Encylopedia of Actuarial Science
Asset Management

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Asset Management

1 Introduction

Asset management is integral to the actuarial management of any financial security system, although the earliest practical developments in actuarial science took place mostly in life insurance. In more recent years, there has been an increased integration of modern financial theories into actuarial science and the adoption of actuarial techniques in areas of asset management such as credit and operational risk.

The early development of asset management in actuarial science was in determining the principles that life insurance companies should use for the investment of their funds. This was largely at a time when insurance companies invested mainly in fixed interest securities, both government and corporate. The development of the equity markets in the 1900's, as well as the later development of derivative and other security markets, has allowed more sophisticated approaches to asset management and an increased focus on asset management as part of actuarial risk management. Asset management is fundamental to the financial performance of financial security systems including life insurance, pensions, property, casualty and health insurance.

We will start with a brief overview of the historical development of asset management in actuarial science, then briefly outline major asset management strategies used, as well as key models that have been developed, as well as issues in implementing asset management strategies.

2 Asset Management Objectives and Principles

The first actuarial contribution to the principles of asset management of life insurance companies funds is acknowledged to have been that of A. H. Bailey [1] in which he set out what are generally referred to as "Bailey's Canons". These were (1) that the safety of capital was the first consideration, (2) that the highest rate of interest consistent with the safety of capital should be obtained, (3) that a small proportion should be invested in readily convertible securities, (4) that the remainder may be invested in securities that were not readily convertible, and (5) that, as far as practical, the fund should be invested to aid the life assurance business.

Penman [8] reviewed these principles and highlighted the problems that arise in asset management resulting from too generous guaranteed surrender values, a lesson that has been hard learned, even to this day. He also identified the increased importance of currencies, commodities, inflation and income tax in asset management in the early 1900's. He noted the importance of matching the currency that the reserve is invested in, and the currency of the life insurance contracts. The impact of inflation on asset values is discussed with the suggestion that an increase in investments such as house property and ordinary shares may be, at least in theory, appropriate investments. The importance of income tax is recognized since investors who did not pay income tax on interest at that time, the big Banks, were paying high prices for British government securities. The importance of diversification by geographical area and type of security was also recognized by Penman.

Interestingly, in the discussion of the Penman paper, R. J. Kirton mentions the early ideas underlying the theory of immunisation, noting the effect of holding securities that are "too long" or "too short". Also in the discussion of the paper, C. R. V. Coutts noted the importance of the rate of the interest, and that there was a trade-off between safety of capital and the rate of interest. The difficulty was determining the minimum degree of security that was acceptable. He also highlighted the need to "marry" the asset and liabilities as far as possible, by which he meant holding investments that were repayable at a time to cover contract payments from the fund over the following forty or fifty years, an asset management strategy now known as matching.

Pegler [7] sets out his principles of asset management under the title "The Actuarial Principles of Investment". Here we see for the first time a discussion of a risk adjusted yield. His first principle is "It should be the aim of life office investment policy to invest its funds to earn the maximum expected yield thereon." However the expected yield takes into account the chance of the yield being earned and he suggest a "risk coefficient" which is "equal, or a little less than, unity for high class securities and a comparatively small fraction for those of a highly speculative nature." His second principle recognizes the need for diversification and is "Investments should be spread over the widest possible range in order to secure the advantages of favourable, and minimize the disadvantages of unfavourable, political and economic trends." The third and fourth principle were respectively, "Within the limits of the Second Principle, offices should vary their investment portfolios and select new investments in accordance with their view of probable future trends", and "Offices should endeavour to orientate their investment policy to socially and economically desirable ends." Pegler was proposing what has become known as an active investment strategy in his Third principle.

Redington [10] developed the principle of immunization of a life insurance company against interest rate movements. Assets were to be selected so that the discounted mean term, or duration, of the asset and liability cash flows were equal and that the spread of the assets cash flows around their discounted mean terms, referred to as convexity or M^2, should exceed the spread of the liabilities around their mean term. These ideas have been extended in more recent years.

Markowitz [4] developed the first mathematical approach to asset management where an investor's trade-off between risk and return was used to establish an optimal portfolio of assets. The Markowitz model was developed using variance as measure of risk. The major contribution to asset management of this approach was that the risk of an asset should be measured based on its contribution to total portfolio risk and not through its own risk. Diversification had value because of the potential reduction in total portfolio risk from combining assets that were not perfectly correlated. The optimal portfolio could be selected using optimization techniques and thus was born the quantitative approach to asset management.

Actuarial science is primarily concerned with the management of portfolios of liabilities. Issues of solvency and fair pricing are critical to the successful actuarial and financial management of a liability portfolio. Asset management is fundamental to the successful operation of a financial security fund, such as an insurance company or pension fund, because of its impact on profitability and the total risk. Incorporating liabilities into the asset management of a company has been an area of interest of actuaries. Wise [15] developed a model for matching assets to a liability based on reinvestment of surplus (asset less liability) cash flows to an horizon date and the application of a mean variance selection criteria. This approach to matching liabilities using the asset management strategy was further generalized by Wilkie [14] and then integrated into a common modelling framework by Sherris [12].

3 Asset Management Strategies

Asset management strategies involve determining the allocation of funds to asset classes as well as to security selection within asset classes. *Strategic asset allocation* is concerned with long run asset class allocations that become the benchmark for investment managers to implement. These strategic asset allocations are usually developed using asset-liability modelling to take into account the liability cash flows. A benchmark asset allocation is determined as a long run percentage allocation for different asset classes. This takes into account the risk preferences of the fund as well as the nature of the liabilities.

Tactical asset allocation involves moving away from the strategic asset allocation in order to improve returns by taking into account shorter term assessments of market risks and returns. Tactical asset allocation involves shorter term variation between different asset classes such as cash and equity. *Market timing* is a form of tactical asset allocation where the long run equity market percentage is reduced when equity markets are expected to fall and increased when equity markets are expected to increase. The ideal would be to have 100% in equities when markets rise and 0% when markets fall with the balance in cash. Sy [13] analyses the performance of market timing strategies.

Market timing is a form of *active asset management.* Active asset management aims to use market research, information, as well as exploiting market imperfections, to determine asset allocations in order to improve returns. The process uses value judgements and is not rule based. Successful market timing requires superior information or superior information processing ability.

Passive strategies are those where value judgements are not used to alter the asset allocation and this can occur at the asset class level or the individual security selection level. At the asset level this implies that no market timing is used and at the security selection level this involves the use of index funds replication. Index funds are designed to track the performance of a benchmark index for an asset class. The benefits of a passive strategy are lower transactions costs and lower asset management fees. Passive strategies effectively assume that markets are information efficient or at least that gains from active trading are offset by the transaction costs involved.

Dynamic strategies involve explicit rules for altering asset allocations. Perold and Sharpe [9] examine and compare dynamic strategies. The simplest rule based strategy is the buy-and-hold strategy. However strategic asset allocations are most often specified as a constant mix asset allocation where the percentages of funds allocated to each asset class are fixed through time. Even though the constant mix strategy has a fixed percentage asset allocation for each asset class, it is necessary to rebalance the holdings in each asset class through time as the relative value of the asset classes change through time. A constant mix strategy involves purchasing asset classes as they fall in value and selling asset classes as they rise in value. This is required to maintain a constant percentage of total funds allocated to each asset class.

Dynamic strategies are most often associated with *portfolio insurance* where a floor on the portfolio value is required. Over a fixed horizon, a floor on a portfolio value can be created by holding the asset class and purchasing put options on the portfolio, holding cash and purchasing call options on the portfolio, or more usually, created synthetically using dynamic option replication strategies. Leland and Rubinstein [5] discuss the process of replication of options using positions of stock (shares) and cash. If the value of the assets are currently A_0 and the floor required is F_T at time T, then the theoretical option based strategy using call options that will guarantee the floor is to purchase n call options, each with strike $\frac{F_T}{n}$ and maturity T, where

$$n = \frac{A_0 - F_T e^{-rT}}{C(K,T)}$$

r is the continuous compounding default free interest rate and $C(K,T)$ is the call option price, and to invest $F_T e^{-rT}$ into zero coupon default free securities maturing at time T. This strategy is usually implemented using dynamic replication of the call options because traded options do not usually exist for the time horizon and asset classes involved. Option based portfolio insurance has a number of drawbacks including the requirement for a specified time horizon and also problems with the dynamic option position as the time to maturity of the options becomes imminent. Just prior to maturity the replicating strategy can involve large swings in asset holding between cash and the asset class as the underlying value of the asset moves because of the high sensitivity of the holding in the asset class to changes in the asset value immediately prior to maturity.

To avoid the problems of fixed maturity option replication, longer term asset management uses constant proportion portfolio insurance or CPPI. CPPI invests a multiple of the difference between the asset value and the floor in the risky asset class with the remainder invested in default free securities. Defining the cushion, c, as the difference between the asset value and the floor, $A_t - F_t$, then the amount invested in the risky asset is given by

$$E = mc$$

where m is the strategy multiple. CPPI strategies sell risky assets as they fall and buy them as they rise in order to meet the floor.

Black and Perold [2] study constant proportion portfolio insurance (CPPI) and investigate how transaction costs and borrowing constraints affect portfolio insurance-type strategies. CPPI is shown to be equivalent to investing in perpetual American call options, and is optimal for a piecewise-HARA utility function with a minimum consumption constraint. Cairns [3] includes a discussion of optimal asset allocation strategies for pension funds including an analysis of CPPI strategies.

4 Asset Management Models

Asset management strategies are developed and implemented using a range of models. These models range from simple mean–variance optimizers to complex dynamic programming models. Here we cover only the basics of mean–variance models.

To determine an asset management strategy, a range of models are used in practice. The classic model is the mean–variance model developed by Markowitz [4], which is based on a trade-off between portfolio expected return and risk, using variance as a measure of risk and a single time period model. Asset portfolio management is then a process of maximizing expected return for any level of risk or of minimizing risk for any given level of expected return.

Defining R_i as the return on asset i, w_i as the proportion of the fund invested in asset i, σ_i is the standard deviation of the return on asset i, then the expected return on a portfolio of assets will be

$$E(R_p) = \sum_{i=1}^{n} w_i E(R_i)$$

and the variance of the portfolio will be

$$\sigma_p = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \sigma_{ij}$$

where $\sigma_{ij} = \rho_{ij}\sigma_i\sigma_j$ is the covariance between the return on asset i and the return on asset j and ρ_{ij} is the correlation between the return on asset i and the return on asset j. Other measures of risk have been used in this asset selection process including semi-variance and quantile based risk measures such as probability of a negative return. The mean–variance model is consistent with an expected utility based model on the assumption that returns have a multivariate normal distribution or that individuals have quadratic utility. VaR has become an important risk measure in bank trading books and is related to the probability of ruin measure in actuarial science.

Factor based models are used for asset management in both optimal portfolio construction and in asset pricing. A factor model assumes a return generating process for asset i of the form

$$R_i = \alpha_i + \beta_{i1}F_1 + \beta_{i2}F_2 + \ldots + \beta_{ik}F_k + \varepsilon_i$$

where α_i is constant for each security, F_k is a common factor influencing all asset returns to a greater or lesser degree, β_{ik} is the sensitivity of the ith asset return to the kth factor and ε_i is a random mean zero error term. The factors often include expected inflation, dividend yields, real interest rates and the slope of the yield curve among many others. In asset portfolio construction, diversification will average the factor sensitivities and reduce the random variation. Asset portfolios can be constructed to have desired exposures to particular factors. The factors can also include liability proxies for asset-liability modelling purposes.

To incorporate liabilities, Wise [15] and Wilkie [14] define the end of period surplus as

$$S = A\sum_{i=1}^{n} w_i R_i - L$$

where L is the random accumulated liability cash flows at the time horizon and A is the current value of the liabilities. Mean–variance analysis can then be based on the distribution of surplus, allowing for the liability cash flows by modelling the mean and variance of the liability along with the covariance of the liability with the asset returns.

Matching and immunization are strategies that use asset management models for interest rates to select fixed interest assets to meet specific liability streams or to ensure that the value of the assets and liabilities are equally sensitive to movements in market interest rates. In the actuarial literature, Redington [10] was the first to develop models for immunization.

Increasingly credit risk models are being developed to quantify and price default risk in loans and corporate fixed interest securities. These credit risk models estimate expected default frequencies, or probabilities of default, and losses given default. Portfolio models are important for credit risk since the benefits of diversification of market wide risk factors have a significant impact on default probabilities and severities. Factor models have been developed to quantify default probabilities and to measure the benefit of portfolio diversification in credit portfolios. More details on these models can be found in Ong [6].

5 Asset Management - Implementation

In practice, once a strategic asset allocation strategy has been determined, professional asset managers are employed to implement the strategy. Professional managers provide various forms of asset management services ranging from balanced funds to specialist funds for different markets, investment styles and security types. The balanced fund manager carries out both asset sector allocation and securities selection using an agreed asset allocation as a benchmark portfolio. Managers also offer specialist funds such as small cap equity, large cap equity, value and growth equity funds, domestic and international bond and equity funds, as well as hedge funds offering a variety of alternative investment strategies. Asset management will usually involve multiple asset managers some of whom are specialist managers in particular investment sectors. A major concern in the strategy implementation process is the measurement of investment performance.

Performance measurement is based on the calculation of time weighted returns that adjust for the effect of cash flows on the relative performance of different asset managers. Performance is measured against a benchmark, which is usually the strategic asset allocation for the fund. Performance is usually measured by adjusting for risk since high excess returns may result from taking high risk positions and luck. Common measures to risk adjust returns for performance measurement include the Sharpe ratio

$$S = \frac{\overline{R_i} - \overline{R_f}}{\sigma\left(R_i\right)}$$

where $\overline{R_i}$ is the portfolio average return over the time period, $\overline{R_f}$ is the average default free return and $\sigma\left(R_i\right)$ is the standard deviation of the portfolio return. Other methods of determining risk adjusted returns include the Treynor ratio, which is similar to the Sharpe ratio but includes only non-diversifiable risk, and the portfolio "alpha" which measures the excess return earned over a portfolio with the same exposure to the factors driving returns.

Asset return performance is then allocated to asset allocation policy and asset selection within asset classes. This is based on a benchmark return index for each asset class. If we let w_{ai} be the actual portfolio weight in asset class i and R_{ai} the corresponding actual return then the excess return over the benchmark will be

$$\sum_i w_{ai} R_{ai} - \sum_i w_{pi} R_{pi}$$

where w_{pi} is the strategic asset allocation weight to asset class i and R_{pi} is the return on the benchmark index for asset class i. Market timing decisions are taken by moving away from the strategic asset allocation weights so that the impact of timing is measured by

$$\sum_i w_{ai} R_{pi} - \sum_i w_{pi} R_{pi}.$$

Asset selection decisions within each asset class are captured in the difference between the actual asset returns and those on the index benchmark and are measured by

$$\sum_i w_{pi} R_{ai} - \sum_i w_{pi} R_{pi}.$$

This leaves an interaction term that captures other effects.

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