"Pensions and economic values"

R. J. Chapman, C. A. Speed

United Kingdom

Summary

This paper suggests a model for linking strategic pensions decisions with economic and shareholder value. The paper builds on recent UK work that models a completely defined economic system, which includes all parties to the pension arrangement. By modelling the pension plan alongside the company the papers brings out the interaction between the parties with financial interests in the plan. This framework is used to quantify the wealth transfers between parties resulting from management of a sample pension plan, including transfers resulting from changes in investment strategy. This information allows the impact of strategy decisions on shareholder value and on risk management to be evaluated.

Key words

Actuarial, pension, shareholder value, economic value, deflators

“Pensions et Valeurs économiques”

Cliff Speed , R. J. Chapman

United Kingdom

Résumé

Cet article suggère un modèle pour relier les decisions stratégiques des pensions avec la valeur économique et actionnaire. Cet article se base sur le recent travail britannique qui modèle un système économique complètement défini, qui inclut toutes les parties de l'accord de pension. En modelant le fond de pension a cote de la compagnie, cet article fait ressortir l'interaction entre les parties aux intérêts financiers du fond. Ce cadre est utilisé pour mesurer les transferts de richesse entre les parties qui proviennent de la gestion de l'échantillon du fond de pension, incluant les transferts provenant des changements dans la stratégie d'investissement. Cette information permet l'impacte des décisions de stratégie sur la valeur actionnaire et sur la gestion des risques d'être mesurer.

"Pensions and economic values"

R. J. Chapman, C. A. Speed

United Kingdom

Pensions and shareholder value

This paper suggests how actuaries advising on occupational pension plans can broaden their valuation techniques to embrace the concept of shareholder value. The context of the paper is defined benefit pension plans in the UK but the proposed techniques can be applied in all jurisdictions and to all types of employee benefit arrangements.

Stakeholders

In order to extend the scope of their advice we propose a stakeholder model that allows actuaries to consider all the parties with a financial interest in the pension plan. The model allows for financial risks on a market-related basis and so it can be used for economically coherent risk management of the pension plan.

Building a model

The stakeholder approach requires a combination of three elements: a pension plan model, a model of the company and an economic projection system.

Using the model

The power of this approach is that if we wish to see the financial effect of strategic decisions connected with the pension plan we can:

- run the model to establish the stakes of the various parties under the base case
- run the model again under the new strategy
- compare the stakes of the various parties under the two strategic scenarios to see who wins and who loses
- obtain a profile of the major financial risks surrounding the pension plan
- repeat the process until a strategy agreeable to all parties is achieved.

Transparency

By effectively "marking to market" all its valuations, the model provides information to users that is wholly transparent. In other words, the model does not produce figures that are influenced by user assumptions. Also many pension models leave out of the picture some important stakeholders, thus creating winning strategies without considering the losers.

Accounting requirements

The move to actuarial transparency is reinforced by the parallel moves within the accounting profession towards "fair value" accounting. The new international pensions accounting standard, IASC 19, implies a higher degree of transparency in financial reporting than has been evident previously.

Contrast with past advice

Pensions actuarial advice in the UK has in the past been plan-specific, ie it has not considered the impact on other parties to the pension arrangements. A scenario or strategy that appeared to create winners on a plan-specific basis would, on the principle of "no free lunch", have created undisclosed losers amongst other stakeholders.

Looking to the future

In the UK defined benefit plans are maturing fast and their financing and investment is becoming increasingly a matter of risk management. In the corporate field, shareholder value techniques look at risk management solely from the shareholder dimension. In the pensions field, we are suggesting a "stakeholder value" approach that looks at risk management issues for all parties connected with the company and the pension plan.

Traditional approach - plan-specific reporting

Actuarial valuations

Valuation reporting in the UK has traditionally not been market-related and has relied on assumptions set by the plan actuary. In the last few years, reporting has been moving gradually to a basis where assumptions are set by reference to the market. More details are given in Appendix 1.

Company accounts

Pension costs in company accounts for UK companies are also moving to a market basis as new accounting standards are phased in over the next few years. At present the costs for most companies are still reported using assumptions that are not market-related.

Asset liability modelling

Actuarial valuation reports in the UK recommend a contribution rate but are generally silent about the risks that funding targets will not be met. This extra dimension of information is traditionally the province of asset liability modelling. This involves simulating the development of the plan under an economic or statistical model to assess the range of possible outcomes.

Weakness of traditional, plan-specific approach

Actuarial valuations suffer from having no risk dimension. Asset liability modelling does have a risk dimension and so provides useful extra information. But asset liability modelling omits some key stakeholders from the equation, for example the company shareholders, and therefore does not provide an objective platform for setting policy on funding and investment. The starkest illustration of this weakness is that asset liability modeling makes the assumption that the employer remains in business, irrespective of commercial conditions, for the whole of the projection period. A further weakness is that asset liability modelling reports risks simply in terms of probabilities and cannot put a market price on the risks faced by the different stakeholders.

Investment policy

Despite the absence of an objective platform or benchmark to act as a reference point, asset liability modelling is often promoted as a means of setting investment policy. The drawback here is that the results are plan-specific, ie they do not fully recognise any stakeholders other than pension plan members. In particular the results only hold if the company continues in existence.

Simple solution

The simple means of overcoming the weaknesses is to include all stakeholders in the modelling. The other techniques used in the modeling, ie projecting cash flows and discounting them, should be conceptually straightforward for actuaries.

Some obstacles

The obstacles to stakeholder modelling are:

- actuaries are not strong on the corporate finance side of the equation. This matters when we come to model the cash flows within the company and to consider issues such as credit ratings
- actuarial science and modern finance techniques have diverged and now need to re-converge quickly if actuaries are to maintain a credible force as contributors to risk management
- actuaries may find some conflicts of interest in trying to advise all stakeholders on the even-handed, transparent basis implied by this methodology.

Stakeholder modelling

The methodology of stakeholder modelling is explained in Appendix 2. Some of the building blocks are described in the next section.

Building blocks for the stakeholder approach

Treating pensions as corporate debt

Pensions are promises to make payments in the future and in that sense can be considered as corporate debt. This is the case irrespective of the existence of a separately funded pension plan.

Existence of separate pensions plan

If a separate plan does exist it might be argued that because the assets are legally separate from the company they cannot be construed as company debt. But, for example, shareholders can look through these legal arrangements to see their financial exposure. And factors such as deciding which parties own any surplus within the plan reinforce the approach of considering the pension plan as part of the whole financial enterprise.

Characteristics of corporate debt

If we treat pensions as debt, we can learn about the features of pension provision by looking at some relevant features of corporate debt:

- the value of debt is affected by the company's ability to pay and the priority of the debt on winding up
- the assessment of the risk of the company defaulting on its debt obligations is a key factor
- corporate debt may have embedded within it financial options exercisable by borrower or lender.
  This applies also to pension plans.

Changes in capital structure

We know from the work of Modigliani & Miller (1958) that, to the first order, changes in capital structure do not affect the overall value of the company. By extension therefore, changes in the capital structure of the pension plan do not affect the overall value of the enterprise, ie the value including the pension plan assets. The individual components of overall value, for example the component attributable to holders of equity stakes, depend on the split of the overall cash flow of the company.

Significance of cash flows

The value of the interests of the various stakeholders in the company's business will change according to how the overall cash flows are directed between them.

The stakeholder modelling approach therefore relies heavily on tracking a complete set of cash flows for the enterprise. If any cash flows can "leak" from the model then the model will not be economically coherent.

Who are the stakeholders?

The parties with a financial interest in the corporate entity operating a pension plan, and whose cash flows we are tracking, are:

- employees, ie members and non-members of the pension plan
- former employees entitled to pension benefits
- shareholders
- other providers of capital, including bondholders
- government, in the form of tax and social security receipts
- suppliers and customers
- consultants, eg accountants, actuaries and investment managers

Cash flow projections

The key to the stakeholder model is the projection of all the cash flows related to the company using an economically coherent model. Amongst other characteristics such a model would be arbitrage-free, ie it could not generate inconsistencies that could generate a risk-free profit.

Stochastic discounting

In order to present the results, the cash flows are discounted back to the valuation date. To maintain economic coherence this discounting is done on a stochastic basis using "deflators". This contrasts with the deterministic techniques normally applied in pension valuations. Deterministic techniques make an allowance for risk that is arbitrary and therefore valueless if we are seeking to understand the effect of economic conditions on all stakeholders. Deflators are described in Appendix 3.

Sample results - Company XYZ

Company XYZ

To demonstrate the use of stakeholder modelling and how it provides information on shareholder value we modelled a large UK company and its main pension plan. Details of the pension plan and the assumptions used in our model are included in Appendix 4.

Features of XYZ

The company has been modelled with the following features:

- Market capitalisation £1.03 billion
- Fair value of total debt and related instruments £3.29 billion
- Credit rating of debt A
- 11,600 employees

The main pension plan had assets of £0.6 billion. Its current (initial) ongoing funding level is 108% and its discontinuance funding level is 105%.

Calibration

The future revenue streams of the company were calibrated to tie in with consensus broker forecasts of earnings per share. The historic dividends, earnings and distributable reserves were analysed to construct a dividend distribution model that assumed that current dividend policy would continue. In the base case we calibrate the model so that the market capitalisations of the equity and outstanding debt are respectively equal to the reported stakes for the shareholders and debt-holders under the current strategies.

Strategic management of pension plans

The ongoing strategic management of a pension plan encompasses decisions about:

- investment strategy
- funding methods and assumptions
- contributions payable
- levels of discretionary payments
- the speed of amortisation of surpluses and deficits in the pension plan.

Decisions on these strategic matters are not made directly by the stakeholders, but by agents who are appointed to act on their behalf. For example, directors of sponsors are the agents of the shareholders and trustees of pension plans are the agents of the members. In practice it is rare for decisions to be made by a single party. Actuarial advice is usually taken and often there is consultation between the trustees and sponsor.

Any change in the strategy will not create economic value; hence the total financial value will remain unchanged. However, strategic decisions about the pension plan will alter the value of the financial interests (or stakes) of the different stakeholders. Below we investigate how these strategic decisions alter the financial interests of the different stakeholders.

Base cases

The model provides output showing the financial interests (or stakes) of all the stakeholders in the economic enterprise. In the base cases current strategies for the pension plan and corporate sponsor are assumed to continue and the stakes of shareholders and debtholders are equal to the market capitalisation of the equity and debt.

The model also outputs market consistent valuations for all other stakeholders based on the cash flows they receive. The table below shows how the total financial value of the sponsor and pension plan is divided between the stakeholders.

To demonstrate how the stakes alter we use two base cases:

1. discretionary benefit improvements are made when surplus (as measured on the ongoing valuation basis) exists
2. no discretionary benefit improvements are made.

Table 1 – base cases

	Plan surpluses shared with plan members		**Company benefits from all surpluses**	
Main stakeholders	**Stakes (£million)**	**%**	**Stakes (£million)**	**%**
Shareholders	1,027	25	1,077	26
Debtholders	3,287	80	3,305	80
Government	207	5	212	5
Employees	735	18	673	17
Externals and consultants	(1,139)	(28)	(1,150)	(28)
Total	4,118	100		100
Wind up probability		5.3%		4.5%

The model enables us to quantify the effect the change in surplus distribution policy. The value of the employees' stake decreases by £62m and the main beneficiaries are the shareholders,

whose stake increases by £50m. This is equivalent to a 5% increase in share price. The market value of the debt also increases, implying a higher credit rating for the sponsor.

Investment Strategy and surplus distribution

How the surplus distribution policy affects different stakes is closely connected to the investment policy of the pension plan. An equity strategy leads to a more volatile funding level and results in greater discretionary payments (benefit leakage). In the table below we demonstrate how the stakes change if the pension plan switches to a wholly bond based investment strategy from its current strategy of investing 78% of assets in equities.

Table 2 – effect of investment strategy

	Plan surpluses shared with plan members		**Company benefits from all surpluses**	
Main stakeholders	**Stakes under current investment policy %**	**Stakes under 100% bond strategy %**	**Stakes under current investment policy %**	**Stakes under 100% bond strategy %**
Shareholders	25	25	26	26
Debtholders	80	81	80	81
Government	5	5	5	5
Employees	18	17	17	16
Externals and consultants	(28)	(28)	(28)	(28)
Total	100	100	100	100
Wind up probability	5.3%	4.4%	4.5%	3.9%

The table shows that for this plan, altering the investment strategy has a comparatively small effect on the stakes. It is evident that for employees an equity strategy with shared surplus is best. For the plan sponsor, the best strategy is to ensure no allocation of surplus to members. For debtholders, a bond strategy with or without sharing of surplus is preferable.

Fall in the value of the pension plan's assets

Given the pension plan's current investment strategy (78% equities) there is a risk that the assets will fall in value without a corresponding fall in the value of the liabilities. The table below shows how a fall of 10% in the value of the pension plan's assets affects the different stakes.

Table 3 – 10% fall in value of plan assets

	Base case (surplus shared)	10% fall in asset value	Difference in value of stakes
Main stakeholders	**Stake (£ million)**	**Stake (£ million)**	**(£ million)**
Shareholders	1,027	1016	(11)
Debtholders	3,287	3292	4
Government	207	202	(5)
Employees	735	690	(45)
External and consultants	(1,139)	(1133)	6
Total	4,118	4,067	(51)
Wind up probability	5.3%	5.4%	

The 10% decrease in the pension plan's assets means that

— the initial ongoing funding level falls to 97% from 108%
— the discontinuance position falls to 95% from 105%

The main effect of a £51m fall in the pension plan's assets is on the employees whose stake decreases by £45m. Shareholders also see their stake decrease by £11m, the equivalent 1.1% fall in the share price. These effects would be magnified for a pension plan that was larger in comparison to the sponsor.

Pace of funding – methods

The pace of funding in a pension plan, ie how quickly assets are accumulated to meet the liabilities, can be altered in a number of ways:

— making more optimistic assumptions about future investment returns in the valuation basis
— spreading over a longer future period any special contributions, eg to finance deficits.
— changing the funding method, eg from an ongoing basis to a discontinuance basis

Pace of funding 1 – financial assumptions

In our base cases the interest rate used to discount the liabilities is derived from the yield on government bonds but additions to this interest rate are made which results in a lower reported value of the liabilities. For calculating the ongoing funding position the interest rate implied by government bonds is increased by 2.5% when valuing non-pensioner liabilities and by 0.5%

when valuing pension liabilities. If these advance credits for expected asset returns are removed, the initial ongoing funding level falls from 108% to 86%, and the discontinuance funding level falls from 105% to 99%. This lower reported funding level would require higher contributions and the pace of funding would be increased.

Table 4 – moving to bond-based valuation rate of interest

	Base case (surplus shared) – slow funding	**Bond-based valuation rate**
Main stakeholders	**Stake %**	**Stake %**
Shareholders	25	23
Debtholders	80	80
Government	5	4
Employees	18	20
External and consultants	(28)	(27)
Total	100	100
Wind up probability	5.3%	5.9%

The table shows that:

- an increased rate of funding increases the employees stake primarily at the expense of the shareholders
- the higher contributions to the pension plan takes money off the balance sheet and so makes the sponsor more likely to enter liquidation
- the government is also a net loser from the increased pace of funding because greater use is made of the tax shelter of the pension plan.

Pace of funding 2 – amortisation of surplus and deficit

The table below compares:

- amortisation of surpluses over 5 years and deficits over 10 years (as in the base cases)
- immediate amortisation
- amortisation over 100 years.

For immediate amortisation, deficits in the pension plan are corrected by additional contributions in the next year. If the pension plan is in surplus, a contribution holiday is taken until no surplus remains. No surplus is assumed to be refunded to the sponsoring company while the plan in ongoing.

Table 5 – extended amortisation periods for deficits

	Immediate amortisation	10 year amortisation (base case)	100 year amortisation
Main stakeholders	**Stake %**	**Stake %**	**Stake %**
Shareholders	25	25	25
Debtholders	80	80	80
Government	4	5	5
Employees	18	18	18
External and consultants	(27)	(28)	(28)
Total	100	100	100
Wind up probability	6.2%	5.3%	5.0%

Immediate amortisation of surpluses and deficits give rise to much greater volatility in the pension plan contributions, which affects the wind-up probabilities reported. The immediate removal of deficits provides greater security to plan members but their stake is only marginally improved.

Other factors affecting stakes

In addition to strategic pension decisions, the financial status and the relative size of the sponsor to the pension plan will affect the pension guarantee and hence the value of the pension arrangement to the employees. The directors of the sponsor influence the financial status of company, for example by controlling the capital structure of the company. This will have an impact on the credit rating of the company and the stakes of the different stakeholders.

Capital structure of the sponsor

In the section we consider the impact of increasing the financial leverage (gearing) of the sponsor. We assume that an additional £321m of debt is issued and the proceeds are used to buy back equity.

Table 6 – capital structure – effect of equity buy back

	Base case	Higher gearing
Main stakeholders	**Stake %**	**Stake %**
Shareholders	25	17
Debtholders	80	88
Government	5	4
Employees	18	17
External and consultants	(28)	(26)
Total	100	100
Wind up probability	5.3%	13.2%

Although the main impact is the shift in value from shareholders to debtholders, reflecting the new capital structure, there is also a significant increase in the level of projected wind-ups. Also because interest payments are paid out of pre-tax earnings there is a reduction in the government's financial interest in the enterprise.

Conclusions – Pensions reporting in a shareholder value context

Results from the stakeholder model

The aim of this paper has been to show how pensions can be considered in a shareholder value context. The results for the sample XYZ organisation show how a stakeholder model can be used to illustrate the financial affect of strategic decisions in relation to the pension plan.

Risk management

Risk assessment and reporting is becoming an increasingly important part of pension plan management. Risk is a notoriously difficult subject to define and quantify but our method avoids problems of definition by allowing for risks implicitly within the model on a market-priced basis.

Transparency

In a climate of complete transparency it would be possible to:

- identify the major factors affecting the stakes of the main parties to the pension plan
- define a strategy by prescribing the ranges in which these factors would be managed
- introduce an obligation to report in money terms the changes in stakes of the relevant parties if the strategy was changed, ie new ranges were specified.

Example of transparent strategy ranges

Table 7 – strategy framework

Strategy factor	Strategy A	Strategy B
Funding level	95% - 100%	80% - 100%
Bond/equity split	10/90	50/50
Surplus sharing	50/50 – company/members	None

If all parties agreed a move from current strategy A to new strategy B, then it would be possible to use the stakeholder model to say that, for example, the stakes of shareholders had increased by £50,000,000.

Practical consequences

It is unlikely that pensions reporting would go as far as this example but it might well be that changes in stakeholder values prove useful in the resolution of policy between company and trustees.

Bibliography

Reference list

Ami, D., Kast, R., Lapied, A. (1991). Generalised arrow pricing to understand financial markets. *2nd AFIR International Colloquium*. **4**, 1-26

Arrow, K. (1953). The role of securities in the optimal allocation of risk bearing. English translation (1964). *Review of Economic Studies*. **31**, 91-96.

A.S.B. (2000). *Financial reporting standard 17.* ASB Publications, tel. +44 1908 230344.

Baxter, M.W. & Rennie, A.J.O. (1996). *Financial calculus An introduction to derivative pricing.* Cambridge University Press. ISBN 0-521-55289-3.

Black, F. (1980). The tax consequences of long-run pension policy. *Financial Analysts Journal*, **36**, 21-28.

Clark, G.J. (1992). *Asset & liability modelling – the way ahead?* Paper presented to the Staple Inn Actuarial Society.

Chew, D.H. (1999). *The new corporate finance: where theory meets practice (second edition). International edition.* Irwin McGraw-Hill. ISBN 0-07-116151-1.

Copeland, T.E. & Weston, J.F. (1988). *Financial theory and corporate policy (third edition).* Addison-Wesley. ISBN 0-201-10648-5.

Duffie, D. (1996). *Dynamic asset pricing theory (second edition).* Princeton University Press. ISBN 0-691-02125-2.

Exley, C.J., Mehta, S.J.B. & Smith, A.D. (1997). The financial theory of defined benefit pension plans. *B.A.J.* **3**, 835-966.

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

Greenwood, P.M. & Keogh, T.W. (1997). Pension funding and expensing in the minimum funding requirement environment. *B.A.J.* **3**, 497-549.

Jarvis, J.J., Southall, F. & Varnell, E. (2001). *Modern valuation techniques.* Paper presented to the Staple Inn Actuarial Society.

Jensen, M.C. & Meckling, W.H. (1976). Theory of the firm: managerial behavior, Agency costs and ownership structure. *Journal of Financial Economics.* **3, No 4**, 305-360.

Merton, R.C. (1992). *Continuous-time finance.* Blackwell Publishers Ltd. ISBN 0-631-18508-9.

Modigliani, F. & Miller, M.H. (1958). The cost of capital, corporation finance and the theory of investment. *American Economic Review*, **48**, 261-297.

Moody's Investment Service (2000). *Historical default rates of corporate bond issuers, 1920-1999*. Downloadable file from www.moodys.com/defaultstudy.

Smith, A.D. (1996). How actuaries can use financial economics. *B.A.J.* **2**, 1057-1175.

Tepper, I. (1981). Taxation and corporate pension policy. *Journal of Finance*. **36**, 1-13.

Yakoubov, Y.H., Teeger, M.H. & Duval, D.B. (1999). *The TY Model.* Paper presented to the Staple Inn Actuarial Society.

Appendix 1 - Current reporting of UK actuarial valuations

Key items of actuarial valuation reporting

Actuarial reporting in the UK covers the following main outputs:

- the actual funding status of the plan
- the company contributions required to maintain a target level of funding

Importance of assumptions

The headline figures in actuarial valuation reporting are normally given as if the sponsor will remain an ongoing concern able to finance the pension plan without limit of time or resources. In these circumstances valuation assumptions have remained a matter for the plan actuary and the divergence of assumptions is wide. In other words valuation results for two similar plans could be significantly different.

Discontinuance

Even with discontinuance valuations there is considerable latitude on assumptions but in this case the divergence of results is generally much less marked.

Move to market-led valuations

In the last two or three years many UK pension plans have moved to a form of market value valuation for their ongoing results. However in most cases arbitrary adjustments are made to the results. These judgmental adjustments can have a significant effect on the results.

The "long term"

In the UK there is a considerable body of actuarial tradition that believes that clients are paying for advice which is in some sense better than the market. Often this advice is given under the banner of "long term" considerations. This approach is valid if in the long term the sponsoring employer is around forever in good financial shape with an unchanged commitment to its pension arrangements. This assumption is heroic in the light of a steady flow of company failures over the years.

Appendix 2 - Stakeholder model in the UK

Basis of model

The model projects all the cash flows in the enterprise and attributes them to the relevant stakeholders. From these cash flows we calculate the value of each stake in a manner that is consistent with observed market prices.

Inputs

The basic input to the model is the total value of the company and the pension plan, i.e. the total wealth in the system at the outset. The model requires the following specific inputs:

- the pension plan details, including benefit structure, investment strategy and solvency level
- the company's financial structure, last year's accounts, dividend policy
- an assumed trigger point for a company entering liquidation
- the market value of the company and the pension plan
- income tax, corporation tax and social security rates
- economic and statistical inputs for the stochastic economic model.

Value of the company

Details of the company's capital structure are also required as this contains information about the risks faced by different stakeholders. For example, the risk in holding shares in a company is affected by:

- level of gearing
- reserves available
- dividend cover

The value of the company at any time is assumed to be the total realisable value of all the assets available in the event that the company enters liquidation, allowing for any discontinuance pension plan deficit at market value. The value of the firm measured in this way does not recognise the value of future profits to the shareholders.

Overall value

Although the pension plan's discontinuance deficit is included in the accounting valuation of the company, the assets held in the pension plan are not. Hence the combined value of the company and pension plan is the value of the company plus the market value of the assets in the pension plan.

Calibration

The stakes represent the economic value to the different stakeholders in the combined economic entity. If the equity (and debt) of a company were quoted we would have a market assessment of the stakes of the shareholders and loan stockholders. In that case the model would be calibrated to these market values.

Accounting values

The shareholders' and loan stockholders' stakes (ie the equity and debt market value) from time to time differ from the accounting value of the company because the market assesses the value of future cash flows.

Closed system

Although the stakes of different stakeholders alter from time to time, the total value of the combined entity remains unchanged as we are dealing with a closed economic system. To the extent that the shareholders' stake exceeds the realisable asset value of the company after meeting all prior claims there must be an offsetting change in other stakes. In our model the main example of an offsetting change is the externals stakeholder (i.e. the difference between suppliers and customers). For a profitable company the externals will have a negative stake that represents the value of a cash stream which we label as future oligopoly profits. If the company ceases to trade, the externals' stake reverts to zero as they make no further contribution to the economic system.

Stakeholders

The model tracks the cash flows between the following stakeholders:

- employees, both members of the pension plan and non-members
- shareholders
- loan stock holders
- the Government as a raiser of taxes
- externals (the cash flows made to suppliers less payments received from customers)
- consultants and advisers

Objectives of stakeholders

Our starting assumption is that all stakeholders apart from the Government wish to maximise the value of their stake in an enterprise on the basis of information available to them. We assume the Government adopts a passive role and maintains the current level and structure of taxation and benefits.

Lender of last resort

In addition we introduce a lender of last resort who meets the costs of winding up in those circumstances where the residual company assets are not sufficient. The introduction of this lender is a device that simplifies the modelling by providing for cash flows that would otherwise move outside our defined economic system. In practice the size of this stake was negligible in comparison to those of the other stakeholders.

Decision rules

All cash flows between the different stakeholders, including the lender of last resort, are modelled. For each cash flow attributed to a stakeholder there will be a compensating opposite cash flow for other stakeholders. Many of these cash flows are defined by specific rules; examples are:

- tax on earnings paid by individuals
- tax on pensions received during retirement.

Other cash flows need decision rules to be specified, including, for example:

- what discretionary benefit increases will be granted (and in what circumstances)
- what the dividend policy of the company will be.

We have made assumptions about these decision rules in our model but this is an area where practitioners can gain insights by varying the assumptions.

Operating structure of company

The operating structure of the company is an integral part of the model. We introduce the simplifying assumptions that the company outsources all functions other than core production and has no fixed operational assets. All reserves are then assumed to be invested in realisable assets.

Company cash flows

The following cash flows relating to the company are considered:

- sales revenue less supplier costs
- investment income on the company's assets
- staff costs relative to a benchmark
- payments to service debt
- contributions to the pension plan
- fund management fees and other consultancy costs

Profit and loss account and balance sheet

From the cash flow projections, we construct a profit and loss account and deduce a first order estimate of corporation tax payable. Given an assumed dividend policy the change in reserves is calculated, enabling a skeleton balance sheet to be constructed.

Staff costs

Staff costs are modelled relative to an assumed benchmark level for the industry, the rationale being that the value of the benefits received by the employee is the excess over the market rate for that job. The benefit an employee derives from employment is the excess remuneration over the market rate for their labour. So, in the event of the company winding-up their financial loss is limited to the loss of any benefit in excess of the benchmark. The corollary is that the rates of benefit above benchmark will affect the profitability of the company. For this purpose we consider employee benefits to be salary, uplifted by a percentage to reflect other benefits

receivable, including any profit-related pay. We keep pension benefits separate from the assessment of the employees' total remuneration package to reflect their deferred nature.

Shareholder receipts

The shareholders receive any dividend paid, plus, in the event of the company entering liquidation, any residual worth after all prior claims on the assets have been met.

Cash flow identification

The process of identifying all the cash flows received or paid is repeated for all the other stakeholders in the system.

Company wind up

In the event of the company ceasing to trade, a distribution of remaining assets must be made. The cash flows need to be specified in terms of the priorities of the different stakeholders (and as necessary within sub-divisions of the stakeholders).

Initial conditions

Initial conditions need to be set which include the capital structure of the company and details of the pension plan. The pension plan details include:

- benefit structure
- initial solvency level
- investment strategy

Stochastic model and deflators

Once the cash flows and priorities are fully specified, a stochastic model is used to simulate all the future cash flows to the stakeholders. These cash flows are then weighted using deflators and averaged to calculate the present value of each stake. Stochastic models are now commonly used in actuarial work but in order to provide meaningful results for value-based work, the model must be able to produce deflators. We describe the nature of deflators in Appendix 3.

Different strategies can then be compared; for example we can vary the investment strategy of the pension plan to identify how different stakeholders are affected.

Outputs

One of the necessary components for the projection is the stochastic investment model. The minimum requirement for this model is that it produces:

- returns on the investment asset classes
- oligopoly profit for the company
- inflation, salary growth and any other economic variables needed for the liability cash flows
- deflators to provide economic consistency

Oligopoly profit

To describe how the company's profits fluctuate with economic conditions we model a stochastic variable that we call 'oligopoly profit'. These profits are the income from sales after deducting supplier costs and the benchmark staff costs for the industry. We assume that a company achieves oligopoly profit by operating in a market without perfect competition; if a market had perfect competition there would be no oligopoly profit.

Variability of profits

By specifying the market portfolio (ie the universe of investible assets) the deflator approach allows us to price the systematic risk in the market. The systematic risk in oligopoly profit is defined by the correlation between oligopoly profit and market return. The non-systematic element of risk in oligopoly profit is uncorrelated with the market return and therefore does not affect market prices.

Parallels with CAPM

The deflator approach has parallels with the CAPM for calculating the expected return on a stock. Whereas CAPM operates in a one period framework, the deflator-based approach generalises the model to multi-period pricing.

Appendix 3 - Deflators

What are deflators?

Deflators are stochastic discount functions. When incorporated into a stochastic asset model they ensure that asset prices are consistent with their projected future income streams. The use of deflators ensures a model is arbitrage free and that asset prices reflect the inherent risk in a market consistent manner.

Deflators and state price securities

Deflators can be defined in terms of state prices (the price of an Arrow-Debreu security) and the state probabilities.

A state price security pays out 1 if state occurs and 0 otherwise. Let $\Psi_t(s)$ be the price of a state price security for state s, and $p_t(s)$ be the probability of state s where the subscript t denotes time. Then we can write the deflator $D_t(s)$ as,

$$D_t(s) = \frac{\Psi_t(s)}{p_t(s)}.$$

We see that deflators are positive stochastic processes that take a different value in each future state.

In a stochastic model an asset is characterised by the future cashflows it generates. If we denote the future cashflow from an asset in state s at time t by $C_t(s)$ then the asset is equivalent to a portfolio of state price securities, with $C_t(s)$ of each security held. Hence we can write the value of the asset as

$$\text{Value of asset} = \sum_{times}\sum_{states}\Psi_t(s)C_t(s) = \sum_{times}\sum_{states}p_t(s)D_t(s)C_t(s)$$

$$.. \quad = \sum_{times}E[D_t(s)C_t(s)]$$

Deflators and total return indices

We can re-write the expression for the product of the deflator and cash flows in terms of total return indices. Let R_t^i be the total return indices for asset class i, where t is the time parameter. A total return index gives the value of a set of cashflows where any distributions from the underlying asset, i.e. dividends, are re-invested in the underlying asset. Paying the value of the index at time T is therefore equivalent to having the right to all cashflows arising from the underlying asset from time T onwards.

$$R_0^i = E[R_T^i D_T]$$

This expression holds for all T, therefore considering T>t we can write,

$$E[R_t^i D_t] = E[R_T^i D_T] \quad \text{for } T > t$$

When this expression is evaluated at t we have

$$R_t^i D_t = E[R_T^i D_T] \quad \text{for } T > t$$

The advantages of using a deflator based model for stakeholder analysis:

- values can be placed on the stakes of all stakeholders;
- the values will be consistent with market conditions if the deflator model is calibrated against relevant market indicators;
- the alternative risk neutral approach is avoided. This involves changing the underlying probabilities to make the risk premium for every asset zero (This is possible because values are independent of individuals' estimates of the risk premium). This technique, though powerful, appears to have confused actuaries unused to the mathematical formalism; and
- many market models, such as those frequently used to price options, rely on the existence of a perfect dynamic hedge (which equates to the unrealistic assumption of a complete market) whereas deflators can be generalised to incomplete markets.

Literature on deflators

Deflators were introduced by Arrow (1953), and their first appearance in the actuarial literature was at the 1991 AFIR International Colloquium (Ami et al., 1991). Smith (1996) introduced the concepts to the U.K. profession and, more recently, an introduction to deflators for actuaries has been published by Jarvis, Southall & Varnell (2001). A rigorous approach to deflators in a conventional Brownian motion setting can be found in Duffie (1996).

Appendix 4 - Details of XYX pension plan

XYZ pension plan

The main pension provision for employees is the XYZ pension plan, which is a defined benefit arrangement. The company also has other defined contribution (or money purchase) arrangements. Details of the plan are set out below.

Main benefits

- Pension of 1/60th of the final salary for each year of service
- Pensions increase in payment by Limited Price indexation (LPI) – inflation increases up to a maximum of 5% and a minimum of 0%.
- 50% Spouse's pension on death of the member
- On withdrawal a transfer of the benefits or a preserved pension that is re-rated at LPI over the whole period between withdrawal and retirement

Membership and demographic assumptions

- 4,100 active members of the pension plan
- 1,500 preserved pensioners
- 2,000 pensioners
- mortality in retirement based on PMA80 base year 2020
- mortality before retirement PAM80 with a 80% scaling factor
- 90% of members assumed to be married
- withdrawals from service at a rate of 10% between ages 20 to 40
- full replacement of leavers is assumed.

Investment strategy

- 78% equity investment
- 22% bonds and cash (9% index-linked, 9% fixed bonds, 4% cash)

Discretionary benefits

- When a valuation shows a surplus, additional discretionary benefits are paid to pensioners amounting to 10% of the disclosed surplus.

Contributions

- The Projected Unit funding method is used for the ongoing funding position and calculating regular contributions.
- Contributions are reduced to allow for surplus being amortised over 5 years
- Contributions are increased to amortise deficits over 10 years

Financial assumptions

- The ongoing funding position uses gilt yields and takes credit for an additional 2.5 % pa return on the assets for non-pensioners and 0.5% pa return for pensioners

- The discontinuance funding position uses gilts yields and takes credit for an additional 1% pa return on the assets for non-pensioners. No addition is made for pensioners.

Funding levels

- The ongoing funding level was reported as 108%
- The discontinuance funding level was reported as 105%