MOODY'S ANALYTICS

DB PENSIONS

WHITEPAPER

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Investment strategy selection should take a long-term view

Summary

This paper will propose an alternative investment objective consistent with the long-term investment horizon of a defined benefit (DB) pension scheme and propose a risk measure, the probability of ruin, to assess the suitability of an investment strategy against this objective.

We show that a strategy including an allocation to growth assets is optimal over a long-term horizon, when compared to a hedging investment strategy using long-dated bonds.

We then describe how the regulatory and funding regime leads DB pension schemes to focus more on the short-term. We reassess our investment strategies and compare the result to the original choice of optimal strategy.

A shorter-term focus leads to the selection of the long-dated bond fund as the optimal strategy to the potential detriment of our long-term objective. This result highlights the importance of the investment objective in investment strategy selection.

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Introduction

Financial training leads us to think of DB pension schemes as long-term investors in the sense of their fundamental objective to pay the liabilities as they fall due. However, regulatory and funding requirements influence trustees and sponsors to take a shorter view when setting the investment strategy. This paper contrasts the optimal investment strategy we arrive at by following a standard approach to strategy selection with the strategy we might choose by focusing on the truly long-term.

We begin by considering that most fundamental objective of a DB scheme: the ability and willingness to pay the liabilities as they fall due. Then we allow for the regulations on DB schemes which require a triennial valuation and the establishment of a revised recovery plan at this valuation point. These considerations lead us to a second and more traditional objective based on the shortfall in the scheme and a shorter three year time horizon.

Objective 1: To pay the liabilities as they fall due

The main risk to a DB scheme of not achieving its investment objective is the occurrence of a complete loss event. Some examples of a complete loss event are: a default of a bond, the bankruptcy of a firm in which the scheme holds equity or the forced sale of equities when the market declines. Diversification can mitigate the risk of some of these complete loss events. However, to manage the loss, a forced sale of assets, or other appropriate strategy may be required. We will now consider what this means for the investment strategy.

DB schemes usually have cash flows up to about 80 years and sometimes longer. The liability cash flows can be split into long-term and short-term. The long-term cash flows can be easily managed as there is little risk of a forced sale to cover these cash flows. However for short-term cash flows a scheme can either be cash flow positive or negative.

The scheme can either be cash flow positive meaning that it has a positive net cash flow that will be invested, or cash flow negative, meaning that it needs to divest assets to pay benefits. If a scheme is cash flow positive then market volatility has little impact on the scheme as there is less chance of being forced to sell assets when the market is down. However, if the scheme is cash flow negative, short-term cash flows will need to be hedged to ensure that loss events do not occur. Once the short-term cash flow needs of a DB scheme have been appropriately hedged using low risk instruments such as short dated bonds, we can think of the scheme as having a long investment horizon for its remaining assets.

Having established that the DB scheme is at least partially a long-term investor, we need some way of determining the effectiveness of a chosen investment strategy. Traditional measures, like the following, have a few drawbacks, especially over the long term.

- **Volatility of the funded position**: means little as it relates to market values which as long-term investors we are not concerned with. Also this measure can be difficult to explain over a long time horizon.
- **Expected return**: doesn't provide insight about strategy efficiency, or likelihood of failing to meet our objective. It is only a concern when we need to earn at least the liability discount rate.
- **Value at Risk (VaR)**: useful if measured over the long-term. It can be used to investigate at a given confidence level if the scheme can pay off all the liabilities. For example, we could use VaR at a 95% confidence level to determine the level of additional cash required to pay off the liabilities once the assets have been exhausted. VaR has the drawback of being difficult to explain and usually does not relate directly to the investment objective.

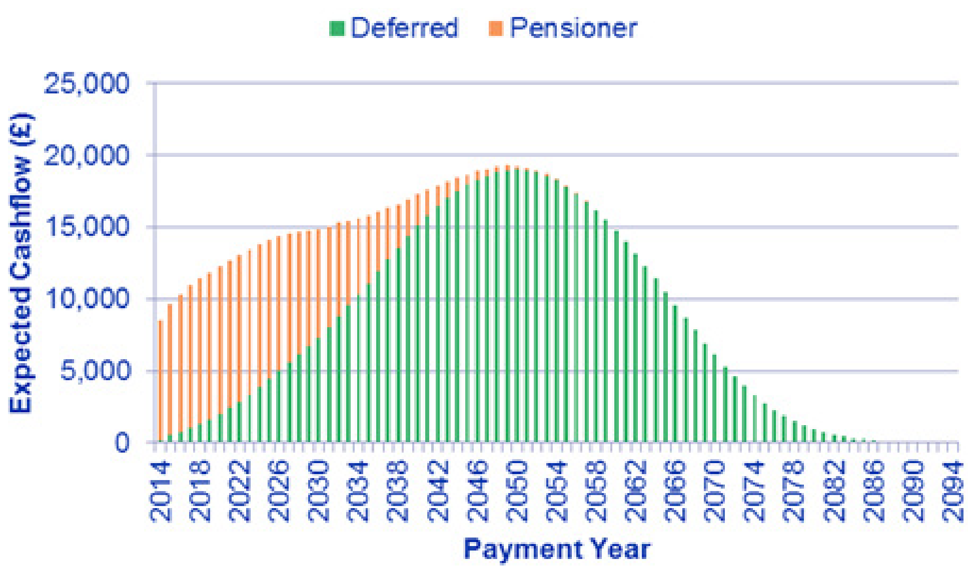
To overcome these shortcomings, we are going to borrow a methodology commonly used in general insurance: the probability of ruin. In the context of a pension scheme we define this measure as the probability that the scheme, in the absence of additional currently unplanned sponsor contributions, runs out of money and is no longer able to pay benefits. This is similar to VaR but considers the problem from a slightly different perspective. This measure is useful in our context because it relates directly to the objective. The probability of ruin considers both return and volatility in one number to some degree. If portfolio volatility is high, the probability of ruin would likely increase. If expected returns are low, the probability of ruin would also increase, it would be less likely to earn at least the discount rate used to value the liabilities.

We will use a case study to determine how to assess the investment objective and therefore evaluate different investment strategies using the probability of ruin risk measure.

Case Study

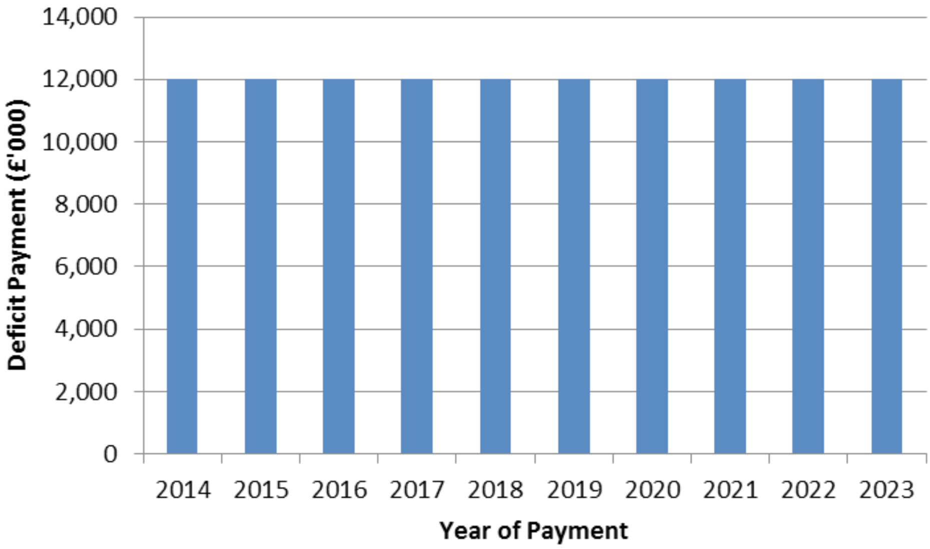
We will consider a closed DB scheme that is in deficit. The sponsor has a fixed contribution strategy to return the scheme to full funding on a gilts basis after 10 years. The DB scheme's benefit cash flows can be seen in Figure 1. We will assume the cash flows are predictable in nominal and real terms for fixed and index linked cash flows respectively, i.e. we will ignore the variability of cash flows introduced by mortality, transfers, marriage, and so on.

Figure 1: DB Scheme Cash flow Profile



The scheme is in deficit, it is 80% funded on a gilts valuation basis. The fixed 10-year recovery plan agreed with the sponsor is shown in Figure 2. The recovery plan has the sponsor paying flat contributions of £12,000 a year for 10 years.

Figure 2: DB Scheme Contribution Profile



Under a long-term risk management system, the concept of a recovery plan based on the funding level is flawed because it depends on a valuation which is not a long-term measure. A measure should be used that assesses the probability of being able to achieve the investment objective at a specific level of certainty, such as the probability of ruin.

This scheme is initially cash flow positive because the contributions are sufficient to cover the outgoing payments. After the first few years, the scheme becomes cash flow negative, when benefit payments begin to outweigh contribution receipts. When the scheme becomes cash flow negative, we should consider using short-dated bonds to produce the cash flow required to cover the shortfall.

We will assess six investment strategies described in Table 1. Our investment universe consists of three assets and a conceptual ungeared liability matching portfolio (LMA).

Table 1: Investment Strategies

Strategy Name	Description
Initial proportion	Initial allocation of 40% equity, 60% short-dated government bonds (average duration three years). Rebalance to the initial allocation at each time step.
Initial proportion 2	Initial allocation of 40% equity, 60% long-dated government bonds (average duration 16.8 years). Rebalance to the initial allocation at each time step.
100% Equity	Initial allocation of 100% equity, no rebalancing.
100% Short Bonds	Initial allocation of 100% short-dated bonds, no rebalancing.
100% Long Bonds	Initial allocation of 100% long-dated bonds, no rebalancing.
LMA	Initial allocation of 100% liability matching asset (average duration of 21, 4 years, matching the average duration of the liabilities), no rebalancing. The liability matching asset is a synthetic asset, which by design provides a perfect hedge for the scheme liabilities.

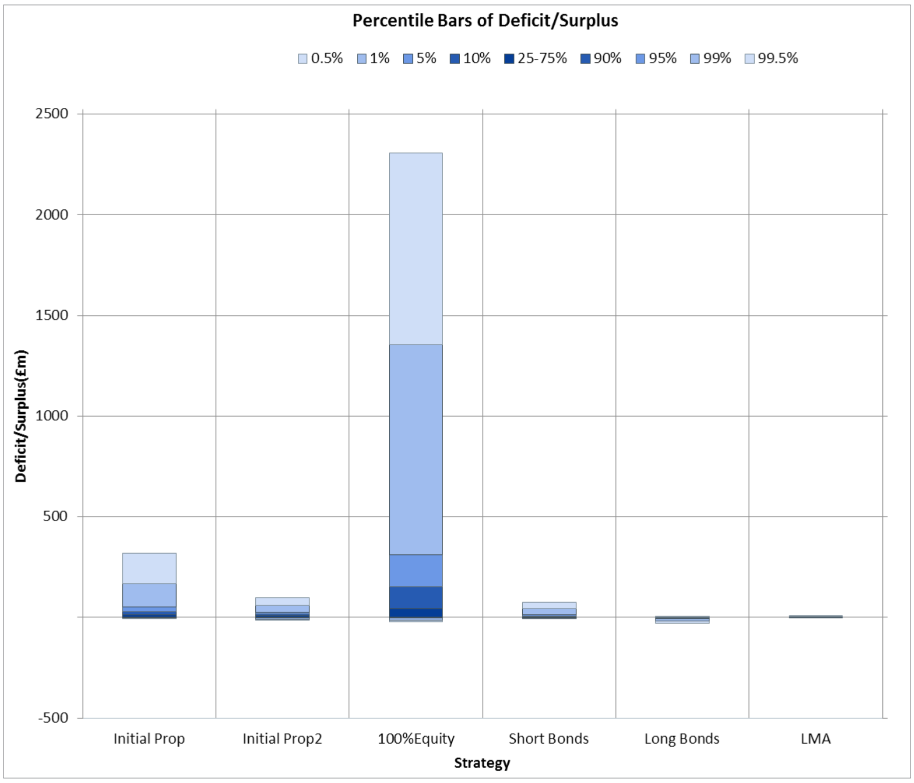
We used Monte-Carlo simulation to estimate the risk metrics and evaluate the investment strategies. Monte-Carlo simulation is a tool frequently used in risk management, where a large number of different scenarios are produced, and the scheme is then assessed under these different scenarios. The results are analyzed to produce a statistical distribution so that the information can be used in decision making. The details of Monte-Carlo simulation are beyond the scope of this whitepaper.

The six investment strategies in Table 1 have been simulated over 80 years to let the liabilities run-off. We then analyzed the residual assets of the scheme (the net assets).

The percentile distribution of the net assets at the end of the simulation was calculated for each strategy. Figure 3 shows the long-term distribution and Table 2 the relevant statistics of the distribution including the probability of ruin. The probability of ruin is the percentage of trials where the net assets of the scheme ended up being below zero.

Figure 3 shows that the 100% equity strategy has the widest distribution and the LMA strategy has the narrowest, as we would expect. Interestingly, the long bonds strategy seems to have most of the distribution below zero, this is due to the lower expected return of the long-dated bonds. The reason for the lower returns is detailed in Appendix A. The LMA does not produce a zero risk level since the contribution schedule is fixed, which means the cost of covering the deficit will have changed by the time all the payments have been made.

Figure 3: Percentile Distribution of Investment Strategies at 79 years



In Table 2 we can see that, from a 95% VaR perspective, the 100% equity strategy is better than the long bond strategy. However, the conditional value at risk is higher, implying that when things go wrong with equities they will go badly wrong.

Considering the probability of ruin, the 100% equity strategy outperforms the 100% short bond, 100% long bond and LMA strategies. This is caused by the bond strategies being exposed to term mismatch risk, re-investment risk and a lack of sufficient excess return to compensate for this term mismatch risk. The best portfolio uses the initial proportion strategy making use of short bonds. This is again due the short bonds having a higher expected return than a long bond fund as detailed in Appendix B. Making divestments from short-dated bonds will have a more certain value than long-dated bonds due to lower duration risk. We can see that addressing cash flow negativity is important and market volatility is not necessarily problematic since the most volatile asset class produces acceptable results.

From a long-term investor's perspective, approximate duration hedging is not a good option for the long-dated bond strategy. Good hedging produces acceptable results as can be seen for the LMA strategy. The initial proportion strategy would be the most effective use of the risk budget, producing not only the lowest probability of ruin but also the second highest median surplus assets. This strategy could still be improved using dynamic rebalancing and hedging cash flows for between 5 to 10 years in the future when market conditions are more favorable. Future papers will consider this subject in more detail.

Table 2: Statistics of Investment Strategies at 79 Years

	Initial Prop	Initial Prop2	100% Equity	Short Bonds	Long Bonds	LMA
Mean	£14,057,966	£6,717,800	£81,020,982	£2,726,008	-£983,478	£315,935
St. Dev.	£50,182,551	£16,111,882	£379,822,794	£14,049,426	£5,749,426	£2,186,317
0.5th Percentile	-£7,130,495	-£15,179,275	-£22,518,906	-£8,376,536	-£31,597,763	-£1,130,681
1th Percentile	-£4,523,726	-£9,634,526	-£14,546,311	-£5,505,556	-£18,559,161	-£791,312
5th Percentile	-£1,309,898	-£2,058,723	-£3,785,293	-£1,790,657	-£4,698,870	-£260,946
10th Percentile	-£550,733	-£884,964	-£2,072,287	-£1,158,415	-£2,505,645	-£149,517
25th Percentile	£881,577	£572,011	-£87,673	-£381,352	-£877,358	-£24,083
50th Percentile	£4,074,937	£3,325,060	£8,067,210	£418,715	-£66,587	£107,462
75th Percentile	£11,310,100	£8,301,642	£43,273,782	£2,063,123	£483,918	£312,587
90th Percentile	£28,544,053	£16,694,326	£152,149,923	£5,855,677	£918,082	£735,532
95th Percentile	£50,425,189	£25,508,283	£312,274,733	£11,674,317	£1,187,462	£1,243,696
99th Percentile	£166,327,987	£59,531,552	£1,355,655,858	£45,269,260	£1,778,662	£4,076,422
99.5th Percentile	£317,193,182	£96,456,492	£2,305,621,250	£73,678,394	£1,986,466	£6,847,643
VAR	-£1,309,898	-£2,058,723	-£3,785,293	-£1,790,657	-£4,698,870	-£260,946
cVAR	-£3,902,147	-£8,131,891	-£16,183,613	-£5,088,601	-£15,508,879	-£827,736
ProbRuin	16.23%	19.35%	25.73%	37.48%	53.30%	29.55%

Objective 2: Managing contribution volatility

The regulatory and funding regime leads schemes to reconsider their investment objectives. The impact of the triennial funding valuation guides them away from the fundamental objective of paying the liabilities as they fall due, and instead towards managing the volatility of the sponsor's contributions. In practice, this means controlling the volatility of the net assets at the triennial valuation, and requires a three-year investment horizon.

Case study

Revisiting our earlier example, we now stop the simulation at three years, when the triennial valuation will be performed and a new contribution schedule agreed. We once again assess the net assets.

Figure 4 shows the distribution of the percentiles and Table 3 shows the relevant statistics from Figure 4. We can see that this scenario produces a similar result to that shown in Figure 3. In this instance, long bonds look like a good investment, their distributional spread is narrow and their median outperforms most of the other strategies. Using VaR as our measure, an approximate-duration bond hedge is one of the best investment strategies, the (long bond strategy). Not only do long bonds have one of the lowest 95% VaR but also a mid-range median.

Figure 4: Percentile Distribution of Investment Strategies at 3 Years

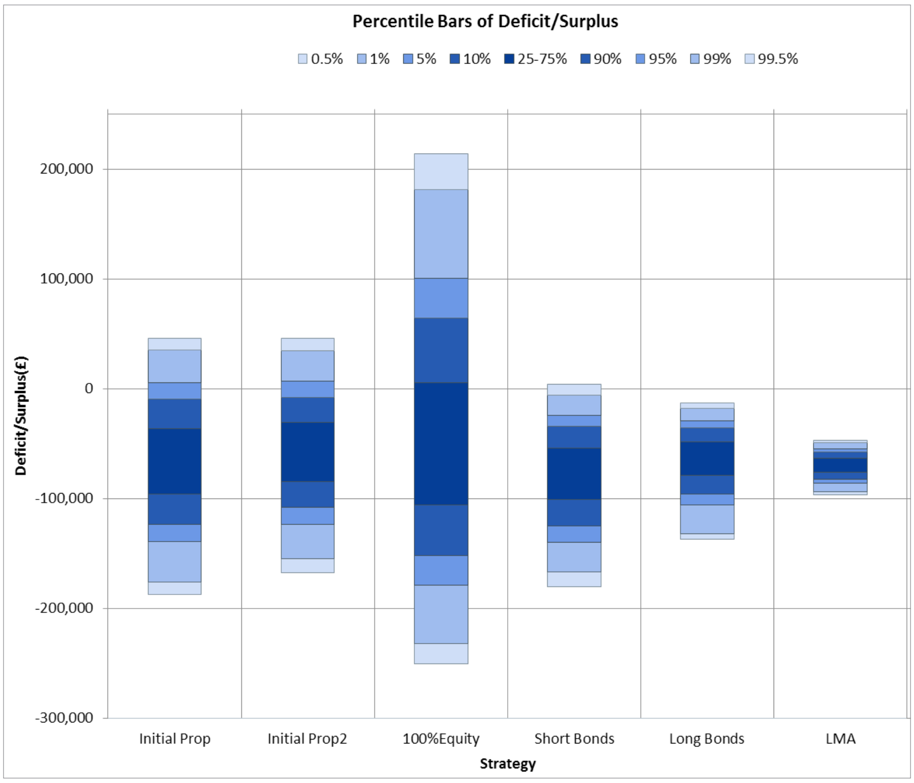


Table 3: Statistics of Investment Strategies at 3 Years

	Initial Prop	Initial Prop2	100% Equity	Short Bonds	Long Bonds	LMA
Mean	-£66,685	-£57,987	-£47,843	-£78,833	-£64,675	-£69,953
St. Dev.	£44,738	£39,927	£86,337	£35,416	£23,610	£9,631
0.5th Percentile	-£187,739	-£167,399	-£250,593	-£180,104	-£137,192	-£97,022
1th Percentile	-£176,373	-£155,011	-£232,390	-£166,997	-£132,007	-£93,940
5th Percentile	-£139,432	-£123,856	-£178,754	-£140,188	-£106,162	-£86,335
10th Percentile	-£123,727	-£108,077	-£152,234	-£125,264	-£96,095	-£82,524
25th Percentile	-£96,244	-£84,815	-£106,261	-£101,308	-£78,839	-£75,940
50th Percentile	-£66,019	-£57,492	-£53,849	-£77,109	-£62,802	-£69,575
75th Percentile	-£36,299	-£31,090	£5,708	-£54,260	-£48,403	-£63,447
90th Percentile	-£9,754	-£8,058	£63,956	-£34,431	-£35,751	-£57,877
95th Percentile	£5,511	£6,515	£100,501	-£24,521	-£29,521	-£55,050
99th Percentile	£34,973	£34,601	£181,401	-£6,181	-£17,827	-£49,477
99.5th Percentile	£46,050	£46,146	£213,774	£3,844	-£13,198	-£46,919
VAR	-£139,432	-£123,856	-£178,754	-£140,188	-£106,162	-£86,335
cVAR	-£161,083	-£143,761	-£211,477	-£157,183	-£119,938	-£91,109

Conclusion

Over a three-year investment horizon, our investment strategy might have been different if we had assumed a long-term investment horizon. We can see that short-term objectives might inhibit the DB scheme's ability to reach its long-term targets. Throughout this paper, we have assumed the pension scheme remains a going concern until all the liabilities have been paid off. If this is not the case, for instance when the scheme targets a buy-out/buy-in over the short- to medium- term, the results would likely be different. The critical point for a pension scheme is not to lose sight of their final objective, be it long-term or short term.

The probability of ruin provides us with a useful single measure to assess the efficiency of our investment strategy relative to our ultimate long-term investment objective. However, it does not provide us with information on how badly we might miss the objective. We could propose a measure similar to conditional value at risk such as:

$$E[NetAssets|NetAssets < 0].$$

For further upside potential, we could set secondary objectives around the median. Arguably, this approach might be redundant and could rather be used to control the probability of ruin further.

Appendix A: Yield Curve Evolution

Given the current shape of the yield curve, the expected returns of long- and short-dated debt might appear counterintuitive. This section aims to provide an explanation of these differences. Figures 5 and 6 show that the short end of the yield curve is expected to increase. This has the effect of increasing short-dated bond returns over the first few years, due to reinvestment of the bond proceeds at higher rates. The long end is also expected to increase reducing the long dated bond returns. As a result, we can expect the short-dated funds to slightly outperform the long-dated funds, as shown in Appendix B: Table 4. Figure 7 shows the 79-year yield curve distribution which is not too dissimilar to the 10-year projection.

Figure 5: 31 March 2014 Government Yield Curve

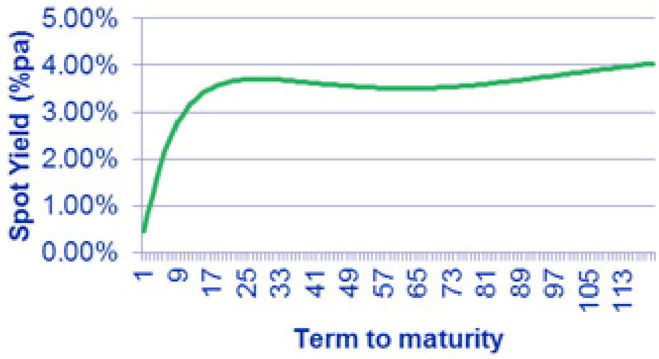


Figure 6: Yield Curve Distribution at 10-year Projection

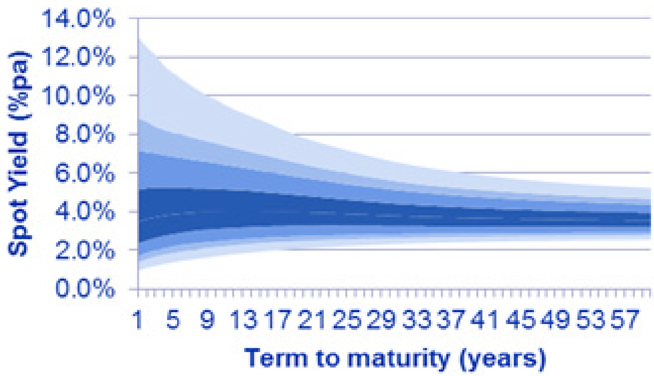
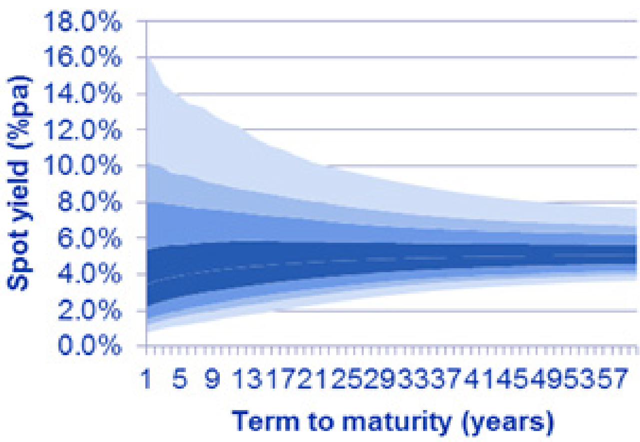


Figure 7: Yield Curve Distribution at 79-year Projection



Appendix B: Expected Returns, Volatilities and Correlations

Table 4 shows the expected returns, volatilities and correlations of the simulation. These statistics are calculated from the roll-ups over the entire projection horizon as opposed to yearly returns. Therefore, some of the volatilities look slightly higher over the longer term, in this situation the final value can vary notably when compounded over such a long time horizon. The longer term correlations are likely to be higher as everything tends to go up over the very long term.

Table 4: Expected Returns, Volatilities and Correlations

10-year

	Mean Expected Return	Volatility	Liabilities	Cash	UK Equity	1-5yr Gilts	Over 15-yr Gilts
Liabilities	2.79%	4.72%	1.000	-0.179	0.073	-0.079	0.656
Cash	2.88%	3.57%		1.000	0.046	0.868	-0.430
UK Equity	5.03%	17.34%			1.000	0.049	0.052
1-5yr Gilts	2.76%	2.25%				1.000	-0.260
Over 15yr Gilts	2.71%	4.62%					1.000

79-year

	Mean Expected Return	Volatility	Liabilities	Cash	UK Equity	1-5yr Gilts	Over 15-yr Gilts
Liabilities	4.12%	9.23%	1.000	0.949	0.437	0.953	0.864
Cash	3.97%	11.57%		1.000	0.443	0.981	0.883
UK Equity	6.01%	19.39%			1.000	0.442	0.437
1-5yr Gilts	4.28%	11.11%				1.000	0.929
Over 15yr Gilts	4.05%	5.58%					1.000