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# THE CURRENT STATE OF ASSET / LIABILITY MODELLING IN THE U.K.

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# ETAT ACTUEL DE LA MODELISATION ACTIFS - ENGAGEMENTS AU ROYAUME UNI

# 28 ETAT ACTUEL DE LA MODELISATION ACTIFS-ENGAGEMENTS AU ROYAUME-UNI

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## RESUME

Cet article passe en revue les différentes méthodes de mise en correspondance des actifs et des engagements des caisses de retraite britanniques par des techniques de modélisation sur ordinateur. L'application pratique de ces techniques est un nouveau domaine d'activité actuariel, en plein développement. Les travaux publiés ne donnent en général pas de détails sur les diverses méthodes et ne comparent pas leurs avantages respectifs.

Ces méthodes sont donc présentées, avec leurs objectifs respectifs, d'un point de vue général, sans se référer à des praticiens particuliers.

Les auteurs signalent les points faibles constatés et mentionnent quelques idées nouvelles qui ne semblent pas avoir encore été appliquée dans ce domaine.

# THE CURRENT STATE OF ASSET / LIABILLITY MODELLING IN THE U. K.

BY A. J. WISE AND M. J. ANNABLE

## INTRODUCTION

This paper reviews the different ways in which U.K.pension fund assets and liabilities are related to each other by computer modelling techniques. The practical application of these techniques is a new and developing area of actuarial work. Details are not generally available from published works and there has been little discussion of the merits of one method relative to another.

We therefore review the different objectives and methods from a general point of view, without reference to individual practitioners.

We point out weaknesses where we see them and we mention one or two new ideas which we have not yet seen applied in this area.

## 2 - BACKGROUND

Historically the actuary's role in setting investment policy for UK pension funds has been limited, in the majority of cases, to providing very broad strategic advice. This advice has been based upon the actuary's general knowledge of a Scheme's liability profile rather than on any scientific analysis of the objectives and risk tolerances of particular Schemes. The investment manager's role in setting policy has been much greater. His objective has been - increasingly - to achieve returns greater than those of his peers as measured by leading performance measurement services. This has led to a narrow range of investment strategies being adopted for a large number of funds.

## 3 - MOTIVATION

Asset-liability modelling is intended to provide a scientific and disciplined method for analysing the long-term investment requirements of institutional funds. It is not intended to be a short-term tool for taking tactical decisions as to the relative merits of investment markets.

There are various factors motivating the development of this work

(1) The investment manager's objectives may not coincide with those of the Trustees, leading to an inappropriate investment policy. The actuary should be in a position to help identify agreed objectives.

(2) There has been increasing interest in the use of specialist investment managers for different categories of asset. Trustees need advice on the long-term strategic aspects of policy to enable them to allocate assets appropriately amongst managers.

(3) Progress has been made with methodology and computing power.

## 4 - OBJECTIVES

The starting point for any analysis of assets and liabilities is the establishment of the objectives to be met. These drive the model and encapsulate the risk and return requirements of the fund. Importantly, they will also help in the formulation of a suitable definition of risk.

Different funds will have different objectives and will be seeking to solve different problems through the asset liability analysis. These objectives and problems may be divided into three broad categories, distinguished by the time frame over which they operate. Some common objectives are summarised below categorised according to whether they are short, medium or long-term in nature.

| | |
|---|---|
| Long Term | - Minimising the possibility that the assets will be insufficient to meet liabilities in the distant future. |
| Medium Term | - Controlling the contribution rate resulting from future actuarial valuation<br>Controlling funding level.<br>Controlling pensions cost f a accounting purposes. |
| Short Term | - Seeking to produce superior returns to peer group or other specified benchmark. |

Asset liability models do not, as discussed above, seek to address short term objectives. The long term objective of ensuring the long term solvency of the fund is of prime importance, especially in cases of closed funds, or declining funds with extensive pensioner liabilities. The long term analysis can also be used to determine a benchmark asset allocation for the typical ongoing fund, relative to which the investment manager can tailor his short term investment policy. In the case of an ongoing defined benefit scheme in which the employer guarantees to meet the balance of cost (which is typical in the UK), the medium term objectives of controlling Scheme costs and funding levels have tended to be those focused upon.

These medium term objectives are all related to the results of future actuarial valuations of a Scheme and have a combination of long - term and short - term features, and these must be reflected in the modelling process. On the one hand it is necessary to model the rates of return which may be achieved on various asset types over intervaluation periods, while on the other hand the model must also reflect the longer-tern methods used by the actuary in calculating the actuarial values of assets and liabilities.

## 5 - MODELLING TECHNIQUES

Having established the objectives of the study it is next necessary to build a model relating assets to liabilities through which the effects of different asset allocations can be examined. Various approaches have been made to the construction of such models. Those contain many points of similarity, but equally also differ in some important aspects. Some of the similarities and differences are discussed below.

Representation of the risk/return characteristics of the main investment sectors - equities, fixed interest etc - can be related to the nature of the liabilities. Models of the joint behaviour of the assets and liabilities involve (at least by implication if not explicitly) the following elements :

(1) the horizon time, over which the asset/liability relationship is to be considered
(2) the economic model for the risk/return characteristics of the assets
(3) the economic model for the liabilities
(4) a definition of risk
(5) degree of matching to be achieved by appropriate asset allocation

## 6 - THE POINTS OF DIFFERENCE

The models currently in use are known to differ in the following respects.

(1) **Horizon time.**

Anything between 1 year and the actuarial horizon of 20 years and more is used, depending on the required objectives as noted in paragraph 4. A horizon time of under 5 years is comparable with that of the investment analyst and cannot take proper account of long term features of the liabilities. A horizon time of 1 year is short term and we would regard the result as pure asset modelling which is within the field of expertise of the investment manager.

**(2) Economic model for the assets.**

An MPT (Modern Portfolio Theory) model uses statistics of the returns on the various asset classes over the horizon time, namely the expected returns, and the variances and covariances. The statistics are derived from past observation of investment returns over many years, modified if required to reflect subjective views about the future. This basic model does not involve estimation or use of any more detailed information about the probability distribution of returns. It cannot readily cope with questions arising from differences between expected future conditions (such as market prices of assets) and corresponding current conditions.

A more detailed approach is to develop a time-series model of the key parameters which govern investment returns : inflation, interest rates etc. Statistical analysis of past years yields correlations etc between these parameters, from which estimates of the required statistics relating to investment returns can be derived. The time series approach seems better suited for use with a long time horizon. It can also be used to generate probability distributions of investment returns if required. It copes in a natural manner with any differences between current conditions and those expected in future years.

Another possible approach, which we believe is not yet in use for asset/liability modelling in the UK, would be based on Arbitrage Pricing Theory. This is a relatively new financial theory which seeks to model investment returns in terms of a few key parameters of economic performance. It generalises the Capital Asset Pricing

Model by replacing one beta coefficient with several, relating to those economic parameters. We believe that Arbitrage Pricing Theory is as yet only used for short term asset modelling.

(3) Economic model for the liabilities.

This needs to be consistent with the asset model. Thus, if the asset model relies on the expected returns and covariances, these statistics are extended to deal with the equivalents in relation to the liabilities, including covariances between asset classes and liabilities. For this purpose the liabilities have to be divided between representative classes such as active members with new entrants where appropriate, current pensioners and deferred pensioners. This is the most basic classification of liabilities, which fails to take account of the age profile of the membership. A m a e detailed classification is akin to the full actuarial analysis of the liabilities.

If the asset model relies on time series modelling of key parameters such as inflation, then the liability model relies on the same time series. This approach enables satisfactory representation of the joint response of the assets and liabilities to changes in the economic environment, such as a period of high inflation, including any time lag effects.

A variation of the last point is to model the response of the assets and liabilities to a number of postulated 'shocks' to the economic environment. Each 'shock' is assigned a subjective probability. This approach is known to be in use in some investment work, but we are not aware of its use for asset/liability modelling in the UK.

A further simplification of this idea is not to assign probabilities but simply to look at the joint effect on the assets and liabilities of changes in actuarial valuation assumptions, allowing for diierent rates of return expected on the different asset classes.

(4) Definition of risk.

There are alternative definitions of risk according to the objectives and time-scale, as noted in section 4. The MPT conventional definition of risk is the variance or standard deviation of asset returns, net in this context of the liabilities. When the standard deviation is considered over a short time horizon such as one year, it will include a substantial contribution from the variability of market prices over such periods. This definition of risk may be suitable for investment purposes but it is inconsistent with the actuarial approach to valuation which in the UK tends to smooth out short term market fluctuations.

When the time horizon is longer and more comparable with that of the actuarial valuation, the natural and relevant definition of risk is one which is concerned with the ability of the assets to meet the liabilities over that larger time - scale. With such a risk definition much of the contribution from short term market fluctuations cancels out, and one is left with longer term variability which is completely consistent with the actuarial valuation approach.

The asset/liability model may well include representation of short term volatility, as for example when using time - series forecasting, but the features of significance are

the variability of inflation and investment returns when looked at over periods of several years.

- When the analysis is based on only the first and second order moment of returns, skewness is ignored and there is an implicit assumption of symmetrical distributions about the means. This assumption is not unreasonable for short time horizons of say up to one year but it is invalid for longer time horizons. Therefore in the longer term analysis, standard deviation can be an inadequate measure of risk. Alternative asymetric measures of risk can be more appropriate, for example :

  (a) the probability of the deficiency exceeding X
  or (b) the deficiency which will not be exceeded except with probability P.

  Either the standard deviation of returns or the deficiency can be used as such or translated into an equivalent measure - typically that of the employer's contribution rate. Then the measure of risk becomes the standard deviation of the contribution rate, the probability of the rate exceeding X, or the rate which will not be exceeded except with probability P.

  Duration has also been proposed as a measure of risk. When considering fixed interest bonds and fixed monetary liabilities, any difference between the duration of assets and liabilities gives a measure of risk of deficiency arising from a change in interest rates. It has been proposed that the concept may be extended to more general classes of assets and liabilities, but the idea is unsound.

**(5) Matching versus mi.- matching**

One approach is to match the liabilities as well as can be achieved, so as to minimise the risk. This approach has the advantage of simplicity and insensitivity to the return assumptions of the model.

Matching provides a basic benchmark, though not one which is likely to deal satisfactorily with the maja investment classes. For example it might be concluded that index-linked stocks are a better match than equities to final-salary liabilities, but they would make a poor benchmark for asset allocation.

An alternative approach is to consider'the efficient frontier of alternative asset allocations which optimise risk relative to expected returns. The calculation of these portfolios is however sensitive to the return assumptions of the model. Moreover when a long time horizon is used allowance may need to be mea& for skewness of returns.

Therefore another approach is simply to look at a few subjectively chosen alternative portfolios and assess the risk/return characteristics of each

**(6) Segmented versus integrated treatment of liabilities**

When the liabilities are dealt with in terms of a few representative classes such as actives, current and deferred pensioners, one approach to the asset allocation is to determine portfolios appropriate to each liability class and then combine them in the liability proportions.

However this is unsound in principle, as the theoretically correct approach is to determine a portfolio considering the liabilities as a whole.

## (7) THE RESULTS AND THEIR USE

The asset liability analysis may result in the derivation of an optimal long-term asset allocation for the set of objectives to be met More frequently, however, particularly when a number of potentially *conflicting* objectives have been set, a scenario analysis is produced illustrating the potential risks and rewards of a number of possible asset allocation strategies.

Ultimately analysis of the results of the asset-liability model may allow the Trustees to formulate an appropriate investment strategy for their Scheme. This strategy might be expressed in terms of a benchmark asset allocation together with permitted ranges for the level of investment in each asset category. In principle the use of assumptions and quantitative methods to derive a benchmark asset allocation enables the Trustees to monitor that asset allocation decision itself over a period of years.

The formulation of an investment strategy using such methods does not preclude the Trustees from taking an active approach to asset allocation in the short term. Investment managers may still apply their skills to achieve the best possible *short* term results within guidelines resulting from the asset - liability analysis, which would be used as a means of control and as a measurement tool rather than to set the day-today asset allocation of the fund.

## SYNOPSIS

This paper reviews the different ways in which U.K. pension fund assets and liabilities are related to each other by computer modelling techniques. The practical application of these techniques is a new and developing area of actuarial work. Details are not generally available from published works and there has been little discussion of the merits of one method relative to another.

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