ABSTRACT OF THE DISCUSSION

Mr P. J. Sweeting, F.I.A. (introducing the paper)**:** For some decades academics have regarded pension scheme liabilities as being bond-like in nature, and actuaries have now come round to this way of thinking. However, it has taken FRS 17, and the realisation that equities can decrease in value significantly, to convince people that bonds might be a better match for pension scheme liabilities. As a result, there has been a significant increase in the variety of bond mandates given by pension schemes in the last few years.

It is important to distinguish between the different types of bonds available. Only some bonds are truly matching; namely risk free bonds in the same currency as the liabilities. Some AAA-rated supra-nationals might also be regarded as effectively risk free, but most investment grade corporate debt can only be regarded as quasi matching. They have a risk of default and, more importantly, of downgrade. These risks are reflected in the higher yields, higher expected returns and higher volatility of these returns. Having said this, investment grade corporate debt remains more a matching asset class than a risk one. High yield corporate debt, on the other hand, is certainly not a match for pension scheme liabilities. Although they offer higher expected returns than investment grade debt, their returns are more volatile and are not highly correlated with those of investment grade bonds.

If you increase your allocation to corporate bonds, you are taking an active asset allocation decision that is increasing your risk. The further down the credit curve that you go, the greater that risk. Should you allow for this risk by modelling every single asset class? Probably no. A good example of why you should not can be gained from looking at the development of the efficient frontier over time. Here the composition of efficient portfolios with regards to risky and matching assets stays reasonably constant over time, but the allocation within these groups, for instance between investment grade corporate bonds and Treasury bonds, changes greatly. This indicates that stochastic asset models might be fine for the big decisions, such as the proportion of non-matching assets to be held, but you might do better by using a combination of risk budgeting and pragmatism when deciding, for example, how much of the matching pot to allocate to corporate bonds.

If, however, the underlying return distributions of the asset classes that you are modelling are non-normal, then modelling can be useful, providing that this non-normality is allowed for. For example, there are skew and kurtosis, skew being the extent to which the distribution is pushed either to the left or the right, and kurtosis being the extent to which the number of extreme observations is higher or lower than expected. Kurtosis is particularly difficult to measure. In looking at the tails, the very highest and lowest observations, you are going to have only a few data points. Skew is potentially a particular problem for bonds, and the lower down the credit curve you go the more of a problem it becomes. Your potential upside is limited. Yields can go no lower than zero and high yield bonds are likely to be 'called', that is redeemed by the issuer, long before this. Your potential downside, however, is that you lose everything.

The statistical analysis in the paper shows that high yield corporate debt is the least 'normal' asset class, in the statistical sense of the word; but here, the non-normality was only significant under one of the two tests used. If non-normality is a possibility, then it makes sense to model it and to use downside risk measures. This is important, because most institutional investors, not just pension schemes, are more interested in a risk of loss than the prospect of excess returns.

I have concentrated on the analysis of market values, which seems sensible, as this is what the assets are worth. However, fixed income investments have the characteristic that they produce income streams that, before allowing for defaults, are known in advance. How volatile are these income streams? The increase in the volatility of income, as you move down the credit curve, is not as great as the increase in the volatility of market values. The income from a portfolio of investment grade corporate debt has remained consistently higher than that from a Treasury bond portfolio. However, income from high yield corporate debt portfolios has dipped significantly relative to other bond asset classes over the last couple of years.

Should we turn our back on market values in favour of an income-based approach when we look at the suitability of bond asset classes? This would suggest that the income should be discounted at a rate other than that implied by the bond's price. This, in turn, would imply that the market price of the bond was wrong, which would imply that bond markets held numerous significant arbitrage opportunities. They do not. The risk that you are taking by moving into credit is generally rewarded with higher expected returns, in the same way in which greater risk from most risky asset classes is rewarded. As such, moving into corporate bonds should be considered in the context of other strategic asset allocation decisions.

Mr M. Jones (a visitor; opening the discussion)**:** My background is in asset management, fixed income, so my comments may have a particular bias to the asset rather than to the liability side.

Over the past 20 years there has been a change in how people view pension portfolios, due mainly to changes in accounting requirements. We have moved from focusing on a portfolio of total returns to focusing on matching the liabilities and assets, with a more risk awareness/risk management perspective.

In terms of bonds, the author has stated that there are only three risk free matching instruments. In terms of pension schemes, there are none. The nature of the liabilities, with Limited Price Inflation (LPI), salary inflation and mortality improvements, are such that you may be able to match some of them with risk free instruments, but not all.

In terms of the scope of this paper, I thank the author for bringing a bit of the fixed income world to a wider audience. The topics that he has covered are broad ranging. The challenge of fixed income is what you do not discuss rather than what you do discuss. The author talks about investigating the role that fixed income should play in occupational scheme investment. When I first read that, I thought that it was a Herculean task. I congratulate the author in managing to produce a paper that is only 49 pages long.

The strength of the paper is that it focuses on those fixed income assets that most consultants are reasonably *au fait* with, that is investment grade assets and high yield assets. I would have liked the paper to have focused on the broader range of investment assets that are available in fixed income, in particular swaps and their uses for pension schemes.

The results of the analysis are as expected. In particular, high yield bonds are shorter-term assets than investment grade bonds, with an average life of about three years, and their behaviour is binary. They either do very well and debt is repaid early, or they do not do well and the debt is restructured. Credit risk diminishes interest rate risk for high yield bonds, whereas the reverse is true for investment grade bonds. Low correlation between the asset classes is therefore not a surprise.

I was surprised by the skew test results, where the data showed that there was a lack of skew for corporate bond returns. With corporate bonds, the upside for your investment is capped; you get your coupons and your principal back. The downside is that, if things go bad, you lose a lot of capital value. Hence, I would have expected an asymmetric distribution of returns with a negative skew. The author comments that the skew figures are sensitive to the sampling period.

A criticism of the paper concerns the dataset used for the analysis. It is all American, and covers a limited period, 1984 to 2002. The reason for this may be the lack of United Kingdom bond data; investment grade data are only there from 1990, and high yield data only from 1997.

In terms of the analysis, much has been done in absolute return space; however, the author points out, in ¶2.2.2, that these returns should be compared with the liabilities. This is then discussed.

In terms of the mean/variance analysis work, the parameters are such that some of the scenarios seem to be so basic as to render the results meaningless. What should we actually take from the output?

Terminology is becoming blurred. Least risk portfolios used to mean government guaranteed, but now we have financial reporting, which bases liability valuation on the corporate bond AA yield, so, what is guaranteed in economic terms of investing in government bonds can, from a

reporting perspective, be more volatile than using a portfolio of AA-rated investment grade bonds.

With a low risk portfolio, a high yield allocation gives extra return, and can reduce overall portfolio risk. Other fixed income assets worth further research are the roles of inflation linked bonds; real return assets for long-term portfolios, rather than just a matching instrument for index-linked liabilities.

I have my greatest disagreement with the author in terms of the matching of assets and liabilities. It is more down to my practical dealing with clients and to cash flow matching requirements. I would not consider talking to a client about high yield assets in a cash flow matching context. Cash flows are uncertain, and short term in nature.

For LPI liabilities, the author points out that sometimes inflation linked assets will produce a surplus and sometimes a loss. Therefore, it is worth exploring a mixture of index linked and fixed income assets for these liabilities.

The paper focuses specifically on the only way to get extra yield, and that is through extra credit risk. That need not be the case. Extra yield can be obtained through taking illiquidity risk. For example, public structured deals, which are complex to analyse and less liquid, already offer more yield than an equivalent standard investment grade deal. Private placement is then a logical extension; typically issued by good credit quality companies which offer an illiquidity premium to the investor.

The paper omits the topic of swaps. Twenty years ago swaps did not exist; now it is one of the biggest markets in the world, traded by banks everywhere, and increasingly used by fund managers. Swaps are financial instruments that disaggregate interest rate, credit and currency risk. There are numerous beneficial applications for swaps when dealing with the risk management for pension schemes. Uncertain inflation risks can be matched by inflation swaps. We need, as a profession, to do more work on swaps and applications for pension scheme asset and liability matching.

Mr P. F. Rains, F.I.A.: The stated purpose of the paper is to investigate the role that fixed income should play in occupational pension scheme investment. I found the analysis a little incomplete. It is characteristic of any analysis based on historic data, even historic data for as long a period as the author has considered, that the results are affected by any special conditions that prevailed during that period. For example, at the end of 1983 United States Treasury bond yields were 12%; at the end of 2002 U.S. ten-year Treasury bond yields were 4%, which was a huge change in Treasury bond yields, which cannot be repeated going forward. Also, during that period we saw the longest economic expansion in the U.S.A. since the Second World War.

I would have liked to have seen a more fundamental analysis of the risk/return characteristics based on default rates and liquidity premiums, and some discussion of what might affect the evident liquidity premiums that exist and how they might have changed going forward. It would then have been possible to review why the liquidity requirements of long-term pension funds differ from the market as a whole. As the author says in ¶2.4.7, the limitations of stochastic analysis should be recognised, and, therefore, we should draw only broad conclusions about any analysis based on historic data.

My main critique of the paper is that the analysis does not take into account some of the latest thinking in portfolio construction. In the past, portfolio construction has been based on the principle that there are a range of traditional asset classes (and some new asset classes, such as high yield) that have stable risk/return characteristics. If these risk/return characteristics can be identified correctly, then an optimal portfolio can be identified and constructed.

With the increasing use of alternative investments, it is possible to look at the desired characteristics of a portfolio in a different way. For example, in the past a fund would take active risk only in those asset classes that were included in the benchmark. However, now, through the use of alternative investments such as hedge funds, one can look at taking active risk in asset classes not associated with the benchmark, and in more specialist and diversified ways. Similarly, it is no longer necessary to accept the liquidity level that is associated with the

benchmark investments. Through alternative investment vehicles, we can look at liquidity independently of other investment characteristics and choose a level that is right for the fund.

These new investment approaches provide a greater freedom of choice for fund sponsors. Instead of being limited in the range, liquidity, risk exposure and active risk types available (in a way that is implicitly assumed in this paper), almost any desired combination can now be held, and its return implications estimated.

Mr J. G. Spain, F.I.A.: I was shocked to hear Mr Sweeting say, in his opening remarks, that the actuarial profession has, more or less, come round to the idea that bonds are now most appropriate for pension liabilities. That is not true. The only vote of which I am aware was about 6:1 in favour of equities still being appropriate in certain circumstances, in June 2002. I am not aware of anything being written which is based upon some representative sample of U.K. pensions actuaries. Maybe it is time for the U.K. actuarial profession to look at this in more detail. Bonds are not the sole appropriate asset for pension scheme liabilities, and there is no statistical evidence, or past actuarial research, to suggest that they are.

Mr I. J. Kenna, A.I.A.: We need to outline the problem that we are facing before considering this paper.

Redington was the first to point out that far more cash was coming into the long-term financial institutions each year than was being paid out. This trend still continues. The result is that there is too much money chasing too few investment opportunities. In particular, there is too much money chasing too few shares. The result is that the market prices of shares are being pushed up to very high levels. High share prices have made dividend yields very low. This raises the problem of where to invest new money to get the sort of yields that pension funds need in order to provide promised benefits.

Redington also pointed out that disinvestment, selling of shares, will eventually have to take place. This will knock the bottom out of the overpriced share market.

For these reasons, equities are less than desirable investments, particularly for defined benefit pension funds.

The Government and the Bank of England have a relatively high inflation rate policy. This results in a low official interest rate policy. Investment grade bonds, whether government or corporate, reflect this policy. Bond yields are low. Combined with target inflation of 2.5% and expenses of 1%, real yields are minuscule. There are only a few index-linked bonds available.

As the paper shows, the only bonds that are left to invest in are high yield, non-investment grade debt, with a Moody's rating Ba1 or Standard & Poor's rating BB+, or lower.

Turning to the rating guide, we see that these grades of bonds are, at best: "Having factor of speculation, no guarantee of investment security, unreliable capability of receiving capital with interest under changed circumstances". No wonder that these securities are known as junk bonds.

As actuaries are aware, the constituents of the FTSE 100 Ordinary Share Index are changed periodically, with failing companies taken out and good companies inserted. This is another factor keeping the FTSE 100 at a high level. I do not know whether a similar device is applied to a junk bond index. It would certainly cover up capital losses.

However, do we really want to say to pension scheme members and pensioners: "Your fund is invested in a judicious selection of junk bonds?"

Mr U. Ilyas: I agree with the author that more work needs to be done on the use of stochastic projections in the calibration of asset models, and on the use of historical data, which may invalidate the modelling exercise. Stochastic modelling should be used for the bigger decisions, such as the split between matching and non-matching asset classes. A more holistic approach to risk is needed when considering other alternative debt instruments.

Other assets which do not fit into the conventional asset/liability modelling (ALM) framework, and cannot be modelled on a consistent basis, for example, for reasons of non-

normality or asymmetric return, should also be looked at, whether it is convertibles, asset backed bonds or other debt instruments, where some liquidity premium can be captured, or, from a risk/return perspective, having attractive investment potential. They would be used to diversify some of the equity risk in a non-matched portfolio. Not knowing enough about such alternative asset classes is not consistent with what Myners advocates. Simply ignoring an asset class because there is not a long time series to enable quantitative modelling or lacking knowledge of the wider investment universe are not good excuses.

Overall, the paper focuses on the role of matching from using bonds and the minimum risk posture. The use of so called 'riskier' debt instruments should be looked at if clients are seeking higher returns away from the matched position. I agree with the opener when he mentioned the use of derivatives and bonds, and see a growth in the use of these two going forward.

Dr C. Keating (a visitor)**:** The problem with this paper is that it takes U.S. data, and draws conclusions about a U.K. market from U.S. data. It is explicitly looking at government bonds and corporate bonds. The author fails to consider, in any meaningful way, the dynamics of government bonds and corporate bonds. In particular, the impulse function to a shock in interest rates is different from country to country. What is completely missing is the comparative dynamics of the U.S.A. and the U.K.

The data set is based on indices. Corporate bond indices have a high bias to them when they operate on reinvestment in the index basis. There is very little reason to believe in financial data such as these where the fourth moment exists mathematically, which is probably why they show the sort of instability that is evident in some of the figures within the paper.

If we are going to consider corporate bonds, currently a relatively small class within the U.K., and if the amount of these is to increase, then we should expect the behaviour of the U.K. corporate bond market to change, which renders any historical analysis invalid.

Also, if there is a significant shift from equities to corporate bonds, what we are actually doing is leveraging the U.K. private sector. That, of itself, will change the risk and return characteristics of the asset classes within the private sector.

Professor R. Blundell, Hon.F.I.A.: The author uses ten-year rolling panels for the measurement of the kurtosis and skewness. Ten years is a relatively short period, and an issue is whether these results are driven by outliers. These kinds of statistics typically suffer from over rejection for this reason. You might look at some kind of boot strap or sampling method to reflect this small sample. There are similar issues for the stability of the coefficients. It would be interesting to know whether the tailing off of the time series is a movement away from some long-term mean or simply a significant decline.

I like the idea of looking at other measures that may justify your findings. If this kind of kurtosis is really evident in the data, and you think that the loss functions people have would take account of that, then you would expect to see this reflected in the pricing and portfolio usage of those assets.

That brings me on to exactly what loss function you have in mind when you have assets with these kinds of characteristics. Most of the discussion in this area relates to second moments, and there is not much discussion of loss functions for choosing portfolios where you might have evidence of kurtosis or skewness. Of course, there is no reason why a fourth moment of this kind should exist for these distributions.

As an econometrician, I would like to see a little bit more of the time series properties of the data themselves. What exactly are the autoregressive properties of these data?

Mr M. H. D. Kemp, F.I.A.: I would like to unpack one of the points made at the beginning of the paper. This is the idea that the yield on government debt is the 'right' way to measure the risk free rate. However, you just need to look at places like Russia to realise that government debt, *per se*, is not necessarily risk free. The author is trying to argue that, in markets where government debt is secure, 'risk free' equates to government debt/paper. Thus, if one plotted

some kind of yield measure versus risk measure, then there would be some relationship in which, as the risk tended to zero, the yield tended to the yield available on suitable government debt.

Is this really the case? At the last sessional meeting (Dullaway & Needleman, 2004) the question was raised as to whether or not you should use government rates or swap rates as the 'risk free' rate to discount insurance liabilities, as they gave different answers. A speaker from the FSA indicated that it preferred the use of government rates. This could have been because it was more conservative rather than theoretically correct.

Several earlier speakers have referred to liquidity. Government debt is likely to carry a liquidity premium, and therefore likely to trade expensive, i.e. on a yield lower than on a hypothetical 'risk free', but less liquid, asset. Working out the right answer to this question is presumably important in relation to asset proportions held in government debt and investment grade non-government debt. The author seems to indicate, in Section 3, that, unless you are hyper risk averse, you almost immediately switch straight into investment grade assets as your risk appetite rises above zero. Is the possible difference between yields on government debt and less liquid assets part of the explanation?

Reference

Dullaway, D.W. & Needleman, P.D. (2004). Realistic liabilities and risk capital margins for with-profits business. *British Actuarial Journal*, **10**, 185-316.

Dr Keating: Let me put the question of whether or not trustees want to buy corporate bonds for their pension plans in a more basic light. Recessions are precisely the times when corporations and corporate pension funds are under stress, as they cannot find the cash. This is precisely the time when corporate bonds have their minimal values. You are buying an asset which is dependent on precisely those circumstances which you want to avoid. How great a risk premium do you, as a pension trustee or pension sponsor, need to buy that sort of asset? That is the question that needs to be answered.

Mr P. D. G. Tompkins, F.I.A.: If I can rise to the challenge of Mr Keating, in the current level of discussion it is appropriate to have a brief contribution about the demand for corporate bonds, and what that means in situations where companies are in difficulties, and large debt burdens could impose further difficulties. The pensions world has changed quite radically in the last few years, in particular in June 2003, and with the protections that are being put in place by the Government. Promises that had been made by employers in the past are going to have to be met by the employers of the future, collectively or individually, either through appropriately risk reduced pension funds or through the levies that are paid, presumably by those with more deficits, and according to a formula which is yet to be developed by current Government thinking.

There are substantial pension fund deficits, indebtedness, which have to be met one way or another. Recently, commentators and advisers have been looking at pension liabilities as a form of debt, and the substitution of that by corporate bond issues. This reflects little change in what is the collective indebtedness of companies to the future pensioners for whom they have taken obligations.

Mr Simon Carne wrote very cogently in *The Agenda 2004*, (published by The Actuarial Profession, which sets the scene for the year ahead) about the fact that corporate debt is going to rise. Much of that debt is going to become more risky, if we are looking at substantial issues and take ups by companies, which may be buying back their shares in order to raise capital through debt. We are going to have a wide range of corporate debt of quality. A well diversified portfolio held by varying trustees will consist of a lot of different grade debt and a lot of different holdings. The author's paper is very timely in that regard, but, of course, subject to an enormous challenge. It has taken 20 years of U.S. data to do some analysis, showing some curious conclusions, *ex-post*, about the way in which high yield debt would have had a place over certain periods in certain risk minimising portfolios. Looking ahead, how much confidence do

we have that such interpretations can be useful to inform the way in which people should be investing in the future? Those changes will be taking place as people seek to reflect the reality of their liabilities by matching assets and choosing to take up corporate bonds to a greater degree, given the absence of large-scale government bond issues for them to purchase.

The author points out, quite rightly, how the choice of the period of study is so critical. We have to view with great scepticism any kind of greater elaboration through, for example, asset/liability modelling studies, which are only as good as the inputs put into them. These inputs are drawn out from historical data analysis, and there are limited periods of time for consistent data to study this.

Mr I. P. McKeever, F.I.A.: As well as volatility in the markets, there were also broad economic changes taking place over the 20 years studied in the paper. There were broad economic changes that took place over the 30 or 40 years before then. We can expect broad economic changes over the next 20 years, the years in which we are most interested. Inflation has fallen quite steadily over the last 20 years, the investment communities took a while to accept that that was happening, which, I suspect, has caused this period to be a very unusual period in history. It will not be repeated over the next 20 years.

We need to think how expected fundamental changes of that nature could affect portfolios over the next 20 years, and consider them rather than just the variability of returns over short periods. As well as the broad economic sweep of changes, we also have the broad sweep of legislative changes. We have had FRS 17 introduced, which is going to affect attitudes to short-term variability in the results of FRS 17 valuations. That, in itself, is likely to affect the performance of investment markets.

Mr P. J. Nowell, F.I.A.: I have been involved with looking at sub investment grade bonds, or 'junk bonds', in the U.S.A. It seems to me that junk bonds are a reasonable investment. The risk/reward characteristics are reasonable, unless you want to apply junk bonds to a fixed-interest liability, such as annuities, where the sort of dangers that we have been talking about are very clear. There was a situation in Canada where that came out particularly strongly. There was a big boom, particularly in the Toronto market, in commercial mortgages, backed by a whole variety of different types of properties. The mortgages were taken out by developers when interest rates were high, and on reasonable margins over that of the Canadian Treasury. There was more and more of a boom, and then the market became oversupplied and the boom stopped. Interest rates went down, because there was a recession, and the Government wanted to stimulate the economy. At that stage the development companies and the associated commercial mortgages started to default, and investors got a double whammy effect. Firstly, they had lost money, but, in order to try to replace an annuity which they had sold on the basis of high interest rates, they had to pay a great deal more to replace the debt asset that they thought they had.

Another interesting point is the correlation between equities and Treasury bonds, which is referred to in Figure 2.12. Over the past three years the correlation over the ten-year period has decreased significantly, possibly due to special factors.

A paper, 'Pensions and Low Inflation' (Meredith *et al.*, 2000), published in March 2000, which coincided with the start of the decline in correlation between equity returns and long-term bond returns, may shed some light on these factors. The paper showed that, when looking at the U.S. market, the correlation between U.S. equities and ten-year bonds plotted against inflation indicates that, with high rates of inflation, there is a strong positive correlation between equities and ten-year bonds. As inflation declines, the correlation becomes negative. The U.K. basis shows very little evidence of this effect. It will be interesting to see whether what happened in the last three years, to the end of 2002, was just an aberration, a particular set of events, or whether it is associated with the fact that we have lower inflation now, and, going forward, we would expect the correlation between equities and bonds to be much less than it has been in the past.

REFERENCE

MEREDITH, P.M.C., HORSFALL, N.P., HARRISON, J.M., KNELLER, K., KNIGHT, J.M. & MURPHY, R.F. (2000). Pensions and low inflation. *British Actuarial Journal*, **6**, 547-619.

Mr D. R. Linnell, F.I.A.: We need to understand past relationships between the different fixed income investments, even though the world is likely to change quite significantly over the next few years. As a profession, we will need to look at and try to model the changes. This is where econometrics may possibly help us.

We have a very interesting situation. We have had a long period in which, as Mr Kenna said, equities have been the 'in' thing, both for individual investment, through insurance companies in with-profits funds, and by professional investors, through money coming into growing pension funds.

Pension funds are maturing; more and more of their assets need to be matched to pensions in payment. New members are not coming into defined benefit plans, because many employers have closed, or are closing, them to new entrants. Where defined benefit plans are replaced by defined contribution plans with individual contracts, experience suggests that individuals are risk averse. They are not going to want to invest in equities in the same way as professional advisers may have done in the past, thereby leaving future cash flows to be invested more in bonds and less in equities. That, coupled with FRS 17 and company requirements to reduce volatility in company balance sheets, will lead to a further increase in bond investment and a reduction in the choice of bonds. However, there are not enough bonds to go round now if a pension scheme wants to switch assets into bonds, so what will investors do in future?

The other aspect to consider is the likely effect on the economy overall; if bonds become more popular prices will go up, and it will become more attractive to issue fresh bonds. That will change the risk profile of U.K. industry in ways which we need to think about ahead, rather than to wait for it to happen. We may get very different economic situations. I note that the period which the author looked at did not include 1973 and the high inflation periods; the period 1984 to 2002 is a relatively stable period in historic terms.

The President (Mr J. Goford, F.I.A.): My perspective is from a life assurance background. The question that I keep asking myself in relation to pension funding is: 'Where is the capital?' In a life assurance company, the more risky your asset/liability mis-match, the more capital you hold. You are interested in fulfilling the promises to customers. I keep trying to find some constant in pension contribution rates irrespective of the asset/liability mis-match. If you determine the amount of capital to provide a given level of security to the pension scheme members, depending on the asset allocation, would there be a 'constant' equal to the contribution rate, taking into account the nature of the assets, plus the loss of capital that may be required, depending on the riskiness of the assets? I have yet to see a 'constant' for pension funds, reflecting the more riskier pension fund asset allocation, and some capital allocation from the company to underpin the pension fund and not invest it in widgets. That may bring it home to finance directors more closely as to what risks they are running by over investing in equities for their pension funds.

Mr D. J. McLean, F.I.A.: In the paper, particularly in Figure 6.1, the sector changes suggest that the high yield market has diversified amazingly rapidly, which looks rather surprising. Is this an aberration or is it simply because all of the telecom stocks had virtually gone bust and were worth nothing, and since then they are worth something again?

There is a reference, in ¶4.2.7, to a period where high yield debt suffered in quite an immature market. I wonder the extent to which that period of an immature market distorts the overall data picture You cannot cut out that period, because if you cut it out you are left with periods of time which are great for high yield.

The use of derivatives is mentioned, and how these could be used usefully, but the high yield for these is very short term in nature. If we want to find a pension fund matching asset, a logical approach is to use, in conjunction with high yield bonds, something like swaps to

put the duration back in. To what extent does that solve the problem or not solve the problem?

Those who are about to have to do some CP195 modelling will presumably need to have some view on the way in which you model various debt categories. There are a lot of them within life company balance sheets, so you will have to do something with them, presumably sophisticated enough for the Financial Services Authority (FSA).

Mr D. Hanson (a visitor)**:** From an economic perspective, the extent of pension fund deficits is fascinating. It raises many issues, for example about what discount rate should be applied and how various approaches to financial engineering might be used, particularly on the tax side of things. The most interesting aspect is how the economics from the financial side of pension fund deficits actually relate to the economics of the real economy.

One earlier speaker said that if you put a great deal of money into corporate bonds, then that might change the way in which corporate bonds operate. Also, one ought to consider how the performance of businesses might be affected by having to increase their prices in order to fund pension fund deficits, which might differ between different sectors. In a highly competitive market, it is difficult to see how companies would be able to do that, and the impact that their ability, or their inability, might have on their company's bottom line. The other side is how businesses in natural monopolies might deal with pension fund deficits. A big debate has been going on within Ofgen and Ofwat, and they have to think to what extent regulated companies should be able to increase their prices to fund deficits.

Ms S. L. Dixon, F.I.A.: As we look at Figure 6.1, we see the diversified industry sectors. Does this offer any solution, albeit even maybe a partial one, to an earlier speaker who was concerned with the double jeopardy problem? Perhaps, by investing in sectors that are diversified from your company sector, you reduce the double jeopardy.

Mr M. A. Pomery, F.I.A.: As a pensions actuary, who has attended many trustees' meetings over the past 30 years, I was reflecting on those meetings while listening to the discussion. Over the first 20 of those 30 years, trustees set about investing the assets of a pension fund totally, ignoring the fact that there were any liabilities there. That was not as silly as it sounds, because, at that time, the funds were very immature and had positive cash flows. Indeed, they had positive cash flows as far as the eye could see, going forward. What has changed over the past ten years is the increasing maturity of the funds and an increasing realisation, firstly among advisers, and then among the trustees themselves, that those assets are actually there to meet liabilities. They are not just an investment pool to play around with on the stock market.

This increasing maturity gets reflected in changes in the basic split between equities and bonds. During those first 20 years, many trustees built up their equity proportions to 70%, and even as high as 90%. By the time when they had put a bit in property as well, there was only a small part left for bonds, maybe 5% or, at most, 15%. All the effort in the trustees' meetings took place discussing the equity holdings with the investment manager. For lay trustees, it is interesting discussing equities with City investment 'houses' in the trustees' meetings — I suggest more interesting than discussing bonds or gilts. Given the changes over the past ten years, we are all going to have to extend our knowledge of bonds, bond markets and investment in bonds. Once the bond proportion builds up in pension funds, which it is doing already, and will continue to do, it is inevitable that trustees and investment managers are going to start looking for ways of improving the returns on their bond portfolios. They will not invest just in gilts, but will look at corporate bonds as well.

It is interesting to observe trustees, and their attitude to risk, when the bond manager comes along and says to them: "As well as having gilts, we think that we should have a few corporate bonds in this portfolio." They look worried, and ask: "Isn't that rather risky? There might be some default there. Should we really be moving out of gilts into corporate bonds?" This is from trustees who still have 75% of their fund in equities! So, there is a need for further education of

trustees. It has started, certainly among the bigger clients with the more sophisticated trustees.

Something that surprised me a few years ago, when I started looking at this for the first time, was just how big the corporate bond market has become. Corporate bonds in this country had overtaken gilts in terms of the size of the market. The Pensions Board set up a small working party on corporate bonds. It produced its report, 'Essentials of Corporate Bonds for Pensions Actuaries' in 2003.

Pensions actuaries and investment consultants are going to need to have a much deeper understanding of bond markets in future. Fixed income investment is a classic area for actuaries, who, being highly numerate, contribute significantly to the debate. The author's paper is a very useful contribution to this debate.

As U.K. final salary schemes continue to mature, they are going to invest a much bigger proportion of their assets in bonds, as they are doing and will continue to do. With the move to defined contribution (DC) schemes, when the members of DC schemes start retiring they will need to buy annuities. More and more final salary schemes will start to wind up and try to buy annuities from insurance companies. As a result of these developments, the demand for bonds is possibly going to exceed the supply, or maybe the supply will grow to meet the demand. Mr Linnell has already touched upon this issue, and the Finance and Investment Board is doing some interesting work in this area.

Mr M. J. Deakin, F.I.A. (closing the discussion)**:** As somebody who worked as a fixed-income fund manager from the late 1970s until the mid 1990s, I have been interested in the way in which pension funds have started to move back into fixed income in recent years.

The overall case for why pension funds want more fixed income has been pretty well rehearsed, although it is clear that not every speaker agreed. Certainly pension funds have more in fixed income now than they had five or ten years ago. The paper is a very interesting contribution to this broader debate. It has explored the case for broadening out from just government bonds into corporate and even high yield debt. There were some comments about investing in a much broader range of assets. That is true, but we have to start somewhere.

I particularly liked the part of the paper where assets and liabilities were brought together, because that is much more important than just looking at the assets in isolation.

Why would anyone, not just trustees of pension funds, want to own corporate bonds rather than government bonds? The simple rule of thumb would be because the extra yield that you are going to earn more than compensates for the risk of default. The data shown in the paper show that typically this is the case.

My own experience of the last 20 or so years in the U.K. would say that much the same would be true if you modelled on the U.K. data. Why have we been paid more than we ought to have been for owning corporate bonds? Part might be liquidity, which has been mentioned by some speakers. For many pension funds, and certainly for the types of fund modelled in the paper, liquidity is not that important. The only time when you would really want liquidity in a corporate bond is at the point when you have to stop holding it because it has defaulted, or been downgraded, and that is the last time that you will get liquidity. You are paid for illiquidity, which is not actually that important, so that is one area where you have to been able to capture some value.

There is a link, which the paper did not pay too much attention to, to the behaviour of corporate bonds and the economy. There is a significant pattern, which precedes the 18 years in the paper, which shows how corporate bond spreads between top and mediocre quality have moved along with the economic cycle. As the economy strengthens, we should expect these corporate bond spreads to narrow as the risk of default appears to diminish. The current pattern that we are going through looks very similar to a pattern of the previous 30-year cycle, and it is a fairly well-established one.

The fact that we have lived through a very long period of sustained economic growth in the western world would be another reason why corporate bonds have, in the past, been a good place to have put your money. However, that is looking back, not looking forward. At current yield

levels, the extra yield that we earn on corporate bonds is not that attractive, certainly on the longer-dated stocks, and I would be more cautious about the future excess return that we will earn than about the returns we have earned over the past few decades. This paper analyses only a very short period of data, because of the lack of data on high yield debt in particular, and therefore misses some of these points.

I was surprised about the apparent lack of skew in the data that was coming through. One of my principles, when I was managing these types of funds, was that you could lose all of your money or a very large part of it. At the best you would gain that extra piece of income for the life of the bond. It seemed that, regarding the balance of risk and reward, although the risk of default might be quite low, the downside risk was much higher than the upside gain.

I also felt that, in debates with companies which wished to reschedule their debt in some form, being paid an extra quarter per cent for a much less secure piece of paper was not necessarily a good trade-off.

The other point in the U.K. has been that we have actually had a market where, generally, institutions have been pretty strong in making sure that they have good security on corporate bonds. That has helped the process, and is different from the practice which we see in Europe or in the U.S.A.

I was not surprised at the outcome of the analysis in the paper, which said that there was a stronger correlation between high yield debt and equities than there was between high yield debt and bonds. It was how I had seen this market when I was a practitioner. I was an investor in high yield bonds ten years ago, just after the period that Mr McLean was asking about. What happened in the early 1990s that caused this distortion?

There is some link between the sheer volume of low quality bonds that were issued in the late 1980s and the very high default rates in the early 1990s. The default rate in 1991 of U.S. high yield debt reached 12%. The average over the past 20 years or so has been about 4.5%. A similar pattern emerged about ten years later. I am not suggesting that there is a ten-year cycle going on here, but in the late 1990s we again saw a very large increase in the volume of what we regarded as low quality, high yield debt, and three years later, in 2002, the default rate had risen to 11%.

Of the 125 issues that defaulted around the end of the 1990s, a quarter had been outstanding for fewer than 12 months before they defaulted. That gives you some idea of the sort of market in which we are operating, but that does not mean that you cannot make money. Certainly, an investment made ten years ago, after we had had all those defaults, when the yield premium on high yield debt was in excess of 1,000 basis points above Treasury bonds, would have been very profitable. What you want to avoid is investing when everyone else has been buying them, and the yield premium is much lower.

A typical cycle would be that, as yields on what we might regard as safe investments, whether they are bank deposits or government bonds, have fallen, investors start to look elsewhere. They start to look at what would have paid them that nice 7%, or 8%, that they used to earn on Treasury bonds, that they cannot get any longer. Gradually they move up the risk curve, until they find where they can get the interest that they want. That has been part of this cycle that we have seen in the high yield debt market, that the interest in high yield, because it was a substitute for the no longer high yielding safer investment, causes yields to fall and yield premiums to narrow. This has allowed poorer quality companies to issue them, and then, inevitably, the bust followed the boom, and we go all round again. That is not to say that there is no space for high yield bonds, at times, in a portfolio.

The paper concludes on a very good point, which is to use swaps and other derivatives to manage duration. If we stick to the traditional methods being used ten years ago, just buying bonds of the right duration to match the liabilities, we are restricting ourselves severely. By using swaps to get the duration match as far as we can, it then opens up a whole range of possibilities of where we can invest the money to get the extra return. This could be through a corporate bond portfolio, selectively through the use of high yield. We have had some speakers questioning whether there would be enough debt out there if we all want to buy them. I am a

strong believer that supply will meet the demand in time, but we do not have to restrict ourselves purely to U.K. corporate debt. The swaps will allow us to buy euro-denominated debt, and a much bigger market, U.S. denominated debt, and swap the currency back. So, I do not think that there is, or will be, a shortage of supply.

There is much more that can be done to develop the debate as to how fixed income, in a broader sense, can play a part in pension fund portfolios.

Mr P. J. Sweeting, F.I.A. (replying)**:** There are a few additional points, many of which have been made, in part, by other speakers.

First, the data set used was U.S. data rather than U.K. data, because the U.S.A. provides the largest consistent time series for bond data. There are caveats in the paper about the fact that U.S. rather than U.K. data are used.

As far as the asset classes go, there are many other bond asset classes that could be analysed. The main ones were covered, that is: 'effectively risk free'; 'pretty much risk free'; 'certainly quite a bit of risk'; and 'something completely different', being equities.

I am not sure that adding other asset classes would have added that much value to the paper, particularly given the results of some of the analysis. Looking at an asset/liability model, the additional information which you get from trying to model extra asset classes is pretty limited. Having said that, there is potentially quite a bit of additional work there.

Second, I should like to cover the skew in the returns of corporate bonds. It is intuitive that, for an individual year's data, if you look at the range of returns on a series of corporate bonds, then those returns will be skewed, because the majority of the bonds will have a very small positive return, and one or two will have very large negative returns. If you are looking at the returns on an index over a series of years, then it is less obvious that you are going to get significant skew in the data. You will get some from the same effect, but the skew will be much less. For the data set which I have used, you are looking at the returns on investment grade corporate bonds, which are driven by government bond yields. With government bond yields falling, the resulting strong positive results mean that any skew from the odd default is going to be largely swamped. That is why you do not get as much skew in the index data as you might expect.

A further point, mentioned several times, is the demand and supply of corporate bond markets. By definition, those are going to be the same, demand equals supply, and, if demand increases, then the supply of corporate bonds from companies will probably increase as well. It is important to take a holistic view and look at the bigger picture. Any company which has a pension scheme invested in non-matching assets is going to suffer risk from that pension scheme. The riskiness of the company and pension scheme combined is going to be increased, the larger the amount of non-matching assets that there are in a pension scheme.

If the pension scheme starts moving into bonds, then it is going to be reducing the amount of risk for the company overall, and effectively reducing its leverage.

What this means is that, if you get more corporate bonds being issued by other companies, because of increased demand, then each company is really only going to be leveraging itself up to the position that it was in before, that is that all that you have really done is to remove the equities from the pension scheme and replace them with bonds that the company has issued itself. It is spread around a bit, but the net effect on the economy is going to be pretty limited. The main effect is going to be that any companies which do this are going to be paying a lot less tax in the long run than they would have done before.

There is an important point here. Many people are implying that the move from equities to corporate bonds by pension schemes is going to make the equity market crash. It is not. Companies are just going to start changing their capital structure from being equity based to being corporate bond based.

It is also worth taking a broader view on this. The U.K. is an island geographically, but not financially. Europe, in particular, is moving more into funded pension schemes, and Europe, in terms of investment, tends to be a lot less parochial than the U.K. and the U.S.A. So, when the

demand increases for investment assets in Europe, it is not going to be for just their domestic assets; there will also be increased demand for U.K. equities from Europe.

On the views that bonds are not necessarily the most appropriate investment for pension schemes, I agree — swaps are pretty good as well. The growth of the swaps market is a very important development for pension schemes, and not just for standard types like inflation and interest rate swaps, which are very useful, but variants such as LPI swaps. If there is a demand for a synthetic product from pension schemes, then there are going to be investment banks out there which are more than happy to satisfy that demand. If there is anything which a pension scheme needs, or if enough pension schemes need, then it will be supplied by investment banks.

The President (Mr J. Goford, F.I.A.): As the opener said, the author attempted a Herculean task. One of the comments, by one of the speakers, was that it has given him some mathematical support and analysis for his intuitive thinking. Basically, that was in the skewness of corporate bonds, and hence I regard this as a classically valuable paper to be presented in this Hall. It remains to me to express my thanks, and the thanks of all of us, to the opener, the closer and all those who participated in this discussion.

WRITTEN CONTRIBUTIONS

Dr C. Keating: In the context of the ongoing, and sometimes vitriolic, debate on this subject, this paper is apposite and welcome. I take this opportunity to respond on behalf, and at the request of, the Committee on Methods and Measures of the European Bond Commission of the European Federation of Financial Analysts' Societies. The comments follow the order of the paper.

The paper is ambitious in that it seeks to determine: "the role that fixed income investment *should* play in ... pension scheme investment". A significant caution is justified here. If we are to move to substantial allocations of corporate bonds in pension schemes, then we should expect to influence the market behaviour of those bonds, which may, of itself, render historic analysis irrelevant. If we are to replace equity with debt in the corporate balance sheet of the U.K. private sector, then we alter adversely the risk characteristics of the corporate sector and, indeed, its ability to withstand the recessions which are so critical to default and credit deterioration.

In ¶1.1.2 the paper states that the application of financial economic theory is resulting in moves away from equities and towards bonds — if true, then this is almost surely a misapplication.

In ¶1.2.2 the paper suggests that relationships may be inferred from U.S. data for the U.K. We would urge caution in this. The reader will recall that the impulse functions (under, for example, VAR or VECM models) of macroeconomic variables to shocks in interest rates are markedly different, from country to country, in both depth and longevity. It is important to realise that these differences in response to monetary policy management are likely to persist structural changes in an economy, and the differences in response have significant consequences for bond returns. Unfortunately, the effects (and differences in them) are most profound when we are dealing with the most sensitive of debt — low grade.

In addition, there is one unique set of circumstances contained within the data set — the removal by regulators of the ability of U.S. insurers to hold meaningful inventories of 'high yield' in the period 1990 to 1992. This resulted in spreads reaching record levels in that period — these spreads were not equalled in 2000/2003, even though equities and credit qualities were far more depressed.

In ¶1.2.6 it is stated that the Lehman indices are used. It would be helpful here to have some discussion of the biases inherent in corporate bond indices arising from the form of the reinvestment practiced. The method of reinvestment in the index employed results in a high bias to the total return. (For further detail on index construction, see Brown, 1998.) It is also

important to recognise that corporate bond indices are of time varying credit quality and other relevant characteristics, such as maturity and coupon, which can serve to confound results.

In ¶1.2.11 the author states: "an increase in the yield spreads of corporate ... will adversely affect the funding ratio". In the context being discussed, this is not true — increasing the discount rate for liabilities will decrease them and improve the funding ratio, *ceteris paribus*. (Ex-ante) corporate bonds are higher and more volatile than government bonds of similar characteristics — using corporate bond yields rather than government bonds (as is correct financial analysis) to value liabilities, therefore lowers the perceived present value and makes it more variable.

Introducing corporate bonds into a pension plan does not reduce the variability or riskiness of the plan. The matching argument is spurious. If I value the liabilities of a plan using the corporate bond rate, I am undervaluing the liabilities. If I then 'match' these liabilities with corporate bonds, I have achieved nothing other than opaqueness of risk. The valuation basis and the assets move in lockstep. However, if the corporate bonds default, the liabilities are not extinguished. Before dismissing default as an arcane abstraction, let me remind the reader that all corporate bonds have finite (though usually small) probabilities of default, which means that, in the fullness of time, they will default. (Maturity and repayment obscure this.)

In ¶1.2.12 the author comments upon some of characteristics of corporate bonds, and proposes, subsequently, to analyse cash flows. It would have been helpful to have some discussion of the differences between government bonds and corporate bonds. By way of offering, the relation between yield and return for a government bond is well known as $r_{t+1} = y_{t+1} + D_t(y_t - y_{t+1})$, where D is the duration of the government bond. However, the duration of a corporate bond is complex to estimate, since much of the yield is ex-ante compensation for default. The obvious (but incorrect) calculations would have us believe that the duration declines with declining credit quality, while commonsense tells us that this is nonsense. Empirically, the relation between ex-ante spread and return (annual) for a high-yield index (1979 to 2002) is shown in Table D.1 and Figure D.1, together with some descriptive statistics:

Table D.1

	Ex-ante spread	Return
Mean	4.76	1.88
Standard deviation	1.98	11.42
Skew	1.77	−0.06
Kurtosis	3.04	−0.25

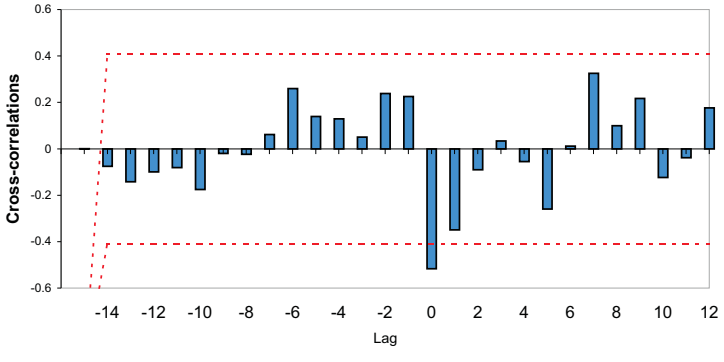

Figure D.1. Cross correlations, ex-ante spread/return

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While this simple example is subject to many possible criticisms, it serves to make one basic point. The analysis of credit is complex, and well beyond the realm of mean/variance analysis.

In ¶1.2.14 the author notes that the data period considered (1984 to 2002) is characterised by declining interest rates. I would suggest that the author should consider rather more fully the effects of cycles and super-cycles in the data; the question of the dynamics of corporate bond spreads and returns is again crucial.

It is a little disappointing to see that the analysis proposed is mean/variance, when the author is clearly aware that the higher moments (to use a turn of phrase) are important. In point of fact, it was the significance of asymmetries and fat tails in corporate bonds which led us to devise the Omega function for analysis. An introduction to this was presented at the Finance and Investment Conference in 2002.

The beta analysis proposed is somewhat suspect, as market capitalisation is a poor measure for debt securities. The rationale here is that, for debt instruments, market capitalisation is biased towards the profligate.

In ¶2.2.5 rolling ten-year averages are considered — as these overlap, it is not at all evident what can really be inferred from these data. It would be far better to consider the performance of each asset class in the context of its historic performance. If we look to the 'Triumph of the Optimists' data set, we observe that returns from equity over the past decade (1993 to 2003) were very poor — being surpassed on almost 90% of all possible occasions — while the returns from government obligations were strong — being surpassed on approximately 35% of all occasions.

In ¶2.2.11 the author states that: "the risk free asset has a standard deviation of zero". This, in fact, is only true if we are in a prospective single period set-up. In a multi-period ex-post analysis, such as this, the risk free rate has (usually) varied. The 'risk free' of financial theory refers to *default* risk freeness rather than to rate invariance.

The author notes correctly, in Section 2.3, that skew and kurtosis can be important, but seems to fail to realise that the unique property of the normal distribution, that mean and variance are independent random variables, carries with it consequences when considering non-normal distributions — i.e. that mean, variance, skewness and kurtosis must now be estimated jointly.

The author states that excess kurtosis measures how fat the tails of a distribution are. While this is the accepted description of kurtosis, it is by no means always true. Examples of distributions where the excess kurtosis misleads are available on request — and some can be frighteningly similar to the log normal.

In ¶2.3.4 the author notes that the estimates of skewness and kurtosis are highly sample dependent. This should raise concerns that they perhaps do not exist mathematically.

In ¶2.3.5 the author states that high yield is apparently less 'normal' than other 'asset classes'. If the author were to consider effects due to credit alone, such as has been done in many transition matrix simulations, he would observe the highest relative skew and kurtosis in AA rated bonds and actually quite small effects in 'high yield' bonds — see earlier descriptive statistics.

In ¶2.3.10 the author refers to the presence of call features in high yield corporate debt, and cites them as possibly causal in delivering asymmetric returns. However, if this were a significant effect in the data sets used, it would render questionable much of the results cited. It is more usual to work with option adjusted data sets. There are, of course, other effects that would create asymmetry, such as ratings migration and default.

Contrary to the assertion in ¶2.3.12, there is evidence in U.S. Treasury data of positive skewness — as should be expected from the effects of convexity. It may be that these are not statistically significant in the context of a Jarque Bera test, but the power of that test is not great. Some more advanced methods of analysis are probably justified, as this is an area where statistical significance may depart markedly from economic significance.

Section 2.4 deals with correlation and efficient frontiers. As is well known, correlation is an applicable measure of dependence only if the data are jointly elliptical. *Any analysis of corporate bonds should consider their dynamics and the time variation of dependence.* In other words,

corporate bonds should be expected to have their poorest values in recessions — arguably they are one of the conduits of monetary policy. What is the premium applicable to an asset whose value is minimal precisely when a corporate sponsor is experiencing adverse business conditions? It is, perhaps, a particularly appropriate question to ask in the context of the subsequent finding of apparent undervaluation of corporate bonds in ¶2.6.3. In this context, at the very least, one would expect a multi-period optimisation, even if derived recursively.

Reference

Brown, P.J. (1998). *Constructing and calculating bond indices, (2nd edition)*. EFFAS/ISMA.

The author subsequently wrote: I should first like to thank Dr Keating for his detailed response. There are, however, some points that he makes which are worthy of further discussion.

Dr Keating warns of the risks of moving to substantial allocations of corporate bonds in pension schemes. In particular, he notes that: "If we are to replace equity with debt in the corporate balance sheet of the U.K. private sector, then we alter adversely the risk characteristics of the corporate sector and, indeed, its ability to withstand the recessions which are so critical to default and credit deterioration." This is, of course, not necessarily true. By investing in corporate bonds rather than in equities, pension schemes expose their sponsoring firms to significantly less risk. In addition, such a change in asset allocation results in increased demand for corporate bonds and decreased demand for equities, which has a corresponding effect on the prices of these two asset classes. Furthermore, a firm whose pension scheme is invested in less risky assets can afford to take more risk on its own balance sheet, and if corporate debt is overpriced whilst corporate equity is underpriced, a debt financed equity buy-back is the ideal opportunity for a firm to put itself back in exactly the same overall risk position as it was before (although, admittedly, with the benefit of a lower tax bill). It is, though, worth noting that, from a firm's point of view, moving to corporate bonds is not necessarily the best course of action, as I mention in ¶6.6.6. For example, a struggling firm may wish to use its occupational pension scheme as a cheap source of finance by running a deficit, and even to take advantage of the cheap financing to invest in risky securities in the pension scheme in the hope that the firm will be saved by one more 'spin of the wheel'.

Dr Keating also takes issue with my statement, in ¶1.2.11, that: "an increase in the yield spreads of corporate over government bonds will adversely affect the funding level." If the liabilities are measured correctly — that is, collateralised liabilities are valued using a risk free rate of interest — then this statement must be true for a pension scheme invested in corporate bonds. This volatility in the mark-to-market value of assets relative to liabilities is important, as any trustees trying to buy out benefits with an insurance company will find. It is true, even if the relevant accounting standard requires the valuation of the liabilities to be carried out using a corporate bond yield — investment in corporate bonds results in a stable reported funding level (which is, in effect, risk opacity), but there is still volatility of assets relative to the true level of liabilities, a point I also make in ¶1.2.11. Most of his comments in relation to funding levels, whilst appearing to be criticisms, actually seem to support the points that I make in the paper.

However, in general, Dr Keating's comments are welcome and helpful, and I thank him for taking the trouble to provide them.