although, in fact, several of the arguments presented in Section 2 and in Section 8 have suggested some advantages to matching anyway. However, the fact that the risks can be hedged, as we describe, suggests that the investment risks associated with defined benefit schemes may not be such a convincing reason for company management to abandon them in favour of defined contribution arrangements. Ironically, it seems from this new insight that, far from controlling these risks, the actuarial techniques used to support equity investment by U.K. pension funds (as analysed in the case of the MFR in Section 5, for example) appear rather to perpetuate them, and thereby endorse the spurious argument in favour of lower risk defined contribution arrangements. According to IFAA (1997), company management should "note that while the long term relationship between share prices and dividends is excellent, in the short term (periods of 5, 10 or even 15 years), the linkage can be temporarily broken. Immediate recognition of the temporary share price drops of the 1970s could have created the misleading impression that long term pension obligations were in peril". Perhaps management would be more convinced by the hedge from our blueprint, which works all the time.

9.10.6 Picking up this final observation in more practical terms, it seems worth mentioning that a policy of hedging, as we describe, combined with some funding target linked to this hedge, will deliver a real and certain 'profit' when salaries grow at less than the break even rate described in ¶9.8.6. Assuming that corporate cash flow will also be tight in such circumstances, this certainty may be seen as valuable to the company. This should be compared with the alternative approach of equity backed investment combined with funding valuations described earlier. By contrast, the latter policy seems more likely to deliver an unwelcome increase in the actuary's recommended contribution rate in these same circumstances (as described in ¶8.8.4).

9.11 *The Age Selection Problems of Defined Benefit Schemes*

9.11.1 The steep gradient of the implied spot rates shown for a defined benefit scheme could be offset by more shallow age-related salary scales applying to members of defined benefit schemes. However, there does not appear to be any evidence that this is the case when we compare across companies providing

DC or DB arrangements, and it is not seen in companies offering a choice between the two types of arrangement (although some defined contribution schemes do have age-related rates which compensate to some degree).

9.11.2 If there is no compensating adjustment to salaries between members of DB and DC schemes, then it is clear, from Figure 9.8.1, that we have a selection problem. Younger members and new entrants have no incentive to join a company offering a defined benefit scheme or to join the DB scheme of an employer offering a choice of arrangements, while older members have an incentive to stay. In the long run this would lead to a stationary population in which everyone is in DC schemes.

9.11.3 However, the problem is more subtle than the simple population dynamics of movements by younger members out of defined benefit schemes. This is a symptom rather than the disease itself. The disease is selection and selection costs real money, because it always conspires to work in favour of those able to choose. The only way to address the real problem is for management to have a thorough understanding of the selection issue, and we would stress the dangers to management of not understanding properly the details of the cost structure of a defined benefit scheme. Explaining to young members the value of a defined benefit promise based on actuarially projected future salary is not the solution. We suggest that our implied spot principle provides the insight required.

9.11.4 The solution to this selection problem appears to be rather simple. The age bias causing it could be removed by offering higher accrual rates in DB schemes at younger ages. In the face of such a simple fix, if employees basically like defined benefit arrangements, then the way in which uniform accrual defined benefit schemes discriminates against younger members seems to be no reason for introducing a DC scheme instead.

9.11.5 Of course, for funding purposes, a sponsor may well wish to pre-fund some future contributions for younger members. Conveniently it is permitted to allow for future salary rises in applying the Inland Revenue surplus limits. In this case, the combination of generous allowance for salary inflation and an accrual pattern weighted towards lower ages provides the largest possible scope for tax efficiencies.

9.12 *Stickiness of Labour Allocation*

9.12.1 Defined benefit schemes have also come under pressure from changes in the pattern of employment. The old idea of a 'job for life' has been replaced by much greater job mobility. Defined contribution arrangements have been perceived as being better attuned to this new environment.

9.12.2 We suggest that our implied spot rate approach provides another way of viewing this problem and a clear solution. The problem involves selection, not according to age, as addressed above, but according to length of service. In final salary schemes, an employee with longer service effectively enjoys a higher implied spot rate than a new joiner. This both discourages the new joiner and serves to lock in the existing employee.

9.12.3 It is sometimes suggested that this 'lock in' feature is of benefit to the shareholder and represents an advantage of defined benefit schemes. However, we contend that this is illusory. Firstly, if the shareholder is, as a result, paying the long serving employee significantly more than the spot rate set by the labour market, it is not surprising that the employee is happy, but the shareholder is not saving employment costs as a result. Secondly, the effect must cut both ways, so employers trying to attract new employees from competitors will, as a result, have to pay more (by crediting him with added years of service, for example). Thirdly, it is our belief that a more mobile labour market enhances overall economic welfare, since labour is allocated more efficiently. Thus, a form of pension arrangement which reduced mobility would be detrimental to the economy overall and shareholders in particular.

9.12.4 The problem does not arise in career average schemes. However, a tweaking of the financial benefits of the pension scheme is not the only answer here. We contend that, in any event, better information in the wage bargaining process would lead immediately to more efficient allocation of resources. To some degree this has already happened with the advent of defined contribution schemes, where the cost structure is much more transparent. In order to achieve similar benefits from a defined benefit scheme, employers and employees may find it useful to negotiate on an implied spot basis rather than on pure salary. Actuaries have a valuable role to play here in providing a financially sound, market-related and impartial basis for such calculations. This would represent a major step forward from the currently common situation where a business unit has an agreed budget for wages, but the impact on pensions cost is supposedly neutralised by an appropriate asset mix within the fund. This may appear to work broadly in aggregate, but at a marginal level it plainly does not, unless the increase in an individual's salary is negotiated with reference to pension fund asset performance.

9.12.5 A logical consequence of the use of implied spot rates in the negotiating process would be final salary defined benefit schemes accepting transfers in on exactly the same basis as transfers out (that is without building future salary growth into the receiving calculation). At a stroke, this appears to us to solve one of the main problems of defined benefit schemes in the modern labour market. The suggestion seems to be at odds with actuarial theory (as defined by GN11, for example). However, this actuarial view is, we believe, another facet of the unhelpful 'scheme centred approach' which we highlighted earlier in connection with investment issues. Arguing that this more generous treatment of incoming transfers is a more 'expensive' approach simply does not wash if we look at the rest of the employee's remuneration package. This is because the employee will simply demand a higher salary if the employer is less generous with pension benefits.

9.12.6 The above result follows if we assume that the rate of pay is ultimately set by the labour market, not by the way that the shareholder chooses to arrange the individual employee's remuneration package. The alert reader will,

perhaps, notice some similarity here with the principles applied in our analysis of investment issues. This is not surprising. They are basic principles of economics. We are just applying them now to the labour market. Again, we are led astray if we look at the pension promise in isolation.

9.12.7 Just as there was, to first order, no optimal asset allocation for the pension fund investment policy, now there is, to first order, nothing to choose, at the margin, between giving the member an extra £1 (economic value) of pension benefits or an extra £1 of salary. The market sets the going (spot) rate for the job.

9.12.8 If we pursued this argument to extremes, the employee would probably not thank the employer for paying him 99% in pension benefits. However, this observation serves to put us on the scent of an optimal solution, if we allow for 'second order' transaction costs.

9.12.9 We can see from this construction that the member does not necessarily need to participate in the employer's scheme. In theory, at least, he could negotiate enough additional salary each year to cover the implied spot price of his pension benefit, along the lines shown in Figure 9.8.1. We can think of this as an age and service related promotional salary scale. Armed with this additional salary, the member could invest in a hedged portfolio, as we described above, to secure this tranche of defined benefit pension. Owing to the tax breaks on pension savings, he would not be able to invest this directly himself, but would channel his savings through some insurance or other arrangement delivered by the financial services sector. Pursuing this to more fantastic limits, if he was offered too much pension, he could (in theory at least) reverse this transaction and deliver to himself more immediate salary!

9.12.10 This is clearly far fetched, which is a good job from the viewpoint of the corporate pensions industry in general and pensions actuaries in particular, because they can operate profitably delivering a more efficient version of the same thing. If we assume that employees do, in principle at least, like the idea of a defined benefit pension promise (and our analysis in Section 2, together with lobbying by trade unions and others, suggest that they do) then the corporate vehicle can settle the salary negotiations necessary, enjoy economies of scale, reduce administration costs, avoid sales, compliance and legal costs of the financial sector and arrange the hedge cheaply. Furthermore, the potential problem of over provision can be addressed by pitching the promise slightly on the low side and allowing employees the option of AVCs (these would however need to be offered on a defined contribution basis, to avoid further selection problems by members gearing up their exposure to salary increases).

9.12.11 The main objection to this solution appears to us to be actuarial rather than economic.

9.13 *Conclusions*

9.13.1 This final section has drawn, directly or indirectly, on nearly all of the main themes in this paper. Looking back now, the result is very satisfying and the journey we embarked upon now seems worthwhile.

9.13.2 It has turned out that, by applying the same financial theories consistently, all the way through to the labour market, we are rewarded with new insights into defined benefit schemes. These insights hold out the hope of addressing what we believe to be the three main criticisms of such schemes in a modern corporate environment, namely:
— investment risk;
— selection by age; and
— selection by service.

9.13.3 In particular, the market consistency of our hedge, which works all the way along, prevents employees from selecting to exploit the off-market nature of traditional actuarial defined benefit calculations. We assert that conventional scheme-based actuarial approaches to corporate pension advice are unhelpful in addressing these criticisms. Given that our analysis in this paper provides some rationale for shareholders providing defined benefit corporate pension schemes for their employees, and they appear to be valued by members, it would be ironic indeed if arcane actuarial approaches proved to be the major hindrance in adapting such schemes to a modern business environment in the manner we propose.

10. CONCLUSIONS

10.1 *Economic versus Actuarial Value*

10.1.1 When actuaries talk with economists about valuation, there is plenty of scope for confusion over terminology. An actuarial funding valuation has a different purpose from an economist's value, and the different methods employed reflect this. However, there is a remarkable lack of clarity, not only as to when one method or another should be used, but also as to the theoretical basis for calculations currently carried out as a matter of routine. Worryingly, this confusion seems to extend even to standard student textbooks on the subject.

10.1.2 This difference was brought into sharp focus in our analysis of corporate pension provision from the perspective of financial theory. In particular one of the main conclusions, that the way the assets of a fund are arranged between equities and bonds does not have a material impact on the economic cost of the liabilities, appeared, at first sight, rather iconoclastic.

10.1.3 However, on further examination our finding is that arguments for equity related discounting of pensions liabilities using funding valuation techniques are flawed as a means of calculating economic value. Funding levels and assessed values of assets can vary widely according to the view of the actuary performing the valuation. Values assessed by one actuary could be well above current market values, whilst another could select values below current market, even if they assume the same long-term rate of return. Furthermore, holding up actuarial values as economic values can lead to some embarrassing inconsistencies, and, even when we look only at current actuarial valuation

methods purely as funding tools, there is potential for rather inopportune advice being given from a corporate finance viewpoint

10.2 *Our Blueprint*

We have therefore set out a blueprint for a market-based approach to valuation using the conventions adopted successfully by banks. Our conclusion is that, although historically a distinction has been drawn between asset and liability management by banks and pension funds, financial theory offers no good reason for this distinction, and corporate management of pension schemes, as well as members' understanding of them, could be improved by adoption of these principles.

10.3 *Practical Applications*

10.3.1 We go on to show that, although we base our initial analysis on simple examples, many of the practical difficulties associated with pricing more complicated liabilities can be worked around using standard techniques and guiding principles from modern finance. Furthermore, empirical comparison of these results with traditional actuarial approaches shed further light on some of the inconsistencies in standard actuarial valuation theories, in particular the alleged link between equity returns and salary growth, which we dismiss as spurious.

10.3.2 Under the market approach, subjectivity remains, but to a lesser degree. In particular, standard term structure models can be used to price 'bond like' liabilities which are not exactly replicated by traded bonds. The values generated can be interpreted by both shareholders and members, and have meaning, since comparisons could be made with the values of other assets and liabilities in their personal portfolios.

10.3.3 We also show how application of market principles to setting both contribution rates (the traditional purpose of funding valuation techniques) and investment policy could lead to positive gains for shareholders and members arising from material (but second order) issues ignored by conventional actuarial approaches.

10.3.4 Finally, we suggest that the current method of costing pension provision obscures a number of important issues. Instead, we advance an alternative framework for measurement of employment costs based on commodity pricing principles, with similarities to the proposals made by McLeish & Stewart (1987). This new framework holds out the hope that, with suitable adjustments either to transfer value bases or rates of accrual, and a better understanding of cost structures, defined benefit schemes may once again be able to compete on a level playing field with defined contribution schemes.

10.4 *A Look to the Future*

10.4.1 The continuing role of funding valuations has been thrown into sharp focus in recent months by a number of actuarial papers (Clarkson, 1997;

Pemberton, 1996) attempting to defend the method against alternative market-based approaches, even for banking products such as derivatives. We hope that this paper will encourage the actuarial profession instead to embrace, advance and develop market based techniques as the way ahead.

10.4.2 The potential rewards from this new enlightened approach are, in our view, substantial, and enable us to end this paper on an optimistic note. Recent years have seen a move by U.K. companies away from defined benefit pension schemes towards defined contribution arrangements, although we observe, in our initial analysis of corporate pension provision, that many of the traditional advantages of defined benefit schemes still remain. We suggest that, far from encouraging this trend, a better understanding of the issues from a corporate financial perspective enables the profession to redress this situation. In particular, knowledge of the underlying investment issues opens the opportunity to work with company management in both controlling risks and supporting strategies aimed at maximising firm value. Furthermore, we assert that our 'implied spot rate' approach represents a new and powerful tool for human resource advice, which can be used to address some of the perceived inequalities of defined benefit schemes more directly. In this frame of mind we can look forward to the future.

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ABSTRACT OF THE DISCUSSION

Mr S. J. B. Mehta, F.I.A. (introducing the paper): The actuarial profession has adopted a wide variety of different approaches to monitoring the pace of scheme funding in the past. In the late 1970s the use of market values was very widespread, although some actuaries still used historic costs when valuing the assets. Since the 1970s there has been a trend in the United Kingdom away from market values towards using smoothed market and discounted cash flow techniques. With the advent of the Minimum Funding Requirement (MFR), we now have yet another basis for equities — market value adjusted by the current U.K. dividend yield divided by 4.25%.

This trend appears odd, given the strong moves in the financial community to market value and the increased acceptance of market values, even among the accounting profession, which has so strongly been wedded to historic cost. Clearly, there are short-run advantages to management of using a non-market-value basis. There is enormous flexibility in the presentation of results, since one actuary could choose a value of 130% of market value and another could choose 70%. This allows choice, both for any individual valuation and also for the smoothing of results from year to year, so that the effects of short-run volatility of market values can be ignored. Unfortunately, there is a distinct lack of evidence of low long-term volatility of market values relative to short-run volatility. It is difficult to validate long-term assumptions, since one needs even longer-term data to assess their significance. If long-run risk for equities was so small, why would anyone buy bonds? Put this way, it becomes difficult to argue that equities are always cheaper than bonds, and, therefore, should always be bought in preference to bonds.

We question whether it is to the advantage of the profession to be able to use judgement in discounting cash flows using arbitrarily selected discount rates. An alternative would be to present results using as much objectivity as possible, so that members and trustees could ascertain the degree of solvency based on current market values, and shareholders could make like-for-like comparisons between the funding positions of the schemes which they sponsor. The shareholders could also use pertinent market-value-based data when assessing the values of their interests.

In the paper we demonstrate how the liability side of the valuation can also be assessed at market values, thereby giving scope for the profession to provide information of genuine value to shareholders and trustees. Essentially, we propose valuing fixed liabilities using bond yields, index-linked liabilities using index-linked gilt yields, and salary-related liabilities using the yield on assets that most closely match these liabilities.

One of the main features of pension funds in the U.K. has been the focus on equity investment. It has become accepted wisdom that equity investment reduces cost and has a favourable risk/return trade off. Both concepts are examined closely in the paper, and are found to lack a rigorous theoretical basis.

For the sake of illustration, one can consider a pure defined benefit scheme — that is one where benefits are pre-defined and do not depend on investment return surpluses. From a member's viewpoint, there is no benefit obtained from adopting a risky strategy, and we show that a hedging strategy can be found which will minimise risk, not just at some long-term horizon, but at every moment in between. One obtains a naturally smooth pattern of results without any need for artificial smoothing.

For shareholders, we find that the assumed benefits arising from an equity orientated pension fund investment strategy do not exist. For a pure defined benefits arrangement, the pension fund assets and liabilities are akin to an off-balance-sheet position, and any excess return or loss on an equity mismatch is no different from the position that would have applied had the shareholders held these equities directly, or if they had been held on the balance sheet of the company. In fact, we show that, from a tax viewpoint, shareholders would be better off if the pension fund switched to bond-based investment strategies.

Logic is one thing, but will the profession embrace market-value-based approaches? I can imagine a busy pensions actuary looking at this paper and saying, "This is all very fine; I am sure the arguments are correct; but I am too harrassed to consider changing to new, more complex technology at present." We believe that actuaries can use the arguments and conclusions set out in this paper in a very practical way. The arguments put forward are very straightforward.

To date there has been little evidence of change. My paper (Mehta, 1992) suggested market-value-based approaches for the life industry, and Dyson & Exley (1995) followed with some initial ideas for defined benefits. We believe that there are good reasons to expect change in the future. Low risk strategies — that is hedging approaches — are universally preferred among investment banks. Across Europe, regulators and trustees show a significant preference for pension fund security rather than risk taking, and perhaps the introduction of the MFR in the U.K. will also generate renewed focus on member security. The trend towards economic value added and shareholder value analysis, both with a market value basis, is very strong, at least outside of Continental Europe.

Our three-way argument demonstrates clearly that equity investment does not generate shareholder value. One pound of market value of equities is worth the same as a £1 of market value of bonds. We remain optimistic that, ultimately, the profession will embrace market values. Clearly use of such values is controversial among U.K. pension actuaries.

We would stress that our paper does not focus on shareholders rather than members. The position for both trustees and shareholders can be considered, and we show that the trustees of a defined benefits scheme should prefer a low risk, that is a bond-based, asset strategy.

Mr C. J. Exley, F.I.A. (also introducing the paper): I will emphasise some of the good news that this paper brings. Not only do we have a coherent, pragmatic, yet simple framework for costing scheme benefits and for framing asset liability policy, but the principle good news is that the trend towards defined contribution schemes is not necessarily irreversible. It turns out that defined benefit schemes make a great deal of sense from an economic value perspective, but this value is, at best, disguised, and, at worst, thrown away by existing actuarial practice.

We find that there are a large number of advantages of defined benefit schemes; to list but a few: flexibility in the timing of contributions; tax advantages from pre-funding; lower administrative costs; and the value placed by members on the certainty of defined benefits.

However, against these are the usual criticisms of defined benefit schemes: the investment risks; the lack of suitability for a mobile labour force; and the supposed lack of appeal to younger members. Our paper rejects all three of these conventional criticisms, which seem to arise from confusion within the existing actuarial framework.

For example, the investment risk associated with many defined benefit schemes arises from the decision to fund with equities, not so much from the decision to provide a defined benefit scheme itself. The profession has tried to convince clients that equities match defined pension liabilities in the long run. Clearly, they do not believe us. Companies perceive defined benefit schemes to be risky; they do not believe that equities match the benefits. In effect, they are voting with their feet against such theories. It may be a revelation that they can have defined benefit schemes for their employees without equity risk. Our experience is that finance directors are much happier with hedges which actually work.

The suggestion that a more mobile and less secure labour force prefers a less certain pension is rather curious. One might have expected employees to place more value on retirement security in an uncertain employment world, and that this should really be the era of the defined benefit scheme! The problem is the actuarial treatment of transfers in. Treat them on the same basis as transfers out and you get a portable pension. The actuarial funding strain caused by this is irrelevant to the overall employment costs. Focusing on this funding strain is a mistake, following directly from scheme-centred thinking. On the other side of the coin, we argue that the supposed 'lock-in' effect of the existing approach on long-serving employees, sometimes quoted as an advantage, is also specious. Are these other employees locked in, or just paid too much?

More generally, labour mobility is good for the economy, so let us encourage it.

We see why younger employees may value defined benefit pensions much less than older employees. It is because their pension accrual is less valuable! If the age-related pay scale compensates for this by giving more cash to younger members, then this may be seen as a good feature of defined benefit arrangements — that is, catering for the cash preferences of younger staff. If, on the other hand, you offer a flat contribution defined contribution arrangement, then younger members may select defined contributions, because they prefer more to less, not because of inherent preference for defined contribution arrangements.

So, existing actuarial theories may invent problems for defined benefit schemes which do not arise in reality. Some of our criticisms of these existing theories in our paper may, admittedly, have been rather severe. I speak for all of the authors when I say that I hope that we have redeemed ourselves by offering the salvation of defined benefit schemes through our new financial-based theories and by carving out a crucial role for the profession to move forward.

Mr A. J. Wise, F.I.A. (opening the discussion): This is the first time, I believe, that we have discussed a pensions paper with such a clear shareholder perspective. The authors have written a long paper with much evidence of personal conviction. They have a clear vision of the modern market economy in which there is a price to be associated with every financial asset and liability. Where the market does not supply such a price, the authors apply dynamic hedging arguments to indicate how the price would be settled if that liability were traded in financial markets. Where the market does not supply an adequate range of benchmark assets, they appeal to recent financial models of interest rate term structure to fill the gaps. This, I understand, is their blueprint for assessing the economic value of a pension. Thus, economic value is a market price if a market price exists.

In terms of this outline formulation, I do not disagree. My 1984 paper (Wise, 1984) on matching asserted, in effect, that the market price of a matching asset portfolio can be used to price any pension liabilities. The authors are making a similar assertion, but in terms of hedging instead of matching. As it happens, my recently published note on dynamic portfolio rebalancing (Wise, 1996) used the same principles as dynamic hedging, and showed how this works, even over long time periods. So, I will not take issue with the contention of this paper that hedging arguments can be extended to the long time horizons of pensions.

However, the question is whether, in practice, this theoretical idea adds value to our work. The authors may have strayed too far away from the theory which they know into the areas of practical application. This paper does not adequately recognise the diversity of U.K. defined benefit arrangements; it does not recognise the diverse and often subtle balance of forces and interests between pension fund members, trustees and company, and it does not recognise all the reasons why U.K. pension funds have been so weighted towards equities in the first place.

Actual or feasible pension scheme designs range from the pure defined benefit, corresponding to the authors' national average earnings (NAE) bond at one extreme, to a pure defined contribution scheme at the other. In between are all manner of hybrids, such as the final salary scheme with money purchase underpin. In a market pricing context, the discount rate for defined benefit schemes can, therefore, range from the yield on high quality bonds, or even less than that yield, to an expected equity rate of return, including all points between.

Section 7.2 argues that index-linked stocks would be better than equities for pricing NAE bonds. However, what does market pricing have to say about typical final salary pensions? Is the NAE bond close enough to the real object of valuation? The authors have not adequately examined this question. They say, in ¶5.7.2, that the financial markets look to the economic reality, but what is the economic reality of a defined benefit scheme, whether final salary or otherwise?

I know of one unusual scheme which the employer has no power to wind up; unusual, because most schemes include such a power. The economic reality of the liabilities differs between these two types of scheme, and the existence of an employer's option to wind it up is a financial option with positive value to shareholders and a negative value to employees. It has long been regarded as a safety valve of last resort, and the analysis of Section 2.2 is, in my opinion, faulty.

Up to April 1997, many schemes have not specified pension increases in relation to prior pensionable service. In seriously adverse conditions, such as a disastrous equity market, the discretionary increases awarded from such a scheme might have to be cut back to below the LPI rate which will apply for future service. Favourable early retirement pensions are another important example of discretionary benefits, which are not even mentioned here. So, the authors have been far too hasty, in Section 2.2 and elsewhere, to dismiss the relevance of discretionary benefits and other types of embedded employer option. The history of equity investment for defined benefit pensions is inextricably linked with these options. Without them, the whole background to pension fund investment and actuarial valuation would have been quite different from what we see today. What this means for shareholders in a company is

that the downside to equity investment is less onerous when that equity is in that pension fund. This observation contradicts a basic premise of this paper, which proceeds from Section 2.3 onwards, that equity investment in the pension fund looks the same to a shareholder as equity held either by the company or in that shareholder's own hands. The premise is wrong.

Why are the authors avoiding this aspect of the economic reality? Perhaps they are a little confused about the revision of accounting standards, where it might be that some subtleties of U.K. pensions may have to be sacrificed to gain widespread acceptance of a new standard. If that is the authors' explanation, then it is a poor one, because it is for us to identify the economic reality of these pension liabilities, and it is then for the ASB and IASC to decide how to account for it. Did the authors simply feel that discretionary benefits are too subjective and untidy for their precise theory? If so, then I disagree, and they may have missed a nice opportunity to show how financial theory can be applied, even to these less well defined aspects of pension schemes.

In Section 7.3 the authors discuss pricing cap and collar options on LPI pension increases. A similar option pricing approach can, in principle, be applied to the entire liabilities of a typical final salary scheme, where the ceiling corresponds to the final salary target benefit and the floor corresponds to the absolute minimum in terms of either accrued pension amount or the MFR. In this model the area between cap and floor is equivalent to a defined contribution scheme — the benefits emerging being no more and no less than whatever the actual scheme assets can finance. This may be the economic reality of pensions in future.

If there is no such discretionary area in the scheme, then the cap and the floor are at the same position, and the scheme is a true defined benefit scheme of the type which the authors have studied and which is a rarity. If there is a gap between the cap and the floor, then the pension value may partly reflect an equity investment policy. This option pricing analysis supports the pro-equity policy which schemes followed in the old days, when the gap used to be wide. Now that the MFR and LPI are closing the gap, the pro-equity argument is squeezed, and the authors could be right to point us towards index-linked bonds for the future. However, I cannot yet say that they are right.

In Section 9 the authors discuss an integrated model of employment cost and staff turnover. Have they not considered integrating investment returns into this model? Consider the demographic risk associated with the unknown average future period that employees remain in a pension scheme, a factor which the authors seem to have overlooked. Is this demographic risk a reason to reduce the discount rate? It was recently suggested to me that the converse may be true, in that periods of low salary increases may be positively correlated with longer average periods of service, and vice versa. There may be some economic justification and evidence for the point. If so, it would affect the analysis in Section 7.2, where it is pointed out that equity dividends and salary increases have not been very well correlated. Perhaps the correlation is better when average service length is also allowed for — as, in theory, it should be. This is another reason why the NAE bond may be, after all, not quite so good for representing final salary liabilities.

We really need an integrated model of salary increases, staff turnover and other demographic risk factors, and investment returns. The authors would need such a model as well, because any hedging argument relies on knowing how all the relevant stochastic factors behave together; but then, having chosen such a model, one must be prepared for the criticism from researchers and practitioners who disagree or show where it breaks down. Without a complete and trusted model, how far can we trust any practical application of the authors' theoretical arguments in the complex area of pensions? Does not the evidence of past years suggest that the judgemental models of experienced practitioners are at least as good?

I have a different point on Section 9.8, where it is argued that the correct actuarial method for assessing the economic value of pensions earned in a period is not the projected unit method, but the defined accrued benefit method with projection of early leaver revaluation, not salary increases. The actuarial method to which the authors refer was originally called the current unit method. This was once in widespread use among insurance companies, and was used for some large self-administered schemes in the 1970s. So, the idea of costing pensions on accrued salary levels is scarcely new, and, indeed, it has re-appeared, both in the MFR and in our profession's recent proposals for disclosing pension costs of directors in published company accounts.

The relevant accounting drafts and standards all work on the proposition that there is a difference in the economic reality between a year's accrual of pension promise based on current salary and a year's worth of pension promise based on future salary. If the authors do not see this difference, they will, indeed, conclude that the current unit method, or DABM, is the one to use, and they will put exactly the same assessment of value on two widely differing types of pension obligation — based on current and future salary respectively. If, however, they see the difference, then, perhaps, they will come to appreciate the logic of the projected unit method.

Section 3 attacks the traditional methodology of pension valuation, which the authors call the funding valuation. I do not use the funding approach as described in this paper, because, in contrast to the method described in ¶4.6.1, I do not concentrate on the assets actually held.

My method, the 'actuarial method', involves placing discounted cash flow values on the assets and the liabilities, and using a selected asset model for the asset side of the valuation. With the help of this paper, I now see that I have four distinct ways of applying this actuarial method in practice:

(1) This is the authors' 'funding valuation', where the notional portfolio is taken as the actual portfolio or a close representation of it. This is the one that they attack. I have not generally used this approach, and its defects were well known at least 25 years ago.

(2) This uses that notional portfolio which hedges the liability characteristics in the dynamic way, as used by Black & Scholes, the 'hedging valuation'. According to ¶4.7.3, the authors' market approach gives the same funding level and is equivalent to this second method. I know that they dislike the presentation of results in terms other than market value, but let us not forget that actuarial values are being marked to market daily in transfer value calculations. The important point is that the hedging valuation and the authors' market approach give the same transfer value at any date.

(3) This uses the notional portfolio which best matches the liability characteristics viewed at a chosen time horizon, the 'matching valuation'. Whilst the authors seek to distance their market approach from the matching valuation, I would point to the increasing availability of options, strips and other derivatives, all of which are traded assets which can be incorporated in a matching valuation framework. Since many of these derivatives are priced by dynamic hedging arguments, the matching approach can also incorporate hedging ideas without the problem of complicated mathematics. One example is in the area of valuing LPI, which is discussed in Section 7.3, rather curiously in an MFR context. Professor Wilkie has already given the option pricing solution to this problem in papers to the ICA in 1988 and 1992. The matching approach could, therefore, be very practical for the future.

(4) This method uses a notional portfolio which is selected by the actuary on subjective grounds. I suspect that this is the normal pragmatic approach of many actuaries, typically with one eye on the actual investment policy, and perhaps, also, with some weight given to matching arguments. This works well in practice, and I do not see any evidence in this paper to refute that. Unfortunately, the advent of the MFR and of new accounting rules will require less pragmatism and more precision in future. The pragmatic approach may have to be abandoned in favour of separate well-defined approaches for funding and accounting valuations.

Much of the authors' criticism of the funding method is unnecessary. The 'actuarial method' is general enough to be useful, both for funding valuations and for assessing economic value, depending on the selection of notional portfolio and the method which results. Having made that point, I think that it is unhelpful to present valuation results in terms other than market value. Pensions are part of corporate finance, as the authors rightly emphasise, and we should beware of continuing with notions and jargon that are not used by management or management consultants other than actuaries. Given, also, the MFR, the time is surely right for a market value presentation.

Pension accounting standards are being revised, and there is evidence of a growing demand for clarity of pension liabilities in the reporting of public company accounts. It is surely essential that we respond to these changes constructively and to the best of our abilities, in helping to provide the public, as end consumer, with the information which it needs. The authors are saying that the pricing mechanisms of the financial markets can, and should, be recognised in actuarial valuations. I agree

with this message. There is clearly much more work to be done on both theory and practice, but this paper contains many valuable pointers for future development.

Mr J. M. Pemberton, F.I.A.: The most important question raised by the authors is the relationship between price and value. They argue the case for using prices as values, and their arguments are helpful, but incomplete.

I suggest two questions which deserve more attention.

1. *What do we mean by the value of an investment*?

Paragraph 4.1.2. suggests that prices reflect future receivables; ¶4.1.3 says that it is axiomatic that value is price. However, the paper does not give an effective definition of the value of an investment. Actuaries place values on their liabilities, which are predominantly cash outflows, and they often need a consistent measure of the predominantly positive cash flows associated with the assets that back the liabilities. It is this which gives rise to a notion of actuarial value. It is a measure of the ability of the assets to meet liabilities. This does not obviate the possibility that price is the best measure of value to use, but to assume that this is always so is over simplistic.

2. *What is the relationship between price and value*?

There are four reasons why prices and values may differ:

(1) *Divergences of opinion amongst investors.* There is interesting literature on this within economics, which shows the complex relationship which may arise when we drop the implausible assumption that all investors have common beliefs about the future. 'The 'Marginal Opinion' Theory of Stock Price', by R. G. E. Smith (*Financial Analyst Journal*, November 1967), is an excellent starting point. Prices may reflect marginal, rather than aggregate, opinions concerning value. This possibility is not acknowledged in this paper.

(2) *Differences in liabilities between investors.* It seems entirely appropriate that we should choose a valuation measure which reflects the ability of the assets to meet the liabilities, and thus tends to place higher values on assets which more closely match the liabilities. The authors refer, in Section 3.3, to a supposed conjuring trick in which two schemes are both better off from exchanging assets, which leaves them both more closely matched. I am reminded of the long standing confusion which surrounded the question of international trade — for a long time it seemed a conundrum that such trade should occur — surely one party must be worse off? Of course that is not the case, as economists have now shown; the exchange is mutually beneficial to both parties. Correctly analysed, the situation here is closely analogous — there is no conundrum.

(3) *Differences in risk preferences between investors.* Attitudes to risk may differ, even amongst investors with similar liabilities. Again, it is entirely appropriate to reflect these attitudes in our measures of investment value.

(4) *Differences in the purpose of valuation.* The authors cite a list of possible purposes for a valuation in Section 4.3.

I am not suggesting that this list is complete; but it is sufficient to show that there is considerable richness to the relationship between value and price which deserves greater attention.

Where the authors are on strongest ground in pressing for market-based assumptions is in advocating the use of the market's term structure of interest and inflation rates, where these term structures are a key parameter of value. However, I make two points:

(1) In many circumstances these term structures will not be key parameters — where they are not their use could distract attention from more important aspects of the valuation.

(2) These term structures are special cases of parameters that can be determined from the current structure of market prices, using a set of auxiliary assumptions which is acceptably modest. There are very few other examples. Certainly attempts to price equity derivatives using the structure of current prices, as appears to be proposed in ¶6.7.2, is not possible without recourse to very powerful auxillary assumptions.

The authors are advocating strongly the use of prices at the expense of actuarial values; but whether we use price as value should depend on the context — price may often be a good first approximation to value, but, in many circumstances with which the actuary is concerned, this may not be the best approximation. Often it is the difference between assets and liabilities which is crucial. This paper has not solved the practical problem of placing market values on liabilities. A new synthesis is required between price and actuarial value; neither is adequate by itself.

Mr P. A. Randall, F.I.A.: There are a number of detailed areas where I take issue with the authors. Examples are their emphasis on aggregating the views of shareholders and pension scheme members, and of members' pension and other portfolios; arguably, an insufficient regard to the reality of separate interests, and especially to the separate legal personality of the scheme; and in the emphasis on the purely financial aspects at the expense of other important practical elements in some of the applications explored later in the paper. In particular, I am yet to be convinced by the arguments leading to the assertions, in ¶¶2.3.7 and 2.5.5, about the impossibility of deriving optimal pension fund investment strategies in isolation.

However, I shall concentrate my remarks on the first part of the paper, where I think that the essentials are right. Two key messages come from that part. The first is the need for market valuations to apply, and the second is that the market value of liabilities should be taken as the market value of a hedged, matched portfolio of equivalent cash flows, as closely as this can be determined. This, of course, is not a novel idea. It dates back, at least, to the first paper of the opener (Wise, 1984), as Mr Arthur and I acknowledged when we stressed the same point in our paper 'Actuaries, Pension Funds and Investment' (*J.I.A.* **117**, 1-49). In this respect, I agree that the best hedges for final pay related liabilities should be derived from index-linked rather than equity-based portfolio models.

I think that the profession took a wrong turn and missed a major opportunity when it first embraced discounted income approaches to the valuation of assets in pension scheme valuations. This is not to say that the adoption was wrong, nor to say that it was not a major technical advance at the time, but the wrong turn was to use the technique to produce actuarial values of assets instead of market values of liabilities. We have spent the last 20 or so years trying to get the world at large to understand what we mean. It is a tribute to the communication skills of the profession that we have been as successful as we have.

It is now clear that a unified market-based approach to liability valuation would have been better. We have the need to reconcile: discontinuance and funding valuations; the impact of the MFR; and the vastly greater volume of, and attention to, transfer payments, both bulk and individual. Above all, we have the need to communicate a wider range of ever more complex results to our clients, and to an ever widening public audience. We will shackle ourselves if we continue to work in anything other than market pounds.

We could achieve a first step on this path by a simple adjustment to the current technique; namely to apply the factors derived in our current discounted income, asset valuation approaches, on the liabilities side of the balance sheet instead of on the asset side, to produce 'market' values of liabilities from the 'actuarial' ones. The results would, of course, be the same; but the presentation would be much better. There are some technical advantages as well, in particular the scope to use appropriately differing adjustment factors to each of the major liability classes. Within such a framework, we can, and must, continue to improve our technical approaches to the calculations without further disruption to the presentation of results.

The paper does not provide final technical prescriptions for valuation methods, but it does set out some important principles. The time has come for the profession, as a whole, to make more efforts to produce a detailed synthesis of market-based valuation approaches.

Mr A. Judes (a visitor)**:** I shall comment on ¶2.5.6, where the authors wrote: "It is extremely difficult to create a remuneration structure...to generate economic benefits both to members and to shareholders."

I suggest that there are many such structures that are available and possible. Economic value added (EVA) was mentioned as a tool of looking at a company and its pension scheme. Many EVA-based

incentive schemes are being introduced, where members, as employees, are rewarded as the EVA generated by the company itself grows. Similarly: savings-related share option schemes, which give members a simple savings scheme and a growth in the value of stock; restricted share awards, which give share ownership directly to the individuals; are all examples of remuneration structures which link together the interests, both of members and shareholders — members as employees. In the context of the pension scheme, even self investment in the company via an AVC fund, or indeed performance-related pensions, can also give a similar interest.

Who are the shareholders referred to in ¶8.11.9, because index-linked gilts, as I understand it, are exempt from tax for any modest holdings by individuals, and this may alter the perspective of the individual holding index-linked gilts?

I support the market-based funding approach, and, indeed, refer to some pension schemes where this does happen on an annual basis, that is group unapproved funded final salary schemes for those individuals who do earn above the earnings cap. The basis of valuation which we have agreed with the Inland Revenue permits annual valuations and a mark to market.

Mr C. D. O'Brien, F.I.A.: This paper gives us new challenges. Are we going to change the way in which we value assets in pension schemes?

I favour using the market value of assets. Perhaps actuaries brought up with life assurance valuations find this natural in any event. Market values are a reality which will help actuaries in their communications with their customers, employers and trustees of pension schemes. We would not then be calculating so-called 'actuarial values' of assets, but we have other skills to help manage pension schemes, and ensure that everyone understands the implications of the funding decisions and the asset mix decisions which are taken. We should accept this challenge and not shy away from it.

The International Accounting Standards Committee's proposals on pension schemes use the market values of assets, and I was pleased that the International Forum of Actuarial Associations' response was sympathetic to determining a new way of pension scheme liability valuations which would be consistent with the market value of assets. However, the Institute of Chartered Accountants in England and Wales are against this. It does not like volatility in the accounts, and wants to retain the smoothing implied by the current practice of discounting future investment returns. If these discounted values still continue to be calculated, I hope that they will be called something different from actuarial values. The actuarial profession should be moving on to greater realism.

What about the liabilities?

The authors attribute great significance to the employer's liability on a discontinuance basis. I have made a similar point in the context of life assurance valuations, but I have been told that I am out on my own by highlighting surrender values in my earned profits method of accounting. However, what I said is that the liability should be the greater of the liability on surrender now and the liability if the policy is not surrendered.

So, what if the pension scheme is not discontinued? If you consider how the cost of employment increases with age in a final salary benefit scheme, can you really ignore the rising costs which the employer will face in the future? I suggest that the concentration on spot values can be misleading if calculated on the discontinuance basis.

The authors warn us against confusing accounting conventions with economic cost. I agree that to start off assuming that pension costs should be a flat proportion of salary, as in SSAP24, is wrong, but I also think that SSAP24 is a wrong interpretation of accounting principles. If you look at the accounting framework of either the International Accounting Standards Committee or the U.K. Accounting Standards Board, you will find that a liability is a present obligation, arising from past events, which will result in an outflow of the firm's resources. Obligations may extend beyond what is legally necessary. The accounting framework says that "obligations also arise, however, from normal business practice and custom and a desire to maintain good business relations or act in an equitable manner."

If normal business practice was to reduce salaries near retirement or to discontinue future salary-related pension benefits, then the spot price approach would be the right one. Otherwise, I think that

the employer should recognise, not just the discontinuance liability, but also the liability from future increasing costs, although the outcome need not be a cost proportional to salary, except by chance.

It is the valuation of these present commitments to future obligations which is our expertise, and we should maintain our new slogan: actuaries make financial sense, not just of spot prices, but also of the future.

Mr A. Noble (a visitor): The authors have successfully challenged many sacred cows in the area of pension investment and exposed many inconsistencies in current practice.

One topic that stands out to me as particularly relevant, not just for defined benefit, but also defined contribution, schemes, is the question: are equities somehow less risky the longer you hold them? A few questions illustrate this:

(1) Since equity markets transfer business risks to shareholders for a premium, is it reasonable to suppose that, the longer that you are exposed to these business risks, the less painful they become?

(2) Since investors expect less return wherever there is less perceived risk, does this strategy somehow self-destruct? The Tokyo equity bubble in 1990 may have some relevance here.

(3) Maybe, should companies try to satisfy this sort of demand by issuing 'long-term' shares which carry a lower dividend pay out?

To answer the questions with any confidence, we can look, first, at historical returns. However, we rarely have enough historical data, and we suspect that this is the reason for much of the current attitude that the longer you hold an equity, the less risky it becomes. In fact, some people may believe that there is only one history of capitalism, and that is not a very big sample on which to base results.

So, maybe we can look at some sort of random walk type model where expected returns vary with time, but volatility varies with the square root of time, and, in our mind's eye, we can imagine this equity distribution rising ever upward as we go further out in a holding period. This may encourage us to think that the risk of equities under-performing is getting less the longer that we hold on to them. This is a somewhat inadequate model of risk aversion. If we were to look at something rather more considered, and, in particular, at downside risk, we find that the downside risks of equities tend to more than outweigh, or at least equally outweigh, the increased long-term expected return.

I illustrate this with two questions:

(1) What do we think that the probability is of equities being worth less than, say, 70% of their starting value as you go out in time? If you do an expected utility maximisation exercise, it turns out that there is an increasing likelihood that, with a longer holding period, the target of 70% of starting value will not be maintained. If you want to choose 80%-90%, you get somewhat different returns, and the fact that equities do not perform so well is a measure of the 70% downside risk measure that I have chosen.

(2) What percentage of initial equity value can you be 95% confident of having at maturity? Again, if you do the expected utility maximisation, as you go out in time that fifth percentile decreases.

These are conclusions that many people do not expect.

So, I think that downside risk is very important, and tends not to be valued. If you value it using expected utilities, you find that, if you hold equities for 1, 2, 5, 10, 15, 20, 30 years, the optimal equity mix that will maximise expected utility tends to remain constant. It will be at a lower level if you are more risk-averse, but this is not that intuitive, and again reflects the fact that the possibility of very poor performance of equities is at least an equal counterweight to their expected increased performance.

So, the general perceived wisdom about equities, that the longer you hold them, the less risky they become, is a fallacy. An obvious flaw in the long-term argument appears if investors are able to rebalance their portfolios. If the portfolio is rebalanced regularly, the rebalancing opportunities become a series of short-term decisions, and a long-term decision then becomes a series of short-term ones, so that the question as to whether equities become less risky the longer they are held becomes a non-question.

Mr J. T. S. van Bezooyen (a visitor): The most amazing achievement of the paper is, not that it shows convincingly the academic superiority of the economic value principle, but that it shows how adopting that framework ties a lot of loose ends together. For example, it shows how the value of liabilities can be derived from assets with the same characteristics, and, in a broader perspective, the way to analyse how the pension provision fits in with the total remuneration package.

The concepts in the paper are not new. For example, the irrelevance proposition was put down by Modigliani & Miller in 1958 ('The Cost of Capital, Corporate Finance and the Theory of Investment'. *American Economic Review*, **48**, 261-297), and the fact that they earned a Nobel prize in 1990 means that these ideas have certainly been accepted in the academic world.

When discussing these kinds of ideas with people in actuarial practice, I come across the argument that economic value is a nice concept, but it is not accepted by trustees; it is not accepted by management in general, so we should not adopt it. That is not a good starting point. All economics and business degrees, nowadays, are based around the economic value principle, so, in about 10 or 15 years, when many involved in management will have taken an MBA, those ideas will become more and more widespread. Thus, the logic, the coherence and the need to anticipate future changes in management practice actually dictate the adoption of the economic value principle.

Mr M. J. Jones, F.I.A.: Like the opener, I have been involved in providing advice to the Accounting Standards Board on changes to SSAP24 and, more recently, in formulating their views to go to the International Accounting Standards Committee on Exposure Draft E54. This has given me a keen insight into how accountants think, both here and internationally, and my comments come largely from that perspective.

My key themes are similar to those mentioned by Mr Randall. Pension commitments should be valued by reference to a market-value-related approach, rather than traditional long-term actuarial techniques. An appropriate hedge for these liabilities should be determined in order to calculate their true value. The right hedge for salary-related liabilities for active members is index-linked gilts rather than equities.

I believe that, in pricing the pensions commitment from the employer's perspective, we should be using a market-value-based assessment. Two years ago I did not have this view. In changing my mind, I have been particularly influenced by two factors:

(1) We now have a minimum funding requirement for U.K. pension schemes which is market based. Where the minimum exists, the standard approach will not be far behind. Clients will become increasingly confused by having a minimum funding requirement which is market based and a normal funding requirement which is totally unconnected to market values.
(2) The IASC approach to pension costs, as set out in E45, is clearly going to be an international standard on calculating pension costs, and it is going to be market value based.

We should accept these, as a profession, and decide how best to do things within the market-related conceptual framework. To that extent, I support the premise in the paper. I equally support the logical consequence of the market approach that there should be production of market-related liabilities based on an appropriate hedging portfolio.

This leads to the question of what is the appropriate hedged portfolio. It is generally recognised that, for pensioner liability, a fixed or index-linked gilt hedge is appropriate. The argument really relates to final salary related liability for members in service. As the authors note in Section 7, there is no obvious hedge, because there is no asset with a return linked directly to increases in NAE. We need to channel energy into persuading the Government to issue such a bond in the future. In the meantime the authors provide a convincing case for a strong linkage between salary inflation and price inflation, following which there is a natural link for index-linked gilts as the hedge for final-salary-related liabilities of active members.

The authors shoot down any similar link between salary growth and dividend growth which underlines the rationale for using equities as the hedge for the liabilities. Whilst the arguments look convincing, I have two concerns about this approach. First, the ASB and the employers are very keen on the equity-based hedge for determining pensions costs, because of the likelihood of it producing

lower and less volatile costs. Are we prepared, as a profession, to stand out against these bodies in order to satisfy our own intellectual concepts? Is there a danger that the profession will become marginalised and lose out on the ground gained recently with the accountants, particularly between the IFAA and the IASC?

I also have a concern relating to realities. How wide does the investment market need to be for the investment to be regarded as an appropriate hedge? If just one salary-related bond was introduced by the Government, would this be enough to justify using it directly as a hedging mechanism? If not, then how big would the market in these bonds need to be before that point is reached?

The choice of hedging vehicles, at the moment, is between index-linked gilts and equities. There are wide markets in both types of stocks, but there are far more equities than there are index-linked gilts. Does this matter? Also, if all U.K. pension scheme liabilities are valued using an index-linked hedge, and if these total liabilities are, for example, four times the size of the available market, does that matter?

These sorts of questions, and the arguments put by the opener, mean that, although there is a very good case for index-linked gilts as a hedge, the arguments are by no means over, and the debate is still very much open. The important thing is that it has been opened, and that this paper is an important step in moving it forward within the profession.

To maintain our credibility, both here and internationally, we must produce an agreed approach which both meets our professional requirements and ensures a practical outcome with which our clients and colleagues in other professions are comfortable.

Mr T. G. Arthur, F.I.A. (in a written contribution that was read to the meeting): I agree with many of the points made in the paper. Several important ones have already been aired in the 1989 paper by T.G. Arthur & P.A. Randall ('Actuaries, Pension Funds and Investment'. *J.I.A.* **117**, 1-49). That paper proposed the converse of conventional wisdom; market values matter in actuarial terms, but not in investment monitoring terms. It went on to argue that a relative change in the market values of mismatched assets must be reflected in actuarial evaluation. Its main guiding principle was that assets should be notionally switched into matched form for evaluation. It stated that liabilities can be properly expressed as the market value of matched assets. Finally, it proposed that the benchmark investment portfolio should be the matched assets. All of these features are major proposals in the current paper.

In addition, I agree with the authors on several investment points, in particular:

(1) You cannot have your cake and eat it as far as the equity risk premium is concerned (called *The Conjuring Trick* in Section 3.3).

(2) There is no relationship between equities and salaries, nor does any economic theory worth the name suggest that there is. I have been trying to get this point across for at least 5 years.

I take issue, however, with the idea, expressed in ¶¶2.3.6 and 8.1.3, that there is no optimal risk/return strategy for pension fund assets. This seems to be based: firstly, on an assumption that risk premia always cancel; and secondly, that shareholders may be able to modify the strategy.

Taking the latter point first, there can be no quarrel with the idea of shareholders taking account of the pension fund strategy by modifying their other assets (see ¶2.3.3), but let us be clear that, in most cases, trustees control the pension fund strategy. This is a control which shareholders or their representatives cede in the pension scheme prospectus and other documents, presumably because they believe that it is a sensible part of a remuneration package.

The trustees have no alternative but to exercise that control in the perceived interests of the scheme membership, represented by the assets. What this perceived interest is will vary, but there is normally a clear emphasis on safety in real terms, again conveyed in the prospectus and other documents. This would normally present opportunities for a favourable risk/reward mix, since premia only cancel out if the investor is 'typical' (which, in practice, no investor ever is).

The authors bolster their point here by arguing that, in a defined benefit scheme, investment gains and losses are shared symmetrically between members and shareholders. In my experience this is hardly ever the case, and the losers are more often the members than the shareholders. The problem

here seems to be the authors' contention, in ¶8.2.1, that benefit risks come into play only if both the scheme and its sponsor are insolvent at the same time. However, there are many ways of removing or reducing sponsorship of a scheme without the sponsor becoming insolvent.

Thus, by rather different routes, we seem to approach the same conclusion, which is that the case for a strong degree of matching is seriously under-valued!

Mr D. J. Parsons, F.I.A.: I have reviewed my comments on Dyson & Exley (1995), which are given as an example in ¶5.8.1, and found them entirely valid as a response to this paper as well.

I was also interested to see how Figure 5.9.1 demonstrates a volatility of results which, I suspect, not many pensions actuaries fully appreciate, let alone their clients or the clients' auditors.

The proposals are likely to be met with supreme indifference by many actuaries, to whom they will seem quite irrelevant and far from coherent or simple. Most actuaries are interested only in creating fuzzy snapshots of the financial status of the small schemes that they deal with; that is the ones operated by companies that are outside the FTSE 100 and Fortune 500. The auditors and the trustees, whom we have spent years educating, think that they can understand these snapshots. Have we always been so wrong? In the light of this paper, traditional funding methods will suffer the same fate as the net premium valuation method when more modern approaches were devised.

The part that I found to be innovative was the comment, in ¶8.6.5, which, if taken out of context, suggests that fashionable wisdom on matching could be reversed, and that it may be more appropriate to increase the equity mix for pensioners and deferred pensioners. This is an important area for research and development, with the ultimate aim of providing realistic pension guarantees in defined contribution schemes, including personal pensions, perhaps making redress by guarantee in the SIB Pensions Review more appropriate. It could revolutionise pension provision and, possibly, make the current political proposals for replacing SERPS with individual savings plans viable from the consumers' point of view.

Mr K. J. McKelvey, F.I.A.: This paper encourages us to think about assumptions which might otherwise be taken for granted. The paper is long and complicated, but contains a number of simple core ideas.

One idea is that pension fund assets should be valued at market value. I agree with that view, but find myself wondering how we ever came to use any other value. Someone may answer that it is an automatic consequence of using a discounted income approach for valuing assets, but, of course, it is not. Rather, it is a result of using an off-market valuation basis in that process. So why did we ever start using off-market valuation bases for assets? My father, now retired, was one of the authors of the paper which, among others, started all this (Day & McKelvey, 1964). I asked him that question. The answer was that 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. However, my father considers that market values would be unavoidable now. Thus, the objectives of the 1964 paper and the present paper were the same: consistent valuation of assets and liabilities. In 1964 this objective happened to result in off-market asset valuation methodologies, for reasons which then applied, but no longer do. Thus, I agree with the view that it is time to move to market values for assets and drive the liability valuation from there.

A second core idea of this paper is that the market-based valuation basis for liabilities should be derived from a 'hedging' portfolio of assets, not from a 'notional' portfolio, broadly reflecting the asset mix which will actually be held. The reason why this should be the point of departure is that it is the minimum risk position, and that any risk which may, quite legitimately, be taken on by adopting a different, non-hedged, investment strategy should be treated explicitly, not implicitly. I suspect that existing actuarial methodology actually does address this added risk, but implicitly rather than explicitly. Hence the opener's 'pragmatic' category within the actuarial approach. It does

this by appearing to develop valuation bases based on a 'notional' portfolio, but actually understating the returns expected on that 'notional' portfolio, and thus making an implicit reserve to allow for the risk of having diverged from the 'hedging' portfolio. However, the authors' proposal would allow explicit treatment of these issues, and I support its theory, even if its practical impact may be limited.

A third core idea is that the sponsoring company and the pension scheme should be considered as one economic entity from the point of view of a shareholder. This is not a new idea, and it has some merits. However, I have doubts about whether the exploration of this area is complete. The numbers of economic agents involved are many: not only shareholders; but members; senior management, wearing both member and manager hats; legislators; and trustees. The latter, in particular, are faced with increasingly onerous personal responsibilities which do not include shareholder value maximisation, but do include preparation of the Statement of Investment Principles. I suspect that a simple shareholder value logic is unlikely to be able to explain all that is going on or to determine optimal behaviour.

Most of this paper is robust, but I am left with a conundrum which the authors must also face. The thrust of their paper is to imply that established actuarial methodology leads to economic inefficiency and can be improved. If this is the case, then, given the efficient markets hypothesis (EMH), should that methodology not have been swept away long ago, since its details are far from a secret? However, it persists. Thus, either the EMH is wrong or the established actuarial methodology is not giving rise to economic inefficiency. If the EMH were wrong, then much of the theoretical basis of this paper would be in doubt. On the other hand, if established actuarial methodology is not giving rise to economic inefficiency, then the paper, while introducing many useful ideas, probably raises as many questions as it answers.

Mr P. M. Greenwood, F.I.A.: This paper is very pertinent to the development of the actuary's role in pension provision and in financial services in general. It points out the flaws and inconsistencies of the 'equity yield' valuation school, as applied to contractual benefits developed within the U.K. profession within the last ten years or so. In a way, the paper shows that the long-standing actuarial approach of valuing a cash flow by market risk-free yields from the nearest matching or hedge asset is consistent with modern financial theory. Many who support the equity yield school do so on the basis that the answers produced seem more corporate/client friendly. This is a dangerous approach, and one that drove the accountancy profession into deep water about ten years ago, and led to the establishment of the ASB. This paper shows that the equity approach may not be in the best interests of the ultimate client, shareholder, nor of the member. The profession's reactions to this paper may be fundamental to its future. The profession will not survive if it relies on techniques and assumptions inconsistent with the rest of the financial world; this paper offers it an opportunity to return to the fold.

Perhaps the equity school should be given a further short period to reply in writing. If they cannot produce acceptable answers, then I believe that the profession should urgently take the following action:

(1) It should persuade the International Federation of Actuarial Associations to withdraw its evidence arguing against the risk-free bond approach of E54, the 1996 draft International Standard on Accounting for Employee Benefits.

(2) It should urgently ask the new Government to reconsider the equity-related basis for cash equivalents for contractual benefits and for the MFR. A sound gilt-based solvency test clearly does not have a true economic cost above the original pension promise made by the corporate entity. Those companies or governments who have promised benefits that they cannot afford, or have taken surplus from schemes on the basis of the theories of the 'equity school', should be offered a once-and-for-all opportunity to adjust the promise or the funding.

(3) It should abandon consideration of an equity-based central discontinuance fund, which, if the theories of this paper are accepted, is clearly financially unsound. This is true if you compare it against the theories behind the income bond scandal that we saw a few years ago. This paper explains why that scandal occurred.

Mr P. N. Thornton, F.I.A.: I support the author's aim to bring financial economics more clearly into pensions work, and one of my reasons is that, over the years, I, among others, have worked hard at relating my work to market values, subject to consistency between the assets and the liabilities. This has included choosing assumptions leading back to market values or something close; re-expressing conventional results in market value terms, and also valuing highly mature funds at market value, using the yields on matching assets to value the liabilities, quite apart from using asset valuation models which reflect the results of asset liability studies. Therefore, I have no problem with the authors' 'market-based' approach.

Like Mr Jones, I think that it will be hard to resist, as pension fund liabilities and assets begin to appear on company accounts in accordance with international accounting standards. Over the last year I have been heavily involved with working with the International Accounting Standards Committee, and, to some extent, with the U.K. Accounting Standards Board, regarding accounting standards for employee benefits. The IASC, although not the ASB initially, were anxious to have a market-based approach. They were highly suspicious of assessed values or discounted income methods, and they saw no way of achieving comparability between the accounts for different companies with these methods.

The various working parties of the Pensions Board and the IFAA rapidly decided that this was not the right battle to fight, and we recognised that, in the U.K., market values are already used for bulk transfers, individual transfers, MFR tests, among other matters. Instead, we decided to focus on the argument about the discount rate.

Initially, it appeared that the IASC was set on using a fixed-interest corporate bond yield to discount all liabilities, which caused us significant concern, shared amongst the dozen or so countries on the sub-committee and, indeed, the other countries represented in the IFAA. Subsequently it was clarified that, for liabilities in real terms, price-related or index-linked bond yields could be used, but even there the IFAA saw problems in those countries used to investing in equities. In any case, the United States of America is about the only country with a significant corporate bond market, so the margin over government bond yields provided by corporate bonds would not be available elsewhere.

Initially, we argued that the appropriate discount rate should be derived from an 'appropriate portfolio' of assets, derived, for example, by asset/liability modelling. The international accountants had legitimate concern that the results should not be influenced by the actual assets held by a pension plan, and were very suspicious of the 'black box' which seemed to be involved in asset/liability modelling.

Therefore, we moved to an argument that the liabilities should be segregated, and an appropriate discount rate used for the fixed monetary liabilities, index-linked or price-related liabilities, and salary-related liabilities. On the first two of these, the authors are with us. With this approach, we seem to be getting somewhere with the IASC, because we are now talking in a language which we both understand, but we have yet to win them over from what is currently proposed in E54.

Whilst the term structure of interest rates is, indeed, something that is suggested in the IFAA submission to the IASC, my expectation is that, in practice, the IASC will want something simpler, and will actually suggest something like an average.

We are still seeking an approach that embraces equity returns for discounting salary-related liabilities. This is the area where I part company with the authors. I am suspicious of their arguments that pension fund trustees should not be investing so heavily in equities, and that valuation bases should factor out any excess return expected. This conflicts with economic reality!

The authors seriously under-estimate two issues. The first is the desire of trustees to build up a strong fund independent of the sponsoring company, and to invest in assets which will improve, rather than constrain, the level of funding. Even where there is no prospect or certainty of improvements being made, trustees would still like to increase the level of assets relative to the liabilities to improve members' security, hence their healthy interest in equity investment. Shareholder value is not the trustees' first concern, and too glib an application of the concept of shareholder value does not recognise the significance of trust funds in this context.

The second issue is the authors' under-estimate of the willingness of sponsors to take calculated risks in order to keep pension costs down. The world has changed enormously with the guaranteeing

of LPI increases instead of discretionary benefits and the introduction of the MFR, and so the nature of a calculated risk will change. However, there is still a firm belief among sponsoring organisations that equity investment will generate lower costs or better benefits in the long run.

We must always bear in mind the need to express sophisticated actuarial ideas in simple terms if our clients are to be confident in our advice.

Dr S. Satchell (a visitor)**:** I have four points which are minor academic quibbles. First, I criticise the authors in what they say about time diversion of risk. My reading of the academic literature on time diversification of risk is that it is unequivocal that you would want to hold more equity as you increased the time horizon. The examples mentioned earlier, contrary to this view, can all be motivated by choosing a utility function, but you have to choose your utility function to get your result. The utility functions that accord most with commonsense and with reasonable assumptions of attitude to risk will give you the result that you will actually hold more equity. The example given, where you hold less equity, uses quadratic utility, which does not describe investor behaviour very sensibly.

My second point is about market valuation and the use of market prices, which I am cautiously in favour of. The main flaw, and this applies to valuing banks or equity portfolios, or anything else, is that taking market prices is, in effect, valuing things under the assumption of perfect competition, that is assuming that you can sell everything at that price. That is clearly not the case if you happen to have a portfolio where you have some particularly unpleasant companies, you have 80% of them, and you have to liquidate overnight. Market impact is then very important. The sort of analysis that we see here does not take that into account. I also say that it is very difficult to take it into account.

The third point is about the issue of finding hedges, and this concerns picking the closest minimum variance hedge to value a non-traded asset. That is a good principle, but it becomes an empirical, statistical question. One would want to know if the best hedge explains, say, 2% of the variation, then that valuation, while theoretically interesting, has no practical import. Furthermore, the best hedge may not only be a bad hedge, but it might have very poor returns, and this would not help the pension schemes at all.

The fourth point is about the issue of prices versus values, and there is an interesting view on this point. The great thing about financial economics is that you can always quote the authority that appeals to you! For example, there is an American school, which is typified by the views in the paper 'Permanent and Temporary Components of Stock Prices', by E. F. Fama & K. R. French (*Journal of Political Economy*, **96**, 21, 246-273). This models equity in terms of a slowly moving component plus noise. If you think of the slowly moving component as something which you would calculate by taking historical prices or returns, or whatever, you have some notion of value. It is perfectly sensible to have a long-term process embodied in market prices, and quite natural to want to estimate it.

Mr B. H. Davies, F.I.A.: I am troubled by the view, most clearly expressed in ¶2.3.3, that a pension scheme's finances can be regarded simply as if they were the assets and liabilities of the firm's shareholders. There is a sort of ritual obeisance in a later paragraph to the role of members, but this ignores the possibility of different interests between shareholders and members. I want to emphasise that there seems to be a too ready assumption amongst many actuaries that, with recent legislation on the responsibilities of employers, members have no real interest in the nature of a scheme's investments. I think that that is wrong. Earlier speakers have emphasised the way in which shareholders or their companies can shift the downside of equity investments onto scheme members.

I also pick up the problem which we would face in a world where economic conditions are less healthy than we have seen over the last 20 years. In such a situation, you may find financially hard-pressed employers going for higher yields, and hence higher risk investments, which would provide no protection for the members if the company and the investments go out together. Those two events are certainly correlated. So, there are differences of interest between members and shareholders, and the model needs to reflect that. However, I do not think that that is actually a point that is fatal to the model, but it needs to address the point more clearly.

My second point relates to the arguments, set out in ¶¶2.5.2 to 2.5.4, about the different ways of funding a scheme and not affecting the value of the benefits due under that scheme. That argument

could be applied explicitly to state provided or state mandated benefits. That represents a clear rejection of the arguments that have been put forward most recently by the Adam Smith Institute, which produced the marvellous result that, if you fund state benefits at a 2% return and you fund private benefits at a 7% return, the private benefits are very much cheaper or very much bigger. This paper illustrates that such arguments are nonsense.

Mr P. J. Lee, F.I.A.: The Government's main assets are effectively an equity share in the economy, with anything from a 17½% share up to a 50% share of income, corporate income and personal expenditure. It is an illusion to think that gilts are truly risk-free. Risk-free assets do not exist.

This paper is based on a premise that markets are efficient and correctly priced, but, from time to time, because of custom, legislation, accounting practice and, indeed, advertising in the case of the personal sector, where unit trusts draw personal investors in with an advert through the door saying, "The market has gone up 18% — share in that growth", that markets are not as efficient as the authors conclude. According to them, the demand for U.K. equities has been artificially inflated by current U.K. actuarial pension fund practice.

A shift from equities to bonds, of the order of magnitude suggested, would alter prices massively. How could this shift (which is not factored into current prices) be consistent with an efficient market hypothesis?

More fundamentally, it is the risk element of a modern capitalist economy that provides the income to people for the first 60 years of their lives. If, as the authors suggest, the risk element can be removed for the remaining 30 or 40 years after retirement, then surely we could do the same for the first 60 years of life?

I am not convinced that governments can provide protection with equities against the melt down scenarios that the authors warn us against.

Mr S. J. Green, F.I.A.: There is nothing wrong with using market values for the assets, so long as we use market values for the liabilities. The problem about using market values is that, if you have a situation like that in 1974, where the market value of a portfolio dropped by over 50% in 6 months, it may be difficult to explain to clients that it has not altered the deficit or the surplus in their pension funds.

The authors state that banks should not be in the business of investing in equities, and that they "do not typically apply such exposures as an overlay on a corporate level". However, German banks do precisely that.

The equity risk premium is composed of two things: the risk that the income stream will not turn out as forecast; and the risk that the equity which, because the market level is not right at the date at which you want to sell the equity, will not actually achieve what you are looking for. Therefore, I agree that the longer the time horizon, the more likely you are to achieve what you are looking for, rather than the other way round.

Mr Noble suggested, looking at ¶5.5.1.1, that the further out you were, the greater the risk that equities were not going to achieve 70% of the value you started at. The problem here is that you are looking at the wrong probability distribution. This is a point endemic in the paper. The authors say that the instantaneous inflation rate follows Brownian motion. No empirical work can possibly show that.

The authors, in ¶3.5.3, seem to be advocating the situation, as with American companies, of enhancing shareholder value by having share buy-backs rather than paying dividends. When this was tried in the U.K. it was not ideal. One of the problems is that smaller shareholders usually do not receive the offer of a buy back, and thus lose out.

Ms A. M. Rappaport (President-Elect of the Society of Actuaries): I would like to share with you a little of my experience from the U.S.A. I have always tried to do the best by the people whom I work with and for. One of the things that has not worked out well over my career is in looking at what actuaries were doing about 15 years or so ago, when valuing pension funds was on a rather artificial basis. The economic value of the funds was quite different, and we discovered that people

were buying companies, terminating the pension plans, and using those assets to help fund takeovers. In fact, there was a danger, when the pension fund had an economic value very different from the stated value, that it created a risk to the stability of the company.

We have also heard about shareholders and members not always having the same interests. While I cannot disagree with that, I point out that, within the framework of many people losing their jobs, when employees' interests are viewed as too unaligned with that of shareholders, that may mean a lot of down sizing.

I also want to consider the defined benefit/defined contribution (DB/DC) issue. One of the points that the authors made was that they hoped that thinking things differently might help strengthen the protection of DB plans again. We have had DB/DC debates going on for 30 or 40 years or more in the U.S.A. In fact, the issues about the plans not aligning to changing job situations are very much alive. What we have found, in the past few years, is when major companies look at the plans from a financial perspective, that they are finding DB plans to be better, but that the benefit pattern in DC plans is often looked at favourably, and we are moving, in many cases, to larger companies selling cash balance plans which, from the plan sponsors' point of view, look like DB plans, and, from the participants' point of view, look like DC plans.

Mr R. H. Beardshaw, F.I.A.: If we move away from the macro economics of pension funds, each company has an aim, indeed a duty, to deliver pension benefits in the most cost effective manner for that company. In practice, this has best been achieved in the past by investing in equities, and those who moved into equities in the 1950s and 1960s have seen a handsome payoff. That is not to say that the future will do the same. Indeed, equities, as a class, do carry risks. Part of the equity risk premium relates to the volatility of the return, but pension funds, as they mature, can unwind over, say, 20 or 30 years, thus smoothing out much of that volatility, and so capture much of the risk premium.

I have no argument with the proposal that valuations should be based on market value for both assets and liabilities. However, the use of matched portfolios will put up the cost to scheme sponsors in the short term and, very probably, in the long term, if trustees are persuaded to move to a more matched position which is less cost effective. Overall, I do not see that as being in the best interests of scheme pensioners nor of plan sponsors. Many sponsors would like to see pensioners receive increases above LPI if inflation exceeds 5%, but cannot afford to switch equities into index-linked gilts.

We need a practical approach which recognises the practical world, otherwise the authors' hope that defined benefit schemes still have a future may be fundamentally flawed.

Mr L. P. Tomlinson, F.I.A. (closing the discussion)**:** Those of you who have read *Gulliver's Travels* will, no doubt, remember the bitter war waged between the Big Endians and Little Endians — the dispute being over which end of a boiled egg should be cracked first. The pitched battles that have taken place between financial economists and actuaries have something in common with the Big Endians/Little Endians war. In fact, both sides are applying a scientific approach to complex financial problems, and each discipline can learn from the other.

Financial economists can learn from the robustness, pragmatism and the tried and tested nature of the actuarial tradition. Actuaries can learn from the new ideas and the intellectual content of financial economics. Mr van Bezooyen pointed out that many of these ideas in financial economics have been around for quite a long time, and that we actuaries are now just starting to embrace them. The disciplines should look for mutual respect and to learn from each other. They have much in common.

The authors have produced a very wide ranging and thought provoking paper, challenging the actuarial wisdom in the defined benefit pension fund field. It is fascinating to approach old problems from a new standpoint. If this is developed more, then there will be much less conflict with the actuarial method, and I was pleased to hear the opener and others say so.

I should like to draw five main strands from the discussion. First, I was astounded by the uniform acceptance of the use of market values. Speaker after speaker endorsed the principle of using market values for valuing the assets, and then valuing the liabilities consistently. My actuarial background was in the 1970s when no actuary would endorse market values, so we have moved a very long way since that period.

Secondly, I should like to consider the practicality of what is proposed. A number of speakers have pointed out that, although the theory is very attractive, there are some quite significant practical problems. Mr Pemberton and Dr Satchell spoke about the difficulties of using market pricing and establishing fair prices at all times. The opener spoke about the difficulty of getting demographic assumptions into a model. I should like to see a market-based valuation of assets and liabilities, carried out in practice on a real live pension fund, before fully endorsing the ideas described in the paper.

The third point relates to legal structures, that is the legal differentiation between the pension fund, the sponsor and the various interested parties. It is all very well to approach things on a corporate finance basis and look at the interests as being one amalgam; but a number of contributors, including Mr Randall, Mr Arthur and Mr Davies, pointed out that we run into dangers of a fallacy here. My experience of this is that legal structures do not matter too much until something goes wrong. When something goes wrong, the actual legal structure becomes extremely important, and we ignore it at our peril.

Fourthly, I should like to talk about equities versus index-linked gilts. This is somewhat ironic for me, because, as an investment manager, I am quite enthusiastic about index-linked gilts, and, therefore, somewhat unusual in my profession. I find myself fighting actuary after actuary about the amount of index-linked gilts that should be put into benchmarks for pension funds. Most actuaries are very enthusiastic about building equities into the benchmarks, and only want around 5% index-linked. I, for tactical reasons as much as anything, have been trying to build more index-linked into these benchmarks over the past year or two. It is ironic that actuaries are now moving over to this area.

The opener pointed out the difficulty of discretionary benefits, and how that may influence the equity content. I thought, until fairly late in the debate, where we had Mr Thornton, Dr Satchell and Mr Green all taking up the cudgels, to some extent, from the point of view of equities, that I would probably be the only person pointing out the place of equities. Pension funds are long-term investors, and, as long-term investors, they can afford to hold equities over long periods of time and should earn the equity risk premium. That is the basis for the very substantial investments in equities that pension funds in this country and elsewhere hold.

Index-linked gilts, if widely adopted by pension funds, would represent a creeping nationalisation of the pensions promise. I am sure that we are going to have more of these shortly. There are not too many of them around, so we had better not all endorse index-linked gilts together, because there are only between £30bn and £40bn of them in issue at the moment, so the price is going to go up if we do so. Mr Lee pointed that out.

Mr Greenwood spoke about some of the practicalities of endorsing the index linked as opposed to equities. Clearly the kinds of market transactions that he was talking about would make me want to leave this Hall early to place orders to sell in the equity market.

Mr Lee spoke about the efficient market hypothesis. Again, in efficient market terms, it is fairly clear that the equity market did not know that this meeting was taking place, otherwise its valuation would have plummeted already.

Concerning defined benefit versus defined contribution pension investing, Mr Exley held out the prospect of this methodology being the saviour of the defined benefit pension fund. I tend to find myself in alignment with the final two speakers, who indicated that the simplicity of the defined contribution pension fund tends to win in most cases against defined benefits.

Mr A. D. Smith (replying)**:** Some speakers suggested that, perhaps, we had missed out some of the distinction between trustees, members, shareholders and owners. The interests of shareholders and management may be even closer now than has historically been the case. Shareholders appoint managers to create value; if managers conspire with actuaries against this, then the option is there, in principle, to vote out the old management (and actuaries) and replace it by a new one. As Ms Rappaport has explained, the same effect is more often achieved by a takeover. In any case, for many of our clients it is the stated aim of managers to create shareholder value, in which case it would seem perverse to invent our own contrary actuarial metric to form the basis of our advice. The distinction between members and shareholders is more subtle. Most of the time these interests are diametrically

opposite. For example, if my employer decides to pay me £1,000 more, this takes away £1,000 from the capital providers. The same is true for £1,000 of economic value in pension provision. Mr Judes has confirmed our thesis that very careful analysis is necessary to discover the subtle instances where this does not hold and synergies are available.

If contributors want to argue that the fund is completely separate from the company, then a number of commonly held views are not open to them. For example, they cannot take credit for surplus in company accounts or reduce contributions in any way and claim that members are no worse off. If fund and sponsor are separate, then any trustee allowing a contribution reduction and not fighting for full Inland Revenue maximum funding is guilty of a breach of trust.

The opener suggested something more in the opposite direction, that we fail to recognise the importance of discretionary benefits. I do not think that we have, but we do argue that discretion is not cost effective and results in a synergy disbenefit, which Mr Davies has explained. It does seem an odd way to run a business, remunerating current labour by future sums which are to be negotiated when the time arises.

So, if anyone wants to find any evidence of confusion in the roles of members and sponsor, he need look no further than the traditional scheme-centred approach, as, for example, in the 1984 and 1987 papers cited by the opener. This approach creates an economic entity called the scheme, which is analysed in isolation. The objectives attributed to this scheme are, we suppose, intended to capture simultaneously all the preferences of shareholders, management, trustees and members, all the synergies and all the conflicts, all the caps and all the floors, and all the discretion in the form of a single risk-return plot. This might, at first, seem reasonable, as the pension scheme is an identifiable legal entity; however, given the flexibility of cash flows in and out, this triumph of form over substance is a dramatic over-simplification, which misses many key features.

We suggest that this traditional scheme-centred parallel actuarial universe has not created value. It has misled us into pursuing apparent synergies which do not, in fact, stack up. For example, there is the common fallacy that, by investing in equities, the benefits can be carved up between members and shareholders in such a way that both parties are better off than if they had invested separately.

Another common fallacy is the notion that pension re-valuation for long servers is appreciated by members, but imposes no cost on shareholders. Sadly, at the same time, genuine synergies with the underlying business, for example, tax or expense savings, are overlooked by scheme-centred approaches.

So, our approach is more helpful than the scheme-centred one. If it can be rejected on grounds of real world complexity, then existing methods will fall at the same hurdle. However, the complexity of the trustee/company link does not give us *carte blanche* to develop a totally inconsistent and illogical framework instead. Even if trustees are not shareholders, they should, at least, recognise logic (or the lack of it) when they see it. Furthermore, we have established that all shareholders are individuals, just like members. Even though the link may be complex, the same ground rules apply. A pound does not suddenly become £1.20 because we are talking to members rather than shareholders; nor does risk suddenly disappear, to be replaced with the actuarial version. The complexity suggests that our method may only be a second order approximation in some circumstances — like splitting a DB scheme into a pure DB component plus a pure DC component, perhaps; but it does not invalidate the whole framework.

We have tried to explain the consequences of uncontroversial economic models for occupational pension schemes. It soon became clear that some actuarial funding methodologies, giving rise, according to Mr Pemberton, to a value rather than a price, were rather eccentric relative to the vast weight of conventional economics. In order to mount a parochial defence of actuarial practice, we would need to argue that most economists were talking nonsense most of the time. This does impose on actuaries a burden of proof. Such proof has not been forthcoming to date.

At the very least, as Mr Randall pointed out, the actuaries' rather arcane dividend discount approach does impose significant presentational difficulties on actuaries, and we have historically expended a large amount of resources in carrying out the complex co-ordinate transformation required, for example, to explain assessed values of assets to the outside world. Some clients regard this approach as quaint or even slightly endearing. However, these luxuries are also rather expensive,

and do little to promote our theme that 'Actuaries make financial sense of the future'. We would serve our clients far better by renouncing our parallel actuarial universe and reverting to the same co-ordinate system as the rest of the world. We are pleased that so many speakers have agreed with us.

Mr Parsons has pointed out that some actuaries think that actuarial values are not an attempt to get a single number, but, instead, are a fuzzy snapshot of where the answer might lie. This cop-out seems to go back to the paper by G. Heywood & M. Lander in 1961 ('Pension Fund Valuations in Modern Conditions'. *J.I.A.* **87**, 314-370), who asserted that, "The net liability disclosed by the valuation of a pension fund is not a figure which can be regarded as uniquely determined, but rather something which can be regarded as lying in a possible range of values from x to y".

I contrast this with the aspirations of our President, Mr Ferguson, who opened his Presidential Address in October 1996 with the words, "One of my pet hates is professional advice of the "on the one hand, on the other hand" variety. By contrast I love it when an actuary says "these are the issues and here are the results of my analysis", and then gives clear and unambiguous advice on what to do next". A Heywood & Lander valuation would not be much help to Mr Ferguson. Our more precise approach is, we think, much more satisfactory.

Mr Thornton clarified the position of the IFAA. Its arguments for equity links seem to rely on correlations between national average earnings and equity prices or dividends. Some of their data are shown in our Figures 7.2.1, 7.2.2 and 7.2.3.

It has been suggested that our NAE-linked bonds are not close enough to the real object of valuation because of discretionary benefits. However, it seems to me that, if this measure is good enough for the IFAA, then it might be good enough for us.

Our paper makes minimal assumptions and presents robust conclusions as to how techniques, widely adopted outside the actuarial profession, can be applied to provide a coherent basis for funding, costing and asset/liability management of a defined benefit pension scheme. It highlights fundamental inconsistencies in current approaches and proposes an objective standard for future pensions work.

The President (Mr D. G. R. Ferguson, F.I.A.): I was not the only one who came along to this meeting anticipating a lively and stimulating discussion. None of us has been disappointed. I am delighted that so many of our guests have mixed with our members in enriching the discussion. We have, indeed, had a rich and rewarding discussion. Thank you to all who have participated.

Some of you may have found the paper somewhat daunting. However, as we have seen, there are some fairly simple conclusions that can be drawn.

Mr Greenwood said that investing in equities may not be in the best interests of shareholders, trustees and members. One of the shadows that I thought might be hanging over this discussion was to relate such thoughts to the views of some investment managers in the City, that there is a large number of fully invested bears out there.

I want to thank Mr Thornton, both for telling us about what has been going on in the very tortuous negotiations with the IASC, but also for playing a leading role, with help from other members of the IFAA, in this very important debate. It is essential that the actuarial views are heard and heeded, because the issues being discussed are of enormous importance. The reputation of this profession, small as it is compared with the accountancy profession, has been enhanced by this work that Mr Thornton and others are doing.

As I said to the closer earlier, the hardest job of all on these occasions is that of the closer. I do not think that we could have had a better closer than we had here — from the parable of the Little Endians and the Big Endians to the rapprochement between the different opinions of financial economists and actuaries, and from how much they can learn from each other, to the importance of index-linked gilts as compared with equities, and how the pendulum is swinging in that direction.

All in all, we have had a splendid discussion, and that has been possible thanks to the authors of this paper. We all owe them a debt of gratitude for the thought and hard work that they have put into the paper, and for causing such a lively and stimulating discussion. I ask you now to join me in thanking the authors.

WRITTEN CONTRIBUTIONS

Mr C. D. Sharp, F.I.A.: In the discussion on this provocative paper the subject of inflation was mentioned only once, and that *en passant*, yet it was the threat and the reality of inflation which was the primary factor leading to 'the cult of the equities'. While, at the moment, inflation seems to have been scotched (not killed), it would be a bold individual who would assert that it will not reappear, and yet it is the main feature undermining the benefits from defined benefit schemes insofar as pensioners are concerned, unless they derive their pensions from a state sponsored scheme or from one backed by the more enlightened employers who are actually prepared to meet the full effects of inflation.

It is one of the weaknesses of actuarial techniques that we assume 'a pound is a pound, is a pound, is a pound...', and each time that 'pound' is something different in terms of the purchasing power which is the economic reality, and, while techniques have been developed in valuations and assessing contribution rates, to allow indirectly for the deleterious effects of inflation, there is still a tendency to overlook, or to ignore, this important factor in at least some applications.

When I was a student, we were taught always to remember Elderton's 'Widow's Mite' — (M)ortality, (I)nterest, (T)ax and (E)xpenses. As time went on, and inflation became rife, this had to become the Bishop's Mitre where 'R' was the rate of inflation, but our mathematical and statistical skills did not seem to be able to cope with that awkward factor.

This was, I suggest, an aspect of the subject that could well have done with a more significant analysis and attention in the paper and in the discussion.

Mr C. M. Stewart, C.B., F.I.A.: In Sections 9 and 10 the authors draw attention to the similarities between their commodity pricing approach and the proposals made by D.J.D.McLeish and myself (McLeish & Stewart, 1987). They are, of course, correct. Their implied spot price minus salary is exactly the contribution required to keep the fund on target to meet the member's accrued rights. The principal difference between then and now is that, whereas we envisaged the possibility of having higher accrued rights on wind up than on withdrawal, the authors look only at accrued rights on withdrawal, the presumption being that accrued rights on wind up will be the same.

In the early 1980s the great majority of schemes were valued by the projected unit method, but a member's accrued rights, on wind up or on withdrawal, amounted to no more than a frozen pension, or its cash equivalent. The funding level was, therefore, considerably greater than the value of the members' accrued rights, particularly for the younger members. I suggested (for example, see *FIASCO,* January 1985) that what was needed was a statutory requirement for *wind-up* benefits to be revalued up to pension age in line with the general level of earnings. Clearly, making this change would not have cost schemes a penny, because they were already funding to an adequate level. What it *would* have done was to make the members' entitlement on wind up commensurate with the assets held, which was surely a good idea, given the arguments on ownership of assets which always arose in an *actual* winding up.

Increasing the accrued rights of members withdrawing was quite another matter. This would have increased the cost of schemes, whatever the funding target in use. Nevertheless, it was generally accepted, at the time, that frozen pensions were not good enough for early leavers, and that their accrued rights ought to be increased. As the members concerned would be leaving of their own accord, I thought it reasonable to suggest that a lower rate of revaluation might be appropriate for them. That was then. Today the individual's pension rights have to be clearly identified, and portable, and I doubt if a similar distinction would be deemed acceptable. In the event, the Government made no distinction, and prescribed LPI for both.

In McLeish & Stewart (1987), we adopted prices revaluation of withdrawal benefits as standard, but we also showed the funding levels and contribution rates with higher funding targets, in particular with accrued rights *on wind up* revalued in line with the general level of earnings, and also on the basis of the projected unit method, two bases which naturally gave much the same result.

The curves in Figure 9.8.1 illustrate the authors' spot-price approach very well, but it is a pity that they did not put in any numbers. I have, therefore, put in some of my own, taken from the Appendix

to our 1987 paper. These showed the pension cost on the projected unit method increasing from 8% of pay at age 25, to 22% at age 65 — a much steeper increase than is apparent in Figure 9.8.1. Also, looking at the authors' spot prices, the starting figure for the entry age 25 cohort was 4.4% of pay, and 6.4% for the entry age 35 cohort. These are very low percentages. They would be even lower on the new statutory basis, with real rates of return 1% greater than we used.

These figures support the authors' contention that young employees would be better off in a defined contribution scheme than they would be as members of a final salary scheme. On the statutory basis, members taking a transfer value before age 30 would probably get only their own contributions back, and members leaving in their 30s would get relatively little from the employer's contributions. If final salary schemes cannot do better than this for young members changing jobs, they will very soon lose the battle with personal pensions. These days, a lifetime career with a single employer is no longer the norm, and young members are well able to compare the values of their portable pension rights in different types of scheme. The authors' spot prices at the higher ages may look very attractive, but all the important action is at the bottom end of their scales, and little attention is paid to what might happen later on.

Where do we go from here? The authors advise a user-friendly solution. They suggest that suitable adjustments to the transfer value bases, or rates of accrual, might be made, with a view to levelling out the implied spot prices. A simpler way of achieving the same result would be for those schemes which wish to stay in business to build on the new statutory basis by offering transfer values and wind-up benefits, calculated on the statutory basis, but allowing for revaluation up to pension age in line with earnings, rather than with prices. In schemes which promise pensions at retirement based on final salary, but only prices revaluation of accrued rights on withdrawal or wind up, the very steep increase in spot prices, to which the authors have drawn attention so effectively, is unavoidable.

Earnings revaluation of withdrawal benefits would certainly mean an increase in employers' contributions to final salary schemes, but the impact would be moderated if the improvement in benefits were to be limited to future service. There would also be a number of compensating advantages. For example:

(1) There would be no difficulty in choosing an appropriate basis for calculating the benefit. It would be the prescribed basis.
(2) The higher benefit would be a cash amount, and, with no accompanying obligation for the trustees to try to purchase non-profit annuities instead, this would ease the problem of schemes which still have such a provision in their rules and are wondering what to do about it.
(3) The scheme's funding target would be higher than the statutory minimum, but it would not be a *statutory* requirement, so that there would be no obligation to eliminate a deficiency within one year or five years, and a smaller contingencies margin would, therefore, be adequate.
(4) Valuation on the statutory basis, but with a higher funding target, and a contribution rate sufficient to keep the fund on the higher target, would automatically satisfy the lesser statutory requirement. It might also produce results sufficiently close to the projected unit method to satisfy accounting requirements. We might, therefore, hope that a single valuation on this basis would satisfy all the interested parties and obviate the need for separate valuations.

Mr D. C. E. Wilson, F.I.A.: I congratulate the authors on producing such a fascinating theoretical paper. I stress the word 'theoretical', because I believe that some of the analysis relies rather too heavily on what ought to happen rather than what actually happens in practice. It is hard to argue with most of what the paper says, although I have several specific comments, mostly relating to where I believe theoretical considerations have led the paper away from real life.

In ¶1.2.1 the authors refer to maximising the value of future cash flow. It is not clear to me how this should allow for the utility of different cash flows, and particularly intertemporal utility. This question of utility seems to me to be critical in much of what follows.

The three ways of obtaining equity exposure, in ¶2.3.3, seem to ignore differences in liquidity, transparency and legal substance. This is one of the areas where the theory transcends practicality.

In ¶2.3.7 the authors refer to the future earnings prospects of an individual as part of his or her total portfolio of wealth. This is sometimes referred to as 'human capital'. It seems to me that this is

a genuine and important factor, which has significant implications for changing utility functions over time. This sheds some light on the key question of time diversification, which the authors discuss in Sections 2.3 and 5.5. There is much empirical evidence that individuals' risk aversion does change over longer time horizons, in that they are prepared to increase the weight of risky assets if they are not concerned with (or do not know!) short-term returns. Instead of dismissing this as irrational behaviour, effort should be directed towards devising an appropriate theoretical framework which replicates it. Varying the utility functions used would seem a good staring point for this, as implied by Section 8.14.

The comments, in Section 3, on the funding method, are mainly written from the point of view of a corporate pension scheme sponsor. Some sponsors, such as local governments, may value the stability of required contributions more highly than is implied here for corporates.

In ¶5.5.16 the authors correctly state that increasing overall value requires the member and shareholder groups to place different values on gains and losses in each circumstance. They then dismiss this possibility. However, I believe that these groups *do* currently place different values on the potential outcomes, and that this is demonstrated by the typical pension arrangements that we see in the market place. Thus, if members are happy to accept equity investment, with the shareholder option to default as described in the paper, then shareholders are acting rationally in choosing equity investment.

The high-school economics, referred to in ¶7.2.11, may have more to commend it than the authors imply, although variations in the proportions of national income allocated to labour and profits clearly do occur. The wedge between bond and equity returns arises mainly from inflation surprises and growth surprises, which also disturb these proportions in the short term. Showing how hedging would have worked in the past is not the same as demonstrating how it would work in the future, especially when the period of data used contains, as the authors recognise, essentially no inflation surprises. I believe that many of the risks involved are essentially unhedgeable in the markets. For example, an NAE bond might be useless in the light of the major divergences between salary growth in different industries. If this is true, it may be better to stick with the pragmatic methods of the past.

The annuity example, in Section 8.2, seems to me to provide a demonstration that people do not behave in a way which would be required to make the theory practicable. Thus, if it is true that all annuity providers use approximately the same annuity basis, based on double-A rated bonds, then rational purchasers of annuities should only buy from triple-A rated providers rather than single-A rated companies, so that the price of annuities from the former should be bid up, thus rectifying the supposed imbalance.

Section 9 is a prime example of elevating theory to too great an importance, as I am sure the authors recognise. The implied spot prices described there are well known to actuaries, and, indeed, can help us to understand some of the broad dynamics of the labour market. However, it is clearly nonsense to suggest that many employment decisions are made on this basis, either by employees or, indeed, by many employers. Again, I suspect that many types of selection are more of a problem in theory than in practice.

In their conclusion, the authors refer to the new opportunities for helping company management to control risk. I would argue that actuarial theory in this area, for example as regards the effect of different 'budgeting rules' for pension contributions, has always been about understanding the long-term risks. However, this paper certainly adds significantly to the understanding of the risks inherent in defined benefit pension schemes. I believe that, in order to take this understanding further into practical application in the real world, further consideration is required of behavioural finance theory, the quality of information available in practice and the potential irrationality of investors and scheme members. Meanwhile, I believe that accountants and actuaries still have a role to play.

The authors subsequently wrote: Having reviewed the above contributions, we would agree with the closer that the extent of the agreement on some of the key issues in the paper is very encouraging. In particular, we would suggest that the following themes received almost unanimous support:

— the use of market bases for valuation of assets *and* liabilities;
— the assertion that index-linked gilts, and not equities, form the best match for salary related liabilities; and

— the cost of liabilities is (secondary issues aside) unaffected by the return on the investments used to fund them.

As to the main criticisms levelled at our approach, basically, these can be divided into a number of recurring themes. To round off this response, it may, therefore, be useful to provide a summary of our answers to these, collecting together answers which we have provided already in our paper.

Hybrid Schemes and Discretion

A number of contributors, especially the opener, focused on the fact that what we describe as a 'pure' defined benefit arrangement is rare. Instead, he painted a picture of a highly confusing arrangement, which is supposedly more common in the U.K. On the one hand, sponsors have an option to wind up a defined benefit scheme at any time, and the opener cites this as a very important feature. Of course, such a feature would not, by itself, reduce employment costs or enhance shareholder value, because, if such an option is a realistic possibility, members will place an appropriately lower value on this aspect of their remuneration. However, if it does exist, then such an option would, indeed, reduce the value recorded for the pension scheme liabilities in isolation. We cover this in ¶5.5.13, in the context of bankruptcy of the sponsor, although it is not clear to us how easily a going concern could walk away from benefit promises without compensating employees. As we say in the paper, if the existence of such an option does, indeed, reduce the value of pension benefits, then trustees would need to think very carefully about the merits of equity investment. Furthermore, the option emphasised by the opener obviously drives a coach and horses through the theory that sponsors are entitled to contribution reductions on account of their commitment to stand behind the security of the scheme.

However, the arrangement described by the opener seems particularly confused, since his option-based approach to valuation also seems to recognise the existence of a minimum floor in the promised liabilities, apparently contradicting the existence of the above option to default. In his suggested valuation approach, the opener also describes a 'final salary target' 'ceiling', although this seems rather ill defined, given that, in most cases, accrual rates, auxiliary benefits and pension increases could all be enhanced up to Inland Revenue maxima. If we take these maximum benefits as the ceiling, then the height of this upper bound and the proximity of the floor, in most schemes, suggests to us that equity investment *increases* the value of the liabilities. In this case sponsors would need to think very carefully about the merits of equity investment, whilst members would benefit, as we describe in ¶5.5.15.

This muddled picture is muddled further by the fact that the distribution of surplus to members or sponsors is not calculated on a financial basis, but may, itself, be assessed on a traditional off-market and subjective valuation basis, thus compounding subjectivity on subjectivity.

The opener suggests that all of this complexity can be accommodated using traditional valuation methods. Of course, given a clear description of the complex process he describes, we could attempt to value all of the contingent claims on a proper financial basis by means of some grand matrix of outcomes. Having obtained an answer, this could then be re-expressed as some margin in the discount rate applied to the promised liabilities written into the scheme rules. However, it is by no means clear that this margin would necessarily increase the discount rate applied to the promised benefit level, since, as described above, it is by no means clear that the embedded options to both members and sponsors, in aggregate, reduce the value of the benefits. Nor is it immediately clear to us why, having allowed for such features, they must necessarily, for actuarial reasons, then be encoded into adjustments to arcane assumptions for U.K. equity dividend growth.

The preservation of the judgemental and subjective approach, described by the opener, could be justified if it could be seen to serve some higher purpose. However, on the contrary, we would argue that it perpetuates an inefficient system of benefit provision. We are particularly concerned about the question of 'who owns surplus', under such an untidy system; to quote Justice Walker in the case of The Pensions Ombudsman v National Grid & National Power: "it is a matter of real concern that the destination of surplus should depend, as it often seems to depend, on subtle and complex arguments about the meaning of pension scheme documents".

Such ambiguity seems to benefit neither the sponsor nor the member. In the case of sponsors, the value of the benefits being offered is unclear, so remuneration policy consists of known benefits, such as salaries and a defined benefit pension, plus a series of ill-defined options arising from the complexities described by the opener, whose value depends on factors outside the sponsor's direct control, such as interpretation by the law courts and actuarial judgement. Picking up our theme in introducing the paper, and comments made by Ms Rappaport, it is worthwhile to consider whether it is defined benefits or ill-defined benefits which sponsors dislike. On the other side of the bargain, it is very clear to us that modern individuals prefer certainty to some vague promise, based on discretion exercised by well-meaning trustees, particularly if subject to the sort of sponsor options described by the opener. A good example of such preferences is provided by some recent decisions by members to vote for the de-mutualisation of building societies and insurance companies in return for 'free' shares. Therefore, it seems that the old fashioned social benefits of collectivism and mutualism, inherent in the arrangement extolled by the opener, are lost on today's individual.

Thus, the opener provides another example of a remuneration structure which does drive a wedge through our 'zero sum game' (that is any gain to members is a loss to shareholders, and vice versa) — except that this one actually destroys value, since neither party seems to appreciate the ambiguity in the arrangement.

Shareholder versus Member Perspective

A recurring comment is that our paper is focused on shareholder interests, and thus, by implication, is not necessarily applicable to members' interests. It is, perhaps, worth emphasising, firstly, that all shareholders, like pension scheme members, are ultimately individuals themselves, so, as we stress repeatedly in the paper, the same cash flows will tend to be assigned the same values by both parties — values calculated from a shareholder perspective are equally applicable as values calculated from a member perspective — hence our zero sum game. We should also stress that maximising shareholder value is by no means an abstract economic concept, with the exception of policies which minimise tax payments. Maximising shareholder value also maximises economic wealth, and thus, in colloquial terms, allows us to build more schools and hospitals, if we so wish. Furthermore, even if we adopt a more narrow focus (but now re-admit taxation benefits), enhancing shareholder value allows us to rise above our 'zero sum game', and create wealth which can, in theory, be shared between scheme members and shareholders.

However, this distinction between shareholders and members seems also to be tied to the mutualist view of trustees' duties. In other words, although a particular approach might enhance shareholder (and hence economic) value which can be shared among members and shareholders, the trustees may believe that they have a duty to impose a particular investment policy on scheme members (such as a high equity policy) through paternalistic motives (to counter individuals' risk aversion with their other savings, for example). Clearly, this argument can only be applied in the sort of scheme described by the opener, where members participate in surplus, and would not be particularly helpful if the policy only served to reduce security under the wind-up option that he proposes. However, even under such an arrangement, we might note that individuals are free to choose the way that they arrange their personal wealth. For example, they can invest in unit-linked AVCs, choose a PEP, repayment or endowment mortgage; they can buy or rent their home; they can participate in employee share ownership schemes (equity participation, which may also, as described by Mr Judes, enhance shareholder value). This basically repeats our shareholder's 'three ways' argument from a member perspective, emphasising the similarity between the two groups of individuals.

We can then pursue exactly the same line of argument as for the shareholder. In other words, if it is none of the trustees' business to impose a particular portfolio selection on individuals, then the most worthwhile approach that trustees can take is to seek out asset allocations which, in aggregate, add value to the shareholder and member together — so this wealth can be shared among them. Following this line, it turns out, as we explain in the paper, that, not only does matching the assets and liabilities enhance shareholder value because of increased business efficiency and lower taxation (benefits which can be shared with members), but members also place a higher value on the pension benefits themselves, for the following reasons:

— the member's preference for certainty rather than ill-defined equity participation (noted above);
— other 'utility gap' effects (described in Section 8.14); and
— it is much easier for an individual to add investment risk to his personal wealth (through equity exposure, for example) than it is for him to remove it.

Thus, the interests of shareholders and members are exactly aligned by the approach we propose, in contrast to the alternative adversarial approach to portfolio selection in which an economic gain to one party from taking risks is always a loss to the other.

Time Diversification

A number of academic contributors picked up on the theme of time diversification, confirming our comment, in the paper, that some aspects of this area are the subject of heated academic debate. However, we would like to distinguish between two quite distinct strands to this argument, namely the application of the principle to:
— matching; and
— portfolio selection.

We contend that there is no academic debate over the assertion that time diversification cannot be used to claim a 'long-term match'. For example, the fact that equities are highly likely to outperform a thirty-year stripped index-linked bond over its term to redemption, does not allow us to claim that equities can be used to hedge the redemption proceeds for a lower cost than the current bond price. There seems no way around our argument that, if such a hedge was possible, then nobody would buy the bond at its current price. We should stress that this undisputed assertion is the only aspect of the 'time diversification controversy' relevant to our paper.

On the other hand, we are carefully agnostic about the issue of time diversification in portfolio selection — which is where the academic debate rages. In the paper we raise this aspect only in questioning the simplicity of the argument that trustees are in a position to know the portfolio preferences of individual members, based only on their age profile. We use this argument only to reinforce the above suggestion that trustees should concentrate on investment policies which enhance shareholder and economic value, rather than trying to second guess the risk preferences of individuals.

Market Efficiency

We were glad that the discussion largely steered clear of a rehearsal of the arguments for and against market efficiency, since, as we stressed in our paper and we stress again now, we were careful to ensure that none of the conclusions in the paper rely on market efficiency — as with time diversification in portfolio selection, we can remain agnostic on this. Our arguments for market valuation require only the law of one price, that is, the same price rules for two identical cash flows, regardless of the legal structure which delivers them. This is a much weaker condition than market efficiency, the single price could offer an abnormal excess risk adjusted return from ownership of these cash flows without invalidating our paper.

Mr McKelvey raised a slightly different point, suggesting that our conclusions were inconsistent with the efficient market hypothesis (EMH). Since the paper does not rely on this hypothesis, his suggested circularity in our argument does not follow anyway. However, in defence of EMH (if defence is needed), we would note that an inefficient economy does not imply an inefficient capital market — it is, for example, quite possible for a capital market to efficiently price known inefficiencies in product markets.

Value versus Price

We conclude with what is supposedly a subject of heated debate within the actuarial profession itself, namely the distinction between value and price. It seems to us that serious debate on this issue suffers from the fact that, whereas the concept of a market price is reasonably well defined in the situations we describe (although we concur with Dr Satchell's observation that there is some

ambiguity in what constitutes a meaningful price by match), the concept of 'value' seems to be much talked about, but never defined.

It was interesting, in the discussion, to hear two completely different attempts at defining value. Dr Satchell referred to the concept of some long-term average, around which prices oscillate. This definition of value agrees with our assumption, in the paper, that the actuarial term 'value' refers to some belief in a meaningful intrinsic measure of 'true worth', much like the Yorkshire coalminers argued in the 1980s that the true worth of deep mined coal was much greater than the spot price of open cast coal on international markets. We can accommodate Dr Satchell's version of value, by arguing that the law of one price still appears to rule, whether or not that price is above or below its long run average.

However, Mr Pemberton promotes a version of value which is diametrically opposed to this. For example, different investors supposedly place different 'values' on the same assets, contradicting the concept of value as true worth, and suggesting, instead, a 'utility' connotation, reinforced by his observation that value differs among investors according to risk preferences. However, it is not clear how this idea of value should be applied. It is quite possible for us to place a 'value' of £x on ownership of an economic quantity which trades at £y, but we must then assume that we will then buy or sell, depending upon the relationship between x and y. Although Mr Pemberton does not suggest that his value depends on the quantity held, it would certainly be useful if his value moved closer to the price as he buys or sells more, otherwise he will have to continue buying or selling indefinitely. In any event, whether or not Mr Pemberton's individual concept of value is independent of quantity, its relevance to a pension fund is unclear. As we stress, it is not meaningful to talk about value 'to a scheme'; thus we find the suggestion that the value of assets depends on their ability to match liabilities odd, except in the sense that, if matching enhances economic value as we suggest, then one could arbitrarily assign this value indirectly to the assets. However, the trouble with Mr Pemberton's argument here is that the pension scheme is not the only asset or liability of the shareholder, and it is rather unhelpful to construct a framework where a different value is assigned to matching assets, according to whether they are held directly by the pension fund or indirectly by the shareholder outside the pension fund. Perhaps, therefore, rather than value to 'the scheme', Mr Pemberton means value to members or shareholders, both of whom are basically individuals themselves. Why these individuals should be interested in Mr Pemberton's assessment of value is a most perplexing question.

We suggest that the answer to the debate may lie in Mr Pemberton's fourth reason why price and value can differ — the purpose of the valuation. We basically agree with this. We suggest that non-market funding 'values' can be used to set a contribution rate, which is a mainly arbitrary exercise anyway. Also, if they insist, regulators can impose arbitrary 'values' in connection with statutory calculations. We suggest that market values — or marginal prices — are essential for any decision of economic importance. Indeed we go further, to suggest that optimal decisions can only be made using such values. What do we mean by optimal? We mean maximising economic or shareholder value. As discussed above, this is not a narrow-minded objective, but rather enhances the welfare of the whole economy.

By way of example, suppose we attempt to make an optimal decision on the basis of either Dr Satchell's or Mr Pemberton's values, which, for the sake of argument, both say that £100 of equities in the pension fund have a value of £120. By implication, this means that identical equities outside the fund must also have the same value. Any attempt to find an optimal decision based on this valuation will then instruct everyone to buy unlimited amounts of equities, without identifying who should be selling them.

In contrast, use of marginal prices gives us a much clearer picture, the messages are not swamped by the first order effects arising from differences in values, and, instead, we can look through to second order effects, such as those described in our paper (taxation, transaction costs, utility gaps, agency monitoring, etc.), which have real potential to enhance economic value (for example, increased debt finance by firms combined with increased bond investment by pension funds). Thus, we suggest that Mr Pemberton misses the most important apparent distinction between 'value' and price; namely, prices are useful for making decisions whereas values are not.

Conclusions

In conclusion, we agree with Mr Greenwood that it would be worthwhile if the remaining case in favour of traditional approaches could be set down on paper. One of the lessons that we have learned from our work is that the discipline of setting arguments down in black and white tends to clarify the logical structure of arguments. It does appear that there are many conflicting arguments advanced against our approach. For example:

— As noted above, the opener argues that the option to default is valuable to sponsors, whilst the sponsor's obligation not to default is valuable to members.
— Does the argument in favour of an equity discount rate hinge on the case made by Mr Thornton (in which case pensions in payment are matched by gilts, but NAE growth is matched with equities), or on the arguments advanced by the opener, (in which case NAE growth is matched with index-linked gilts, but pensions in payment are matched with equities)?
— Is the actuarial concept of value, discussed above, unique to each individual (as proposed by Mr Pemberton) or a common measure of underlying worth (as described by Dr Satchell)?
— Is it consistent to concede that, as suggested by Mr Thornton, liabilities are, on the one hand, unaffected by the actual assets held by the pension plan, but, on the other hand, sponsors can invest in equities as a calculated risk to keep pension costs down?

Clearly, it is difficult to disagree completely with all elements of alternative theories which advance contradictory arguments — if a statement is true, then its contradiction is false. However, that is a long way from conceding that the traditional approach is 'half right'.