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Investment strategy design for defined contribution pension plans

The widespread growth of Defined Contribution (DC) plans as the core retirement savings vehicle for individuals around the world has brought with it many risk management and regulatory challenges. The growth in DC has meant that there has been a transfer of risk from the state and employer to the individual. Individual DC customers are now exposed to a broad range of risks:

- Longevity
- Inflation
- Market (equity, interest rate, credit, etc.)
- Contribution and re-investment

As a consequence, individuals retirement planning requirements have become significantly more complex. In an ideal world, members of DC schemes would have access to individual investment advice to allow them to construct a plan to help manage these risks. In practice it has not yet been possible to supply full, individually tailored advice to all DC members on an affordable basis. Instead what has evolved is the concept of default investment strategies that are deemed to be reasonable for any DC member and are used where an individual is uncertain what investment choice to make or doesn t actually make a choice.

Providing a default investment strategy might be seen as indirectly giving investment advice and as a consequence in some countries, the US for example, there has been specific legislation (Pensions Protection Act of 2006) governing this area. In the UK the introduction of the Personal Account in 2012 will require employers to offer a scheme – the Personal Account scheme or another similar „qualifying scheme - with a default investment strategy. With potentially millions of individuals being exposed to default investment strategies it is vital that they are constructed and then monitored in a way that meets the risk management needs of individual DC members.

An Asset-Liability Risk Management Challenge

This report considers the design of a default investment strategy for a DC pension scheme as an asset-liability risk management problem. We describe an analytic framework for addressing this problem and illustrate how this framework can be used to design a default investment strategy in the particular form of a target date fund. This default investment strategy takes account of the scheme members objective or liability, and fits a defined customer risk profile.

Identifying the customer liability for a DC member is a significant challenge as a large number of assumptions need to be made – the following list is not exhaustive:

- Current age and intended retirement age
- Target or expected retirement income
- Current pension fund value
- Future contribution payments (employer and employee)
- Range of available investment assets
- Risk tolerance or risk profile
- Longevity assumptions, including future longevity improvements
- Annuity income basis (eg. fixed or index-linked) and cost margin
- Spouses benefit
- Salary at retirement

Ideally the above assumptions would be specified at the individual scheme member level. Unfortunately, this is not always an economically viable option. To make decisions easier for the individual scheme members, or to support specific pension legislation such as Personal Accounts, the concept of default investment strategies have become very popular. These strategies take into account the various risks inherent in the assets and liabilities of a DC scheme and attempt to provide an approach to investment that is generally appropriate to a defined group of DC members who are similar in respect of the above characteristics, rather than to specific individuals.

Risk tolerance and remaining term to retirement are the most common characteristics used to distinguish groups of DC scheme members. Default funds are often designed with embedded asset allocation strategies that manage the investments over time and in accordance with a defined customer risk profile.

In terms of the other variables such as contribution payments and annuity pricing basis, fixed assumptions usually need to be made in order to define the liability for the typical scheme member.

In the following section, we investigate definitions for the liability and for measures of risk and return in relation to this liability, which are appropriate for use in constructing default investment strategies for DC pensions.

Defining the DC Scheme Liability

For the purposes of the illustrative case study in this report, we will assume the liability is the provision of an index linked income starting at retirement, where the scheme member is interested in the future income level expressed in real terms.

We will assume that our 'default' scheme member plans to make regular contributions at a fixed proportion of salary. Salary is assumed to increase in line with inflation between today and the planned retirement date, with no employment breaks.

The presence of these contributions, or 'liability cashflows', means that the value of the pension fund at retirement and the level of retirement income that this will buy depends not only on the total investment return over the accumulation phase, but realised path of returns throughout the accumulation phase. As an individual's fund value grows relative to their expected future contributions, their potential for large losses which cannot be replaced by future contributions increases. This path dependency becomes a very important factor in the design of default investment strategies for DC pension schemes.

From the above discussion, it is clear that the analytic framework used to design robust liability-based default funds needs to take into account the paths of asset returns throughout the accumulation (contribution) phase, and also the relationship between these asset returns and the value of the liability.

Modelling the DC Scheme Liability: Liability Matching Portfolio

In order to address the issues described above, we have used a stochastic asset model. A stochastic asset model (ESG) has the ability to capture the distributions and correlations of the paths of economic risk drivers in an integrated framework. It can also produce outputs which allow us to define and measure risk in the same terms as those used by a typical DC pension scheme member.

We can use this modelling framework to simulate changes in the value of the DC scheme member liability over the term to retirement. The initial stage in the liability analysis is to identify a portfolio of assets that closely matches movements in the liability. If this portfolio exactly matches movements in the liabilities, then we will fix the future retirement income exactly and would have a risk-free investment strategy, or a **Liability Matching Portfolio (LMP**). However, practical issues mean that finding an exact LMP is usually not possible because:

- Appropriate assets may not exist in a cost-effective or tradable form.
- The DC scheme member liability (final retirement income) is dependent on the price at which assets can be bought using future contributions. Since future asset prices are uncertain, and since most DC scheme members will be unable to borrow against future earnings, the scheme member is exposed to *re-investment risk* which cannot be hedged through replicating assets.

For our defined DC scheme liability, the theoretical Liability Matching Portfolio (LMP) would consist of a portfolio of zero-coupon government bonds with maturities matched to future earnings (i.e. borrowings against future earnings), plus a portfolio of zero-coupon index-linked government bonds with maturities matched to retirement income cashflows.

Importantly, this LMP represents a "risk-free" investment, relative to the defined liability. As such, it provides an objective benchmark against which a DC scheme member can measure risk and return.

Constructing DC Investment Strategies: Least Risk Portfolio

Since it will not usually be possible to find an exact LMP, instead we need to identify a portfolio of tradable assets which gives a reasonable approximation to movements in the scheme member liability. In the remainder of this document we will distinguish between the theoretical Liability Matching Portfolio (LMP) and an investable 'Least Risk Portfolio' (LRP).

The **Least Risk Portfolio** (LRP) provides the foundation for establishing default investment strategies, being the investable asset portfolio which best approximates to the theoretical LMP and minimizes risk relative to the scheme member's liability.

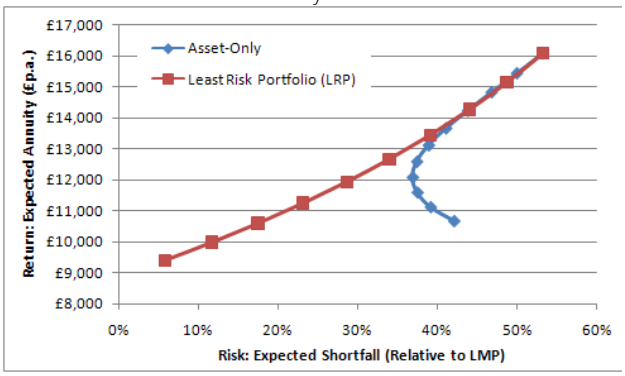
For the defined DC scheme liability in this report, we will assume the LRP is a portfolio of zero coupon index-linked government bonds with maturities which are matched to the expected retirement income cashflows. Although the presence of re-investment risk means this LRP is not "risk-free", it provides the lowest risk investable asset available to the DC investor.

By combining the LRP with other risky assets (e.g. UK Equity) we will increase the level of risk, with the objective of increasing the projected or expected final retirement income. For the purposes of illustration in this report, we will assume that our DC investment strategy will consist of an allocation to the LRP plus an allocation to a single risky asset, a diversified equity portfolio.

Exhibit 1 emphasises the importance of a liability-based approach to designing an investment strategy for DC pension schemes. The risk and return characteristics of LRP-based strategies are compared with conventional 'asset-only' mean-variance efficient portfolios. In both cases, the lines represent a range of portfolios from 100% LRP/Cash to 100% Equity. This shows that, for a customer whose liability is defined in terms of retirement income level, the LRP-based portfolios deliver the same level of "return" (retirement income) for significantly less risk.

Exhibit 1

Combining risky assets with a liability-matched "LRP" gives a better outcome than an asset only solution.



Constructing the Default Investment Strategy

In designing a default investment strategy for a DC scheme, our aim is to introduce risky assets to the LRP in order to match the risk profile and return expectations of the 'default' DC scheme member. In order to do that, we need to be able to define the default risk profile in measurable terms.

Defining Appropriate Measures of Risk and Return

For typical DC scheme members, the most logical measure of 'return' is the salary replacement value of the annuity that will be purchased at retirement (percentage of final salary).

Pension investors are likely to need to accept some risk, due to not being able to invest in a risk free portfolio to match the liability or because they would like a greater income in retirement.

To capture this risk and to understand how much risk the customer is willing to accept, there are a wide range of possible risk measures we can use:

- Volatility: This measures the average dispersion of the return.
- Value at Risk (VaR): This only tells the value of a particular point in the tail of the return distribution, not how long the tail is, i.e. "How bad can it get?"
- Expected Shortfall: The expected shortfall in return multiplied by the probability of that shortfall.

To evaluate the risk/return trade-off, particularly when including additional "risky" assets, members will be concerned about the potential for future retirement income shortfall relative to the "risk-free" investment option (i.e. the Liability Matching Portfolio), and also with the size of this potential shortfall.

As such, Expected Shortfall has been used as the risk basis for designing investment strategies in the example given in this Insight report. However, the stochastic ALM framework is flexible enough to allow any choice of risk measure.

Specifying Customer Risk Profile

In order to construct an investment strategy, we need to define a risk profile in terms of our chosen risk measure. This risk profile tells us how much risk the individual is willing to accept at each stage during the accumulation phase of their pension savings plan.

For most DC pension scheme members their risk profile will reduce as they approach retirement. This is because, as DC scheme members get older and pay contributions into their pension plan, they accumulate financial wealth in place of diminishing human capital. Roughly, human capital can be defined as the present value of expected future earnings. As the scheme member approaches retirement, their ability to use human capital or adjust consumption to offset financial market shocks becomes significantly diminished.

The level and shape of the default risk profile is fundamental to the design of the default investment strategy. As an example (and used in the rest of this report) we could define a target risk profile based on Expected Shortfall in final salary replacement level, that varies linearly with term to retirement at age 65.

- At age 50 the 'default' (male) scheme member is willing to accept an Expected Shortfall in Final Salary Replacement of 14%.
- By the time he reaches age 60, this has fallen to 4%.
- By age 64, in the final year before retirement, this has fallen to 0%; at that stage, the 'default' scheme member would like to have complete certainty about his index-linked income in retirement.

This typical default profile is the rationale behind the popularity of many lifestyle investment strategies or target date funds. To match this form of risk

profile, these approaches identify an asset allocation which changes over successive investment periods prior to retirement; an asset allocation glide path.

It is important to note though that different levels and shapes of risk profile will give very different asset allocation glide paths

Constructing Investment Strategies or 'Glide-paths'

Once we have defined the liability proxy (LRP), have quantified the risk profile and defined the universe of investable assets, we can use the stochastic modelling framework to construct asset allocation glide-paths.

Consider the following example scheme member:

- Male, aged 50
- Retiring at age 65
- Currently pension fund size £90,000
- Salary of £30,000 pa, expected to increase in line with inflation
- Invests 8% of his annual salary into the default investment strategy
- Has no other assets to fund his retirement
- Has a linear risk profile described earlier
- Invests in the LRP and a portfolio of diversified equities

Exhibit 2
Fitted Asset Allocation Glide Path
(% Allocation to "Risky" Asset)

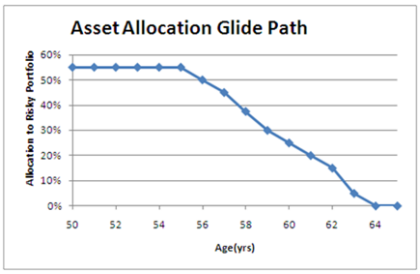
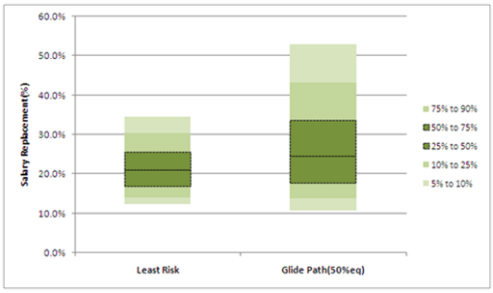


Exhibit 2 shows the resultant asset allocation glide path that matches the risk profile in terms of the changing asset allocation between the LRP asset and a risky diversified equity portfolio.

Of course, the rationale for the default scheme member adopting a "risky" additional risky asset exposure increases the expected return (i.e. the expected retirement income level), while accounting for the customer's stated risk profile.

To understand the extent to which this additional risk exposure generates a better expected return, we have compared the distribution of retirement income under the 'Least Risk Portfolio' with that generated by the fitted asset allocation glide-path, for the example scheme member.

Exhibit 3
Comparing Risk and Return: Least Risk Portfolio vs. Fitted (Risky) Glide Path



There are several observations to be made regarding the results in Exhibit 3:

- Perhaps the first is that the so-called "Least Risk Portfolio" still has a significant amount of risk, in terms of the final retirement income level. Although the median salary replacement rate is about 21% there is a 10% chance this falls outside the range 15% - 30%.
- Secondly, by investing in the default asset allocation glide-path, the median Salary Replacement level is significantly higher at approx. 24%. Furthermore, there is around a 1 in 4 chance that this could exceed 33%. The retiree has a reasonable chance of a higher retirement income than under the LRP.
- Finally, we can see that the additional risk under the default asset allocation glide-path is relatively limited, in very extreme cases (e.g. 1 in 100), the Salary Replacement Rate could fall to as low as 10%.

Conclusion

As DC pension schemes increasingly replace traditional DB provision, individual investors become increasingly responsible for understanding and controlling risk in their pension savings plans. At the same time, many DC scheme members are likely to have very limited knowledge and understanding of investment and risk; employers and pension product manufacturers who fail to offer well-designed DC investment solutions are becoming exposed to significant and growing compliance and reputational risk.

The use of an appropriate stochastic asset-liability modelling solution is the most sensible approach to capturing the path-dependency and risk profiles relevant to DC pension investors. This Insight report has described a coherent framework for applying stochastic asset modelling to the design and review default risk-based investment strategies for DC pension schemes.

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