"RISK SHARING IN EMPLOYER PENSION PROVISION"

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1 Introduction

1.1 In some countries, employer pension provision is a major aspect of the economy. UK pension funds currently amount to some US $1,100 billion, which is equivalent to about 80% of the country's annual GDP**(1)**.

1.2 Most types of employer pension plan – not only defined benefit but also some defined contribution plans - involve taking on significant risks of various kinds. This must be so unless the risk of inadequate retirement income is to be left entirely with the employees. This paper focuses on risks associated with cost and cost volatility and explores mechanisms for risk sharing between employer and employee.

2 Risks

2.1 At the outset, it is useful to remind ourselves of the risks that an employer faces in sponsoring a pension plan. There are many ways of grouping these risks but we have found it helpful to consider the risks associated with:

- The amount of benefit
- When the benefit will be paid
- How long the benefit will be paid for
- The investment return on assets relative to the nature of the liability
- Options that can be exercised by the employee.

3 UK Experience

3.1 The UK has a significant history and culture of company pension provision. It is accepted that individuals find it difficult to save enough for their own retirement, and yet the culture is against providing a level of state pension beyond a perceived minimum level of requirement. In this framework, company pension plans have flourished. The dominant species has been of the final salary type, offering up to 2/3rds final salary.

3.2 Up to the 1980s, company managements did not perceive any major risk in running final salary pension plans and investing heavily in equities. In recent years, changes in the pensions framework are affecting management perceptions about the risks inherent in providing pensions on this basis. The main changes are:

- A statutory minimum funding requirement

- Statutory minimum indexing of company pensions in line with consumer price inflation up to 5% per year
- A change in the company accounting standard for pensions, from SSAP 24 to FRS 17
- Development of the London Stock Exchange code for listed companies, to include requirements on the reporting of company risk management.

3.3 Now, final salary pension promises are seen as risky, and are being replaced by defined contribution arrangements. The risks of equity investment are now seen more clearly, following a new tax in 1997 and the more recent setbacks in the equity markets. Added to this is a growing concern about the continuing trend of improving longevity. It begins to seem that final salary pension plans are recklessly dangerous. What is the truth of the matter, and is there a middle ground to be explored where risks are shared between employer and employees in a controlled, balanced way?

4 Interested parties

4.1 First, a quick review of the interested parties in this matter:

4.2 **Government:** should have an interest in ensuring that its citizens are properly financed for their old age, but may also have a preference for reducing, or restricting growth in, dependence on State pensions and other State benefits. This may lead to tax incentives for occupational pensions, but also to minimum standards for both benefits and funding.

4.3 **Employees:** typically unwilling to provide adequately for their own retirement without employer support and tax incentives.

4.4 **Employers:** strongly influenced in their pension policy by the framework set by Government including tax incentives. Users of capital, as well as investors in their business and in their pension funds. (Later, we discuss a new idea in connection with the capital markets.)

4.5 **Insurance companies:** in the market for provision of annuities to pension plan members. EU solvency requirements effectively require insurance companies to back their annuity business with well-matched bonds, and to include appropriate mis-matching reserves. These requirements put a floor under the cost of annuities and make them look expensive in today's conditions.

4.6 **Accounting standards setters:** the FASB (in the USA), ASB (in the UK) and IASB (international) have shown their enthusiasm for closely specifying the pension cost measures to be reported in company accounts – all now on a bond basis of discounting.

4.7 It could be said that the problem of pension plan design has much to do with the need to balance out conflicting constraints and objectives, some of which are hinted at above. Therefore we next summarise likely objectives after which we briefly review the main types of pension plan design.

5 Potential objectives

5.1 **Post retirement income:** the prime purpose of a pension plan or retirement scheme is to provide an income after retirement.

5.2 **Employee appreciation:** companies will seek to derive value from the benefits provided to support their recruitment, retention and reward objectives.

5.3 **Minimise costs:** for a given level of benefit, companies seek to minimise both cost and cost volatility; these objectives may be in conflict.

6 Risk spectrum of pension plan design

6.1 It may be helpful to consider a "risk spectrum" of plan designs. One extreme of the spectrum is where all financial risks lie with the employer, such as the final salary pension plan. At the other end of the spectrum are defined contribution plans where the risks lie with the employee. In between are career average, cash balance and hybrid designs, to which we refer below.

	Highest risk
Defined benefit	Final salary with fixed employee contribution rate Final salary with variable employee contribution rate Final salary with benefit discretions Career average Cash balance
Hybrid	Final salary with defined contribution top-up Defined contribution for younger employees; final salary for older employees
Defined Contribution	Matching (ie variable) employer contribution rates Fixed employer contribution rates
	Lowest risk

6.2 We next comment on the main risk profiles of these alternative plan designs. It should be noted that, generally, employees appreciate plans with greater guarantees, and hence usually greater risks for the employer.

6.3 **Final salary plans with fixed employee contribution rate:** A defined benefit final salary plan is the most risky type of pension arrangement for an employer. Of course, salary increases are within a company's control, to an extent, but that degree of control is severely limited by the market for workers.

6.4 In the UK, final salary plans are mostly financed using the projected unit method. Therefore pension reserves include allowance for future salary increases even though no such increases have yet been earned. The same reserving principle is built into the major pension accounting standards: FAS 87, IAS 19, FRS 17, etc. However, when management decisions are taken about employee salary increases, usually and unfortunately no thought is given to the back service cost of those decisions. Instead the costs are registered at the next actuarial valuation or company accounting date.

6.5 Expensive errors await an unwary company management - who might for example decide to reorganise employee remuneration structures without realising that a general increase in the basic component of pay will be pensionable and will incur a past service cost.

6.6 Such a mistake (which has no doubt occurred) would obviously be evidence of poor business management. But even the annual pay review carries past service pension cost implications. In principle, a procedure could be established to detect the cost implications at the time of making decisions about employee pay. For example:

- Install a management discipline that recognises the back service cost of awarding salary increases when they are given, notwithstanding that part or all of these increases for a year may be regarded as pre-funded.
- In a multi-divisional company, require operating divisions or subsidiaries to recognise the salary increase cost by paying the cost to head office (who may or may not pay such money into the pension fund – according to funding requirements).
- Fund on the current unit basis and require additional funding of the back service cost of each year's salary increases.

6.7 But in practice, at least in the UK, salary levels and pay increases appear to be set with little or no regard to the knock-on effect on the cost of pension benefits.

6.8 **Final salary plans with variable employee contribution rate:** In the table above we noted the existence of final salary plans with a variable employee contribution rate. There are a few such plans that require employees to pay a fixed proportion (such as one third) of the total ongoing cost – in other words to bear that proportion of any increase or decrease in the cost after an actuarial valuation. This is a design for risk-sharing, but it tends to mean that one generation of employees may be required to pay extra for the pensions of the preceding generation.

6.9 The risks and unpopularity of having to ask employees for a very high level of contribution in times of poor investment returns can make this design unworkable, especially where the membership profile is not well balanced between active and non-active members.

6.10 **Final salary plans with benefit discretions:** A more important way of risk sharing in final salary plans is through the mechanism of benefit discretions. Until recent years the practice of many UK pension plans had been for the employer and trustees to review pensions in payment annually and to award pension increases up to the rate of consumer price inflation on a discretionary basis. But often the funding plan incorporated an allowance for the cost of future pension increases, so that there was a safety mechanism. During a period of poor investment returns on the fund, if pension increases were set at a lower proportion of RPI, then the pensioners would be bearing a part of the cost.

6.11 This mechanism for risk-sharing is now substantially eliminated by the effects of new legislation in the UK which requires pensions to be index-linked up to an increase of 5% each year.

6.12 But other risk-sharing discretions remain. These are:

- early retirement – the discretion of an employer to allow employees to retire before normal retirement age on full accrued pension without actuarial reduction;
- commutation – the power to set the terms on which part of the pension can be converted to a cash sum at retirement (which is particularly attractive for employees in the UK because the cash is tax free whilst the pension is not).

6.13 The commutation discretion is usually under the control of the trustees, not the employer.

6.14 In the Appendix we describe an option pricing methodology for valuing benefit discretions and other aspects of risk sharing.

6.15 **Career average plans:** The career average plan is a defined benefit pension plan without the linkage to final salary. Instead, the retirement pension is based on the accumulation of pension amounts year by year. Each year the amount of pension earned is calculated as a set percentage of pensionable salary. This is added to the amount brought forward from previous years, together with an appropriate annual uplift. The annual uplift is determined in accordance with a clearly understood index, such as that of consumer price levels. The cost of such a plan, per unit of pension accrued, is less than that of the final salary plan because of the lower rate of revaluation in line with prices. Therefore a larger annual accrual of pension than that of a final salary plan can be promised for the same cost.

6.16 Alternatively, an annual bonus addition can be awarded on top of the price revaluation, thus providing a very similar target level of benefit as the final salary plan but with the element of final salary linkage replaced by a discretionary bonus arrangement.

6.17 The risk-sharing feature of a career average plan with bonus can be valued by the option pricing method shown in the Appendix.

6.18 The career average design provides an attractive blend of sharing financial risks between the employer and employees, whilst also enabling the company to align pensions with its own business performance to a limited extent. Further advantages are:

- it takes account of the individual's pay pattern throughout a career, rather than just in the final pay period as in a final salary plan. It therefore caters for employees whose earnings may decline towards retirement, such as under phased retirement programmes that are becoming more popular
- it may be possible to invest in index-linked bonds that will largely hedge the indexation risk in the liability

- there is less risk exposure during periods of high salary inflation or pay restructuring than in a final salary plan.

6.19 Some disadvantages of career average plans are:

- there is still the risk of deficits if investment returns are lower than anticipated
- in the UK there are very few career average plans currently in operation and so the design is not seen as a natural choice.

6.20 However, attitudes to the career average plan may be changing. We briefly mention the experience of two organisations in the UK with career average plans. One of these is The Pensions Trust, a not-for-profit organisation whose business is the outsourcing of provision of pensions for employers in the charities, voluntary and not-for-profit sector. It has established a multi-employer career average plan that has become popular with the participating employers. Employers contribute at a rate well above that needed to provide guaranteed benefits. "Surplus" funds are declared by the actuary from time to time and are transferred to defined contribution accounts on behalf of members. Employers appreciate this hybrid feature, which limits cost and removes any arguments over ownership of surplus. The plan copes very well with the fluctuating earnings that are common among employees in this sector.

6.21 The other organisation is the UK's largest private sector employer, and this company has recently introduced a career average plan with annual bonuses. The rates of bonus are decided each year by the company having regard to:

- the performance of the fund and
- the performance of its own business.

6.22 Thus, the pension payouts in the long term should be reasonably well aligned with the company's business objectives, and the extent to which these have been achieved.

6.23 **Cash balance plans:** The cash balance plan is similar in concept to the career average plan but is specified in terms of the amount of cash available at retirement, not the annual amount of pension. This design is more common in the USA, where the accumulation of the cash balance during service is commonly linked to deposit rates of interest.

6.24 Cash balance plans are significantly different from final salary and career average plans. By expressing the benefit promise in terms of cash not pension, the longevity risk is transferred from the employer to the employee. They are similar to defined contribution plans except that they carry investment risk for the employer.

6.25 The funds are typically invested in stocks which should return more than deposit rates, so that the employer can expect to finance the plan at less than the apparent cost as seen by the employee. This looks like sleight-of-hand. However, on the basis that there is no free lunch in the financial world, this mis-matching investment policy also carries the risk that the employer will have to pay more if investment returns go below the deposit rates credited to cash balances. The risk is just like that of a final salary plan that is substantially invested in equities. It is a risk that can be controlled, and

reduced as much as desired, simply by investing an appropriate portion of the assets in cash deposits that match the liability.

6.26 Note that in principle any kind of index – whether related to investment or consumer prices – can be specified.

6.27 **Defined contribution pension plans:** At the other end of the financial risk spectrum are the defined contribution pension plans. Here the cost is within the employer's control and all investment and longevity risk is with the employee. Present UK legislation requires pensions from these plans to be taken as purchased annuities, except to the extent of any commutation for cash at retirement. In other words the longevity risk must be passed on from the employee to an insurer. This legal requirement is now being reviewed, as we discuss later, and is not a requirement in other countries (for example the 'Section 401k' plans of the USA).

6.28 But even defined contribution plans are not fully risk-free to the employer. Total pension cost depends on the number of employees who choose to participate in the plan. Therefore entry conditions may be an important design feature. Moreover in the above table we made a distinction between defined contribution plans that provide for matching employer contributions and those that do not. Where employees have a choice of contribution rates, which the employer will match partially or fully, there is even an uncertainty over the average future employer funding rate.

6.29 **Hybrid plan designs:** Whilst a pure defined contribution plan is attractive from a financial control perspective, other HR considerations may persuade an employer to sponsor a plan with some guarantees. Examples of this are noted in the table above. A final salary plan can provide a low level of benefits plus a defined contribution top-up,or the final salary pensions can be restricted to employees with minimum age and service requirements, with defined contribution pensions being offered to other employees.

6.30 Hybrid plans require careful consideration to gain a proper understanding of the financial risk profile. Further the complex nature of hybrid plans can significantly reduce employee appreciation.

7 Types of risk

7.1 In discussion of the range of plan designs we have already noted the major risk factors of final salary linkage. We now further the discussion of risk types before looking at alternative ideas for mitigating risk to the employer.

7.2 **Investment policy:** In the UK it is widely agreed that, within the framework that exists, equities are a particularly appropriate form of investment for most final salary pension funds. This view is well justified by the long-term nature of pension plans coupled with the fact that the likelihood of equity returns exceeding bond returns increases over longer time horizons.

7.3 The following table shows the proportions of total pension fund assets invested in equities and property in various countries.

Country	Pension assets	Proportion in equities and property
	US $ billions	
US	7,770	65%
Japan	2,280	58%
Netherlands	420	53%
UK	1,130	74%

Source: Phillips & Drew Pension Fund Indicators 2001

7.4 But in the UK recently there has been increasing cause to question the justification for relatively high levels of equity investment. One of the reasons for a shifting perspective is that the regulatory framework is now forcing a shorter-term view. The economic reality of pension liabilities is similar to that of corporate debt. The business risks inherent in gearing up a company's balance sheet by issuing fixed interest debt and investing the proceeds are clear enough. Perhaps what has been less clear is the economic reality of the pension/investment mis-match when rules and conventions about pension accounting and funding have been so complicated as to obscure the true position.

7.5 Asset/liability mismatch is, in reality, a very serious risk factor. It is generally very difficult or impossible to identify a portfolio of assets that will generate a stream of income that will match the expected liability outgo. Assets that have the potential to match liabilities are annuities and deferred annuities purchased from an insurance company.

7.6 **Accounting standards:** The pension accounting standards of FAS 87, IAS 19 and now FRS 17 all now specify a form of actuarial valuation for company expensing purposes that is linked to the bond markets.

7.7 It follows that if a pension plan is invested substantially in equities then the accounting entries will be volatile from year to year, except to the extent that the accounting conventions smooth the results. This volatility can be a major risk factor for the financial management of the business, equal in importance or more important than cash flow uncertainty.

7.8 Accounting standards change from time to time. In the UK, for example, SSAP 24 was first introduced in the late 1980s and is being replaced by a different standard, FRS17, between 2001 and 2003. It is possible that the international standard will be changed and brought into line with FRS17. The trend of recent changes in pensions accounting standards is towards more faithful representation of the economic reality (or at least that is the apparent intention). To this end IAS19 as revised in 1999 now looks similar to FAS87, whilst the new FRS17 resembles both of these but without any smoothing mechanisms (of corridor and amortised recognition).

7.9 These developments in pension cost accounting may have profound implications for the way that company managements view their pension plan risk exposures in future.

The transition from SSAP 24 to FRS 17 in the UK may cause concern for many companies through operating expense increasing significantly or recognising a plan's surplus or deficiency fully and immediately on the company's balance sheet.

7.10 **Longevity**: Many benefit scales were designed many years in the past when life expectancy was much shorter.

The age of 65 as the time when people should receive state pensions was chosen by Otto von Bismarck 130 years ago, at a time when life expectancy for a male was about 40 years. [(2)]

7.11 The cost of benefit promises has increased significantly as a result of increasing longevity and there is no indication that this trend is about to cease. Indeed, with modern advances in medicine fuelled by the advances in genetics, the rate of improvement in mortality may accelerate.

People will soon live twice as long as today, and have the potential to live for 1,200 years. [(3)]

7.12 Will there come a time when medical advances can extend the span of human life almost indefinitely? Uncertainty about future longevity is a key risk factor.

7.13 In a defined benefit plan the pension promise at the time benefits are earned, that is during a member's employment, represents a commitment to make pension payments up to 70 or more years in the future. This is an extremely long time horizon when compared with long term planning horizons for most businesses. It is difficult to hazard a guess at what social, economic, commercial and medical conditions will be prevalent so far into the future. If life expectancies continue to increase, is it still sensible to give such commitments?

7.14 **Legal and regulatory risk:** Many governments are in the process of trying to reduce their own State benefit liabilities because of demography. Governments cannot rely on individual savers to make adequate personal provision. If savers do not make appropriate provision for their retirement the government can be left to pick up the bill through, for example, minimum income guarantees. Therefore governments are potentially or actually interested in shifting more of the burden to employers. Examples of this from UK experience are noted below.

7.15 Integration of benefits with State pension carries the risk that the State pensions will be reduced so that an increased burden is transferred to the integrated company pension plans.

7.16 Further, as the importance of and reliance on occupational benefits increases, governments have an incentive to ensure that those occupational benefits are secure – reducing the risk that pensioners will need to rely on State subsidies in retirement. Governments increase the security of occupational benefits by requiring that the benefits be backed by assets and by imposing restrictions on the amount and type of assets. All this State 'interference' increases companies' costs (and uncertainty about those costs) and reduces flexibility in meeting companies' benefit obligations.

7.17 The UK experience over many years has amply illustrated the hazards of providing company pensions when the Government has such a keen political interest in the results for the citizens. The history in brief is this:

- Occupational pensions first became significant early in the 20th century when new tax legislation created an attractive framework.
- Company pension plans were typically modelled on the Government's own final salary plan for its civil service.
- Market forces of competition for workers gradually increased the coverage of occupational pensions, until they became the normal part of the remuneration package for most staff.
- Successive governments began to place constraints on occupational pensions, even though there was and has never been a requirement on employers to offer pensions. Chief among these impositions were the requirements to escalate deferred pensions of early leavers and pensions in payment in line with consumer price inflation, up to 5% per year. The minimum funding standard was introduced in 1997, and this too has created more problems than solutions, particularly in its choice of investment model.
- Pension plans have been forced to increase benefits for one group on grounds of European law on sex discrimination.
- The present position is that a new minimum funding regime is likely to be introduced, in which greater reliance will be placed on the guidance of the actuary coupled with improved disclosure of information to plan members. (Perhaps this is going to be another example of risk transfer, in this case to the actuary.)
- There is also a growing expectation that for the first time the UK will introduce legislation requiring membership of an employer's pension plan to be compulsory. This could add significantly to employer costs, depending on what minimum requirements are set.

7.18 Defined contribution arrangements have not escaped legal risk. The once revered Equitable Life Assurance Society (which effectively founded the work of actuaries) fell foul of an unexpected legal ruling by the House of Lords in 2000. The problem here affects about one million people, and it is unresolved at the time of writing this paper. On top of this problem, many members of defined contribution plans have now experienced for the first time the shock of a major fall in the value of their funds. We have a minimum contribution requirement for defined benefit plans. Will there be one day a minimum benefit requirement for defined contribution plans, turning them into hybrids?

7.19 At present companies see the transition from defined benefit to defined contribution plans as a way of shifting the risks to employees. We speculate that a future legal framework might discourage this.

7.20 **Taxation:** The taxation position of pension plans can be changed, particularly where favourable taxation status was once granted as an incentive to establish occupational

pensions. Examples of such changes which have been witnessed in the UK or elsewhere include:

- Partial or complete removal of tax allowances on employer and employee contributions
- Tax allowances previously given may be removed or restricted on investment income. Taxation relief treaties with the overseas countries may change.
- Tax allowances previously given on benefits in payment may be reduced or removed.

8 Risk-sharing solutions

8.1 We have identified the main areas of risk to employers. We have also noted the spectrum of alternative plan designs that are available. The basic choice from among these alternatives enables company management to divide the total pension risk between employee and employer.

8.2 Now we discuss some further ideas for managing the pension risk. The ideas we discuss are in the two key areas of:

- asset/liability mis-match
- longevity risk.

8.3 **Asset/liability mis-match before retirement:** No traded asset is available, or is ever likely to be available, that will hedge the final salary pension liability. This is because salary increases are under the direct control of management. It is possible that bonds that are tied to an index of national salary escalation might be marketed, but we are not aware of any such instruments at the present time.

8.4 In the UK, bonds indexed to consumer price inflation do exist. The first such instruments were British Government bonds, and they were issued in the early 1980's in response to demand from one or more insurance companies. Other countries including Canada, France and the USA have followed suit. Some UK companies have now issued index-linked corporate bonds.

8.5 In our discussion of alternative plan designs, we referred to the career average formula where the accrued pension is augmented each year in line with a suitable index such as consumer price inflation. In principle, the cash balance plan could be indexed in this way. Here lies an elegant solution: namely that companies should consider issuing pension promises of a type which are capable of being matched by available traded assets of similar type. In other words, if the same index (probably consumer price inflation) is used for the asset as for the liability, then the asset/liability mis-match can be properly managed. This risk factor can even be eliminated, if so required.

8.6 Ideally, to eliminate asset/liability risk, an index-linked pension plan would be invested 100% in a diversified portfolio of index-linked corporate bonds – if it were possible to create one. The yield on such a portfolio could be equivalent to the company's cost of servicing its own long-term debt. Such an investment portfolio

would be conceptually close to investing the fund in the company's own debt, but with the credit risk diversified to a minimum.

8.7 There is an economic logic to this idea. According to finance theory there is no free lunch, so why design and invest a pension plan as if there were? In comparison, the common practice of promising pensions linked to final salary and investing the fund in equities seems illogical. It is a practice merely based on precedent and circumstances.

8.8 In practice, the circumstances are that most companies will not issue fully inflation-linked debt. The possibility of a return to higher rates of inflation would be an unacceptable business risk. Some governments do issue inflation-linked bonds, but the yields can be relatively low. A company that borrows from the market and invests cash into its pension fund and from there into government bonds is wasting the difference between the two rates of interest.

8.9 However, there is scope for refinement of the risk-sharing, this time in relation to the corporate debt. If fully inflation-linked debt is too risky for most companies, what about limited price-indexed (LPI) bonds? Within the last year, this new idea has been promoted in the UK and a few small issues of LPI bonds have appeared. The limit on price-indexation is 5% per year – the same as the statutory rate of indexation of pensions in payment.

8.10 From the point of view of an issuing company, the risk of LPI bonds can be acceptable. In fact, for businesses whose earnings are strongly influenced by inflation, servicing this type of debt may be more attractive than paying out a fixed rate of interest. We, therefore, suggest a combination of these two ideas for efficient pension plan design in future:

- Career average pension formula, indexed to LPI
- the development of substantial markets in LPI bonds, in which such pension funds can invest.

8.11 The development of such bond markets will require explanation and education on a large scale if it is to succeed. Actuaries are the people to do this.

8.12 **Longevity risk:** The nature of a defined benefit promise in respect of the period after retirement is that of a guaranteed annuity. The guarantee is to pay a stream of income to a pensioner for the remainder of the pensioner's life. The income stream may have additional provisions attaching to it: for example the income may escalate and/or may continue on the death of the pensioner to the surviving spouse, perhaps at a reduced rate.

8.13 Annuities are provided to ensure that former employees have a regular income throughout their retirement. Providing a guaranteed income helps prevent former employees from becoming impoverished at a time when they are least able to work for a living. Many employees are not financially literate and find saving and investing adequate resources for retirement and then managing those assets during retirement challenging. These issues are compounded in a former employee's advancing years as their faculties wane.

8.14 Section 401k plans have become very popular in the USA and may be a model for future developments in the UK. But Section 401k plans do not provide any kind of annuity guarantee. It will be interesting to observe the US experience of these in future years, when they will be tested for resilience against the problems of stock-market fluctuations and ageing pensioners. To be blunt, what is the risk that these funds will run out of money?

8.15 If 401k plans were widely available, why would any company wish to take on the risk of financing pension payments to former employees for an indeterminate and probably ever-lengthening number of years? And where such plans are not available, is it possible that at least part of the longevity risk can be shared between employer and employee?

8.16 Three alternative solutions are:

- Specify the pension promise in terms of a lump sum at retirement, so that the cost is independent of longevity. Provide for conversion of lump sum into pension within the pension fund on a basis which is set by the company, and which can be varied from time to time according to investment conditions and expected longevity.
- Provide for regular upward reviews of retirement age according to emerging mortality experience. For example the objective could be to arrange that the expected period of receipt of pension remains broadly constant, perhaps in proportion to the period of employment.
- Fund for a target rate of pension increase, but guarantee less - even no increase at all. Annual increases would be a discretion of the company.

8.17 Clearly, any of these ideas requires a regulatory framework that allows it. In the UK at present, the first option is currently workable, the second is constrained, and the third is now being eliminated by legislation that started to take effect in 1997.

8.18 Mike Wadsworth and Alec Findlater have presented an alternative to the traditional annuity model to the Congress in their paper on *Reinventing Annuities* **(4).** Their paper considers the issues affecting the design of annuities and in particular the trade-off between investment guarantees and survival guarantees. In the paper, Messrs Wadsworth and Findlater propose a new model, which divorces or unbundles the investment aspects of an annuity from insurance against survival. The concept of the proposed model is of an investment fund with the following key features

- assets available for lifetime but forfeit on death
- income taken by cashing in assets between a minimum and maximum (subject to periodic review)
- survival credits added to the fund, representing a transfer from those who die to those who survive (subject to periodic review)
- investment return on the fund enhanced through the survival credits.

8.19 Under this model, guarantees can apply, to a greater or lesser extent, to the investment fund or the insurance against survival. Nevertheless, the annuitant or pensioner may be carrying both investment and longevity risk to some extent and so the sustainable level of income cannot be guaranteed in the same way as a traditional pension.

8.20 For a member of a retirement benefits plan, this proposed model provides a natural extension to the accrual of a retirement lump sum offering flexibility in

- the investment strategy post retirement
- the shape of post-retirement income over time

and at the same time ensuring that the assets last for the member's lifetime.

8.21 For the sponsor, the advantage is that their risks can be limited whilst taking comfort from providing some measure of income security to former employees in retirement.

9 Summary/Conclusion

In some countries, employer pension provision is a major aspect of the economy. The risks involved, especially those relating to investment, mortality, accounting standards, legal and regulatory requirements and taxation, can be very significant. This paper has considered how these risks impact on different types of employer pension provision and looked at some ways of mitigating these risks. The area of mitigating these risks is where actuaries are as competent as anyone else to advise and should be encouraged to add value to their clients by doing so.The opportunity exists in particular to look at:

- New or relatively uncommon types of plan design, such as career average plans
- Securities that could reduce significantly asset/liability mismatching, such as indexed bonds with a cap on the indexation (powerful in conjunction with a career average plan with matching indexation)
- Revisiting the traditional annuity structure – it may be possible to increase the attractiveness of annuities by unbundling the investment guarantees and survival guarantees.

References

(1) *Phillips & Drew Pension Fund Indicators 2001*

(2) *In Place of Micawber: Empowering Financial Consumers, a lecture by the Chairman of the Inquiry into the Provision of Information and Advice set up by the Faculty and Institute of Actuaries*

(3) *John Harris, Member of the UK Human Genetics Commission, as reported Sunday Times, 25 June 2000*

(4) ICA 2002: Reinventing Annuities, Mike Wadsworth and Alec Findlater

Appendix

1 This appendix describes a method for valuing pension liabilities by option pricing. The method is applicable to the situations mentioned in paragraphs 6.14 and 6.17, where there is an element of employer discretion over the amount of the benefits payable.

2 Take a simple example of a liability of £1,000 cash due in ten years time subject to future price indexation. The principles of what follows are similar if we were to look at a more realistic pension liability profile.

3 We work in terms of real discount rates throughout. Any valuation of the liability is therefore of the form $1{,}000 / (1+i)^{10}$ where i is the real discount rate.

4 Suppose the following alternative rates for the rate i:

- 2% currently available in the gilt market (the genuinely risk-free rate if a 10 year non-coupon paying index linked gilt were available);
- 3% for an assumed rate of return on a mixed asset portfolio which will be used to fund the liability.

5 The alternative liability values are then:

- 820 at 2%
- 744 at 3%

Gilt-based valuation

6 If:

- the liability payment of 1000 index-linked is definite,
- the right kind of matching gilt is available,
- and there is no credit risk that the 1000 will not be paid:

then all liability risk could be hedged out by investing now in 820 of the supposed ten year index-linked gilt. 820 would have to be the market value of the liability.

7 If a company has issued such a liability, then its value from the shareholders' perspective is 820. So long as investors know all about the liability, this value will be factored into the market price of the company's shares.

Asset based valuation

8 This liability is funded, and a pool of assets has been set aside to meet it. The assets are invested in a range of equity and other investments. The actuary and the company management agree that it is reasonable to assume a 3% real return on this fund. The actuary advises the company on the amount of fund to be set aside, and the recommended figure is 744 as noted above.

9 We suppose that the company management accept this valuation and set aside a fund of precisely 744 to meet the expected liability.

10 But the investment policy is necessarily a little risky, so the actuary points out that the fund will probably not earn 3% real. It might do better or worse, and indeed will almost certainly not perform exactly in line with the assumption.

11 In view of this, the actuary advises that the position should be reassessed in the future, when he will compare his assessment of the liability value with the market value of the assets from time to time. If the assets have outperformed the 3% real return, some money can be returned for other use in the company. If the fund has underperformed, the company will need to top up this fund. The management accept this advice, and they accept the risk that there may need to be some increase in contribution from time to time.

12 What is the shareholder view of this?

Shareholder valuation of liabilities	820
Actuarial valuation of liabilities	744
Unfunded	76

From a shareholder perspective the unfunded liability is 76. The shareholder interest in the company's pension arrangements, taking account of the assets and liabilities, has a negative value (-) 76. This negative value is effectively brought into account by the market when valuing the company's shares.

13 The company management have agreed to a fund of 744, but they have committed to something beyond that. On behalf of shareholders they have also committed to review and correct the funding requirement at future valuations.

14 The company management have in effect issued a put option on behalf of the shareholders: they are saying that if the investment return falls short of 3 per annum real, which it could do, then the fund can call for a top up. It may or may not be possible to buy this put option in the market, but either way we can estimate what the price would be. To simplify the model we now assume a single actuarial valuation at the end of the 10 years. The calculation can then be made using the Black-Scholes formula. The parameters are 2% for the risk-free discount rate and an assumed annual volatility of the fund's performance relative to the gilt rate - say 10% for now.

15 Consider a call option on a stock with present price F and future strike price L at time t. This is an option exercisable only at time t to buy the stock then at the fixed price of L.

The Black-Scholes formula for valuing this call option is:

$$C = F\,N(d_1) - L\,e^{-rt}\,N(d_2)$$

where:

- r is the risk-free instantaneous rate of return
- $d_1 = (\ln (F/L)/t + r + \tfrac{1}{2}\,\sigma^2)\sqrt{t}\,/\,\sigma$
- $d_2 = (\ln (F/L)/t + r - \tfrac{1}{2}\,\sigma^2)\sqrt{t}\,/\,\sigma$
- σ is the standard deviation of stock price volatility over unit time

- N( ) is the cumulative distribution function of the unit normal probability distribution.

16 The Black-Scholes formula for the corresponding put option (to sell stock at time t at price L) is:

$$P = L\, e^{-rt}\ N(-d_2) - F\, N(-d_1)$$

17 We apply these two valuation formulae to our simple pension example in the following way. First, replace the stock by the portfolio of investments in which the fund is invested. Next, suppose the liability is the single payment L due at time t. (Note: L is expressed in real, not money terms, so r is the risk-free real return.) Finally, assume a present fund equal to the actuarial assessment on the basis of an assumed instantaneous rate of return g, so that $F/L = e^{-gt}$.

Writing $\psi = g - r$, the expected premium return from the portfolio in excess of the risk-free rate, the formulae become:

$$C = F\,(\,N(d_1) - e^{\psi t}\, N(d_2)\,)$$

$$P = F\,(\,e^{\psi t}\, N(-d_2) - N(-d_1)\,)$$

where $d_1 = (-\psi + \tfrac{1}{2}\sigma^2)\sqrt{t}\,/\sigma$

$d_2 = (-\psi - \tfrac{1}{2}\sigma^2)\sqrt{t}\,/\sigma$

18 Noting that in general N(-d) + N(d) = 1 we derive the equation:

$$P - C = F\,(e^{\psi t} - 1)$$

This is equivalent to the principle of put-call parity, which states that the pay-offs from (and therefore the values of) the put option minus the call option are equivalent to those from the risk-free asset minus the risky stock (or portfolio).

19 The shareholder valuation of the pension liability is the sum of:

Fund + Put option value – Call option value

This is: $F + P - C = F\, e^{\psi t}$

$= L\, e^{-rt}$,

which is the liability valued at the risk-free rate.

20 The present value of the put option, with both F and L at 1000 in our example, is 141. The company might actually be able to buy such an option to remove any future demands upon it, and that would be the market price to do so. The put option is the market-based value of the downside risk to the company – the risk that it will have to meet the cost of future deficiencies.

21 The management also have a call option on their fund – the option which they would exercise to withdraw cash if the investment return exceeds 3% real, which it may well

do. The call option is the corresponding value of the upside benefit to the company of investing in risky assets. The value of the call option is found to be 65 and the net impact of the two options is:

141 - 65 = 76

22 So the value of shareholder interest in the company pension position is a net debit of 76, precisely the figure which we identified above.

Risk-sharing liability

23 Now suppose that management can to some extent control the downside risks, such as the management control over bonus rates in a career average scheme.

24 Suppose the liability payment after 10 years is targetted at 1,000, but would be less if the fund is insufficient at that time. Let us suppose a lower limit of 900 that is guaranteed by the company/pension fund. The target of 1,000 would be achieved from future discretionary bonuses totalling 100.

25 The way to model this is to take credit for a put option at 900 instead of 1000, because the company will not be obliged to fund a shortfall if the pay-out is no less than 900. But the call option is still at 1,000. The values are shown as follows, still assuming a fund of 744.

	Shareholders	**Members**
Value of 1,000 payment		820
Call option on surplus	65	
Put option on future deficit	(-) 90	
Loss to members 141 – 90 =		(-) 51
	(-) 25	769

26 The total interests in the fund are still 769 - 25 = 744 but they have been re-distributed. From a shareholder perspective the liability of 1000 could be regarded as valued at a discount rate of 2.7% to arrive at the market-based valuation of 769. The downside risk (valued above at 90) is decreased in value and the market discount rate is increased above the risk-free rate.