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HOW MUCH RISK IS THE USS TAKING?

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It seems that there are insufficient funds to make the probability of running out of money a very unlikely event. This is almost certainly not acceptable to those who would face the consequences of this significant risk arising. We briefly consider the implications of this.

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How much risk is the USS taking?

David Miles*and James Sefton†

Abstract

We analyse the probability distribution of outcomes for the USS in the light of conflicting claims about its sustainability in the absence of changes in contributions or in benefits. We find that a substantial investment in riskier assets (equities) makes the average outcome one in which the scheme is comfortably able to pay accrued benefits. But the risk of having far fewer funds than needed to pay existing pension promises is significant and the chances of large deficits is very substantial. It is neither the case that the scheme is comfortably able to pay pensions nor is it the case that the scheme is clearly unable to fulfill existing pension promises. But the current stock of assets is almost certainly insuffi cient to make the risk small of not having enough to pay pensions already promised.

It seems that there are insuffi cient funds to make the probability of running out of money a very unlikely event.This is almost certainly not acceptable to those who would face the consequences of this significant risk arising. We briefly consider the implications of this.

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Contradictory claims have been made about the state of the USS. Some have argued that the scheme is comfortably in surplus (Wolf 2021, Wong 2021, Marsh 2019a and 2019b). At the same time the USS reports a deficit of several billion pounds, its Trustees argue that substantial rises in contributions (or adjustments in benefits) are needed and the Pensions Regulator sees it at the limits of what it considers an acceptable level of risk even with substantial increases in contributions. These different judgements in large part reflect dif- ferent - often unstated - criteria for judging whether likely outcomes are acceptable Those who believe the USS is in a comfortable position tend to rely on simulations using central estimates of the return on risky assets to assess whether funding is adequate; either the mean expectation of returns is used or the mean minus a small downward adjustment as a "conservative" basis for simulations[1]. Those who are less sanguine - and certainly those who consider the status quo unacceptable - focus more on downside risks and the limited ability of Universities to make good on promises that could involve future additional con- tributions in the tens of billions of pounds. Use of a single discount rate to convert future pension payments into a present value to be compared with current assets - and generate "a" value of deficit/surplus - encourages a focus on some sort of adjusted expected return. But in focusing on a single discount rate and a single estimate of under (or over) funding such calculations are wholly inadequate as a basis for any judgement about risks.

The disagreement that exists today between those who think the scheme is affordable as it stands, and that there is no deficit, and those that believe a large deficit exists, so changes to contributions and benefits have to be made, is intractable if both sides put forward a single number for "the deficit". This makes a strike more likely. What is needed is a clearly quantified assessment, that can be understood by all parties, of how much risk is being taken.

Rather than focus on single outcomes based on a particular outcome for the returns on assets, an analysis which looks at the whole probability distribution of outcomes - given the stochastic processes for asset returns - seems far more informative. This allows an assessment both of the probability that assets are insufficient to pay pensions but also of the potential sizes of shortfalls and their probabilities. In this short note we conduct such an analysis. We use a range of different assumptions about the stochastic processes generating returns on assets. We focus on the risk of uncertain asset returns and take as given a projected profile of future payments that reflect accrued benefits (that is pension promises) made in 2020. We then consider how the assets of the scheme could evolve from that time forwards to see what the chances are that assets then held are sufficient to pay promised pensions without further contributions.

We use the USS reported level of assets and of expected future pension payments (that is

[1] Wong (2018) does perform stochastic simulations but focuses on the probability of underfunding as the risk of bad outcomes rather than looking at the overall distribution of net assets which would show how large the scale of underfunding could be if asset returns are low.

expected future benefits payable) based on membership of the scheme at March 31 2020. At that date assets were approximately £66.5 billion. Estimates of future payments in nominal terms depend on life expectancy, retirement dates and on future inflation. We use the USS assumptions on these variables. We use the same assumed path for future consumer prices (to which payments are indexed) to deflate the projected future nominal (money value) payments back into a path for real (inflation adjusted) payments. We project forward the level of assets by taking paths for real returns on assets and in each period subtracting the real pension payments due to scheme members. The cash flow payments based on pension promises made to members at March 2020 stretch far into the future; the last of such payments is projected to be made in 2102 (though the scale of payments is projected to be very small after 2085, some 65 years ahead). We will show the distribution of assets at the point at which the last projected payment is made and also at earlier points. In so doing we are not accounting for future contributions nor for the accrual of new pension benefits. This is not an assumption that the scheme closes; it is an assessment of whether the assets held in 2020 will be sufficient to pay pension promises that then existed given possible paths for asset returns. We make different assumptions on the stochastic processes generating returns and consider different mixes of safe and risky (but higher average return) assets. For each assumed portfolio mix of safe and risky assets we consider fund assets might evolve with an unchanged portfolio mix. This means assets are rebalanced each year to preserve the share of risk assets to safe assets.

1 Asset Returns and Portfolio Mixes

We assume there are two types of assets: those with certain real returns and risk-assets that have uncertain returns whose mean value is above that available on safe assets to reflect a risk premium. Index linked gilts, if held to maturity, provide a close to certain real yield and are available with maturities stretching out to 50 years. These are safe real assets. We think of risk assets as equities - which have been by far the largest component of riskier (non-bond) assets of UK pension schemes including the USS.

We model the return on risky assets, R_t^e, - which we will call equities - as the sum of an expected component and a random component. We assume that the log return, $r_t^e = \log R_t^e$, is normally distributed with a stochastic component, e_t, that could be independent across periods or might be serially correlated so as to allow a degree of mean reversion.

When the returns on risky assets are identically and independently distributed (i.i.d.) over time (i.e. there is no mean reversion) the process for the log of equity returns is assumed to be

$$r_t^e = \mu + e_t$$

where μ is the mean log return (which we assume does not changes over time) and e_t is a normally distributed random shock with mean of zero and variance of σ_e^2, (that is $e_t \sim N(0, \sigma_e^2)$), and is uncorrelated from one period to the next. We take a period to be one year.

If returns on risky assets display mean reversion there will be negative serial correlation in the stochastic component - large negative (positive) returns will tend to be followed by a series of less dramatic but slightly higher positive (negative) returns. We allow for this possibility in a more general model of equity returns, where now the stochastic component is now a moving average process

$$e_t = v_t + \sum_{i=1}^{q} \beta v_{t-i}$$

where the shock v_t is normally and i.i.d. , $v_t \sim N(0, \sigma_v^2)$, $\beta < 0$. (The variance of the shock, σ_v^2, is fixed such that variance of the stochastic component is σ_e^2 as before). The variable q refers to the length of the MA process; clearly if $q = 0$, then we have our original model.

There is much evidence on the long run properties of real returns on equities. Jorda et al (2018) report real returns on portfolios of equities from many countries over a period stretching back into the nineteenth century. They report an overall average arithmetic real return on all stocks of around 6.5% and with a standard deviation of 22%. Other studies report somewhat lower average real returns on socks and lower volatility. Anaarkulovaa et al (2019), for example, report an average annual real return on UK stocks from 1841 of 5.7% and a standard deviation of annual returns of around 13%. These figures for average returns make no allowance for the cost of investing - that is the reduction in return as a result of paying fees to fund managers and the loss in return from bid-ask spreads and other transaction costs. Such costs will be lower for very large investors than for retail investors but could still be somewhere between 0.25% and 0.5%. The past averages also come from periods when the return on safe assets was generally higher than the real safe rate available in 2020; this means that if the risk premium on equities is comparable with the past the average real return on equities is now somewhat below its past average. With these two factors in mind we take the average real return on equities (net of investment costs) to now be 4.5%. With real returns on safe assets at around -2.5% this implies an equity risk premium of around 7% - a figure in line with long run historic averages, but higher than has been thought plausible in recent years. This average assumed return of 4.5% is also slightly above the average return on equities assumed by the USS. The standard deviation of annual arithmetic returns we set to be 17.5%. We set the parameters μ and σ_e (which are for log returns) to generate annual average arithmetic returns, and the volatility of those annual returns, at these levels.

When returns on risky returns are independent (no mean reversion), the variance of returns over the longer horizon rises 1 for 1 with the investment horizon; thus the variance of 10 years returns is 10 times the variance of one year returns. With mean reversion ($\beta < 0$ and $q > 0$) the variance rises more slowly with the investment horizon. There is some evidence in the literature to support some mean reversion in returns: Cochrane (2001) reports a 10 year variance ratio of 0.68 for US stocks (that is the variance of 10 years returns is only 6.8 times the variance of one year returns) using data up to 1996; Smithers (2021) estimates this ratio to be just over 0.6 based on US stock market data up to 2018. When we allow for mean reversion, we set $\beta = -0.05$ and $q = 9$ to generate a variance ratio of 0.67; hence a large negative (positive) shock to returns will tend to be followed over the next 9 years by a small positive (negative).

Setting the safe real rate, R_t^f, is a much easier task because there has been a deep and liquid market in index linked bonds of varying maturities for many years. At the time of the March 2020 assessment the index linked yield curve was fairly flat with bonds offering an annual real return (if held to maturity) of close to -2.5% for maturities up to around 20 years and closer to -1.7% for longer maturities. By mid 2021 yields had fallen even further and the yields curve remained relatively flat but at a level of yields at near -2.5% or lower. In the simulations we use the level of real yields on index linked gilts as it was at March 2020 to generate a path of returns on safe assets year by year into the future. Some investors believe such yields are unsustainable and that yields will rise from here forwards; however these investors have been consistently disappointed so far. Nonetheless we allow for such mean reversion in some of our simulations; in some simulations we set real returns available on safe assets at a much higher level of 0%.

We consider outcomes for various portfolio allocations with the share in risky assets,α, varying from 75% down to 25%; with the share of safe assets being the other $(1-\alpha)$ percent. If the initial level of assets (at time $t = 0$) is denoted A_0, and the payments made each period t by the fund on pensions is p_t then the fund assets evolve over time as

$$A_t = \left(\alpha R_t^e + (1-\alpha) R_t^f\right) A_{t-1} - p_t.$$

The final period is the last one in which p_t is positive; the USS estimate that based on pension rights accrued at March 2020 this will be early in the next century (at 2102).

For each of our scenarios (which differ either by our assumption on the return generating process, or by the portfolio allocation to risky assets) we generate 100,000 possible future paths based on realizations of normally distributed random shocks to returns. Based on the different paths, we estimate the likely distribution of fund assets at the end of each period until the final period. If the assets remain positive for the entire path until the last pension payment is paid, then we record the surplus in the final period. However, if assets turn negative in any period then the fund has been exhausted end and the deficit or fund liability is the value of the remaining pension to be paid. In practice there would some action would be taken along the way if it became likely that the fund would finish with a large surplus - money could be returned to Universities or pension benefits could be enhanced ; and if it looks as if it was likely that fund was to become exhausted then either contributions from Universities and USS members could be increase, or pension benefits reduced. The net assets of the scheme with no adjustments is an indication of the scale of such adjustments that would be needed. If assets are allowed to become so negative that no rescue of the scheme is possible then those with future claims would take a hit - possibly a severe one if the pension insurer is unable to finance most of the shortfall and unless there is a bailout of the scheme.

In the simulations we find that in many cases assets are exhausted before all pensions have been paid. In such cases we calculate what the present value of future pensions yet to be paid is using the real return on bonds as the discount factor applied to future real pension payments. The resulting value is a good estimate of what would need to be paid to an insurance company to take on the pension liabilities that are due but which cannot be paid by the scheme because it has exhausted its assets. This would be an amount due to be paid by Universities if they were to fulfill pension promises after the fund had been exhausted and the promises were to be made good by a third party.

We present several different statistics to help gauge the risk of different outcomes. The key ones are the proportion of the time the USS runs out of assets and the scale of the pensions yet to be paid when assets are exhausted. We also show the chances of different values for the surplus when all pensions have been paid in those cases where assets do not run out.

2 Results

Figure 1 shows the present value of remaining pension liabilities over time. Here we discount remaining pensions due at each point in time by the real safe rates at each period. We use the forward rates as existed at March 2020 to create one estimate of these present values; we also show how those liabilities evolve if real yields were to have moved sharply higher and rather than stay at around -2.5% rise to 0%. These two measures of liabilities are only relevant if the scheme runs out of assets - they show the cost of passing on the requirement to pay remaining pension promises to another financial institution if the USS were to run out of assets and could no longer pay pensions.

Figures 2 to 5 show the key features of the distribution under 4 different set of assumptions; the first two, our base cases, are for an allocation of 75% and then an allocation of 25% to risky assets given real rates are as they were priced in the market as of March 2020 and expected returns to risky assets are +4.5% with no tendency to mean revert. The final

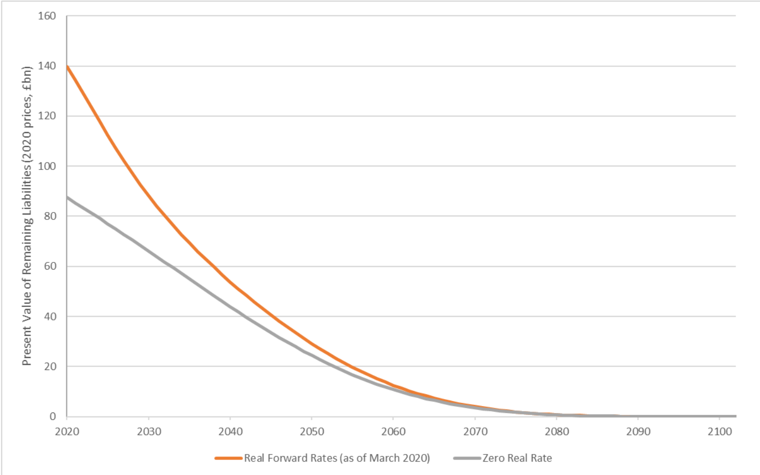

Figure 1: Present value of remaining pension liabilities

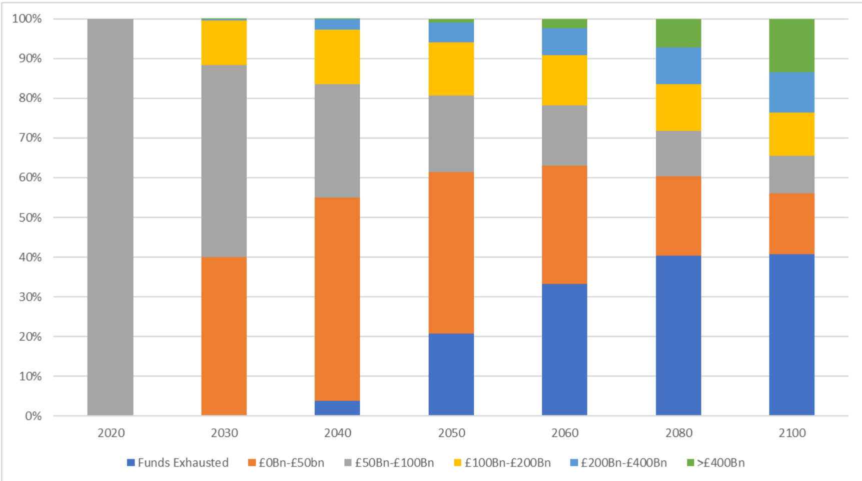

Figure 2: Projected Distribution of USS Fund Assets assuming 75% allocation to equities, no mean reversion in equity returns and real rates as of March 2020.

two take a more optimistic view (a best case, if you like) of likely returns. Again we present for both an allocation of 75% and 25% to risky assets but now we assume real rates are 0% into the future and there is some mean reversion in the returns to risky assets. Volatility of the risk assets is set so the standard deviation of 17.5% in all four cases. Figure 2 shows the distribution of outcomes in our base when there is a 75% allocation to equities, in Figure 3 is for the more cautious case when only 25% is allocated to equities.

Figures 4 and 5 allow for mean reversion in risky assets returns. This makes the volatility in asset returns over longer horizons significantly lower (by about one third) than with no mean reversion while the returns over one year have the same volatility. In these figures safe real returns are set to be much higher at 0%. Both these changes relative to the base case make these scenarios much more optimistic about asset returns. Furthermore we do not price in a sharp downward adjustment in equity prices when the yield on safe bonds

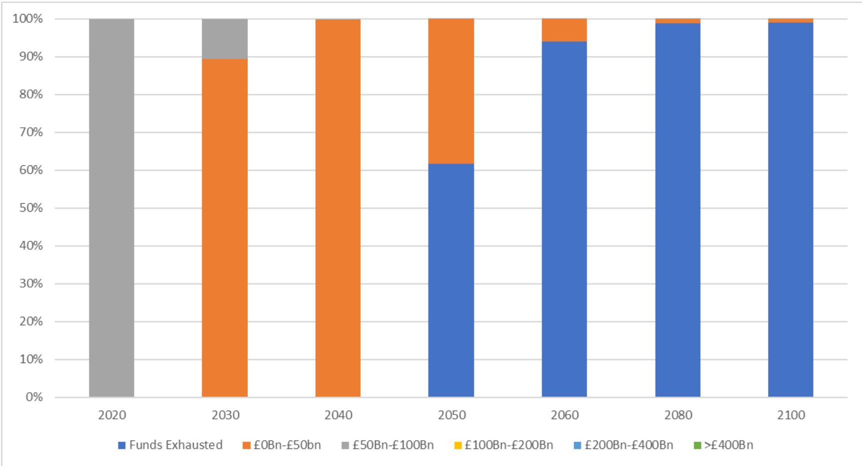

Figure 3: Projected Distribution of USS Fund Assets assuming 25% allocation to equities, no mean reversion in equity returns and real rates as of March 2020.

rises sharply up to 0%, though in practice this seems likely to happen. So the results in figures 4 and 5 are even more optimistic than many scenarios which assume a rise in bond yields.

In each of the figures we show the probability that assets fall into different ranges at different times. The blue bars show the proportion of outcomes where the fund has been exhausted by different dates. Figure 2 shows that there is a 40% probability of the USS running out of funds before all pension promises have been met. About 30% of the time the USS runs out of assets by 2056. Figure 1 shows that if the fund runs out of assets at precisely 2056 the cost of making good on future pension promises would then be around £18 billion. So there is a 30% chance the deficit when the fund's assets are exhausted is *at least* this large. But there is a substantial chance that the fund has run out of assets sooner than 2056. There is a 15% chance the fund is exhausted by 2047 at which time the remaining pension promises are a liability that would cost around £35 billion to pass onto a third party. Despite these substantial risks of exhausting assets the chances are that the USS would be able to pay pensions and have a surplus. Figure 2 shows a 60% chance that there are assets remaining when all pensions have been paid. The size of those potential surpluses are large - a 15% chance they are of a size up to £50 billion and a significant chance (of almost 25%) that they exceed £200 billion. So the chances of a huge surplus *and* of a huge hole in the pension scheme are *both* high.

Figure 3 shows that with a much more cautious asset allocation the chances of the fund being exhausted before all pensions have been paid is very high. There is near certainty that funds would be exhausted by around 2070 and even by 2050 there is a close to 60% that assets have been exhausted. This assumes that real interest rates stay at levels of end March 2020 meaning that a real return of around -2.5% is all that is available on safe real

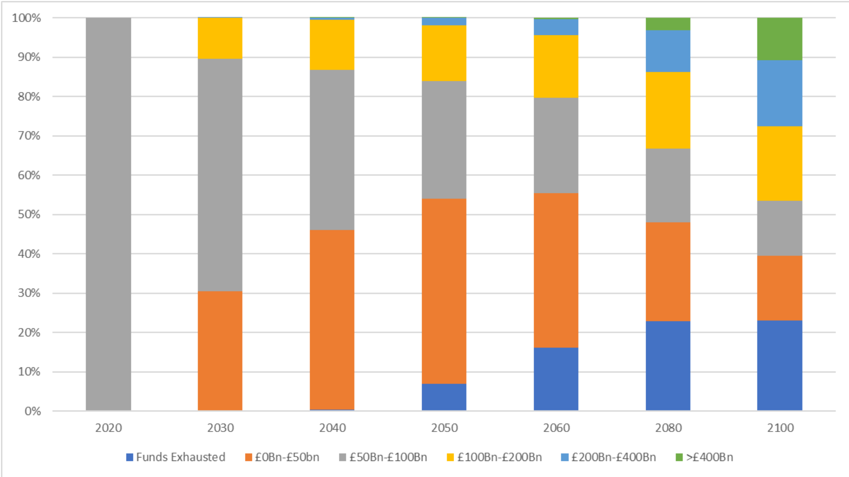

Figure 4: Projected Distribution of USS Fund Assets assuming 75% allocation to equities, mean reversion in equity returns and future real rates of 0%.

assets. Even then there is virtually no chance that assets are exhausted within the next 20 years and so if real interest rates were to rise substantially over the next couple of decades things would not be quite so bleak.

Figures 4 and 5 show some of those less bleak outcomes. Here we combine an assumption of substantially higher returns on safe assets and also assume that there is mean reversion which much reduces the risk of holding equities over long horizons. But figure 4 still shows there is significant risk of running out of assets when equities make up 75% of assets. The chance of that happening at some point is 23%. The chance of assets being exhausted by 2060 - at which point unpaid pensions would cost around £11 billion to pass on even with much higher real interest rates - is around 16%. There is a 10% chance that assets have run out at some point before 2054 - when remaining promises have a value of *at least* £18 billion. But once again the chances of the USS having surplus assets at the end are higher than the chances of it running out of money - there is a 75% chance of some surplus and a 28% chance of a surplus of at least £200 billion.

Figure 5 shows the more favourable scenario but with a much more cautious portfolio with 75% invested in safe real bonds. The chances of fund exhaustion at some point is now higher at around 72%. By 2060 there is a one in three chance the USS is out of money when the remaining cost of pension promises is at least £10 billion.

3 Conclusion

The relative size of the assets USS holds and of its commitments to pay pensions far into the future means that it is challenging to find an investment portfolio that means that its pension promises will be met with very high probability. Investing a substantial share

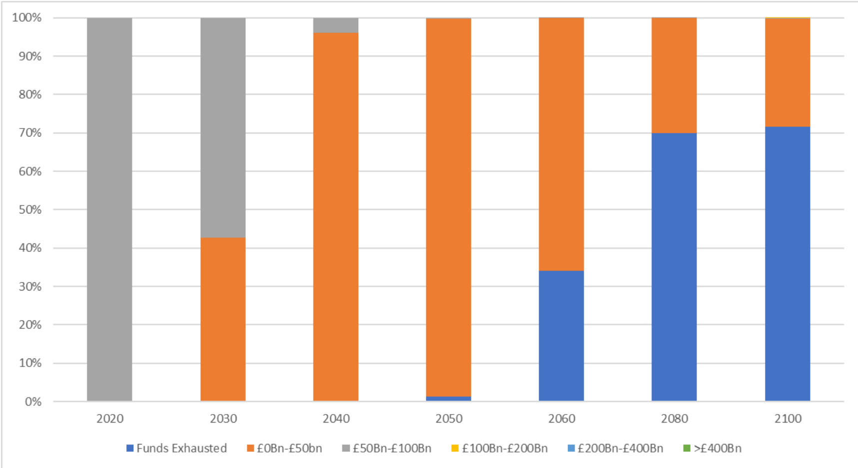

Figure 5: Projected Distribution of USS Fund Assets assuming 25% allocation to equities, mean reversion in equity returns and future real rates of 0%.

of assets in high (average) return risky assets means that it is more likely than not that pension promises can be met *and* that a substantial surplus will be generated; but it also creates a significant probability - often 30% or more - that assets would run out before all pensions have been paid. Allocating 75% of funds to risk assets means that *on average* a very substantial surplus of comparable size to the *total* current stock of assets is generated. Some would call this a comfortable position and one which does not require any adjustment to current contribution rates or any downward adjustment in the generosity of new pension promises. But that portfolio generates at least a one in four chance that there is a shortfall in funds down the road that is often tens of billions of pounds. Whether Universities would be able to make up such a huge shortfall is unclear.

Our results do not show that the USS has a huge deficit any more than they show that it has a comfortable surplus. What they do show is that the more likely outcome is that current assets are more than enough to make good on existing pension promises, but there is also a significant probability (as high as 40% in some of our simulations) that the funds could be exhausted leaving the universities with a sizeable liability to cover.

If what is needed is a stock of assets that makes it highly improbable that assets run out before all pensions are paid then assets would need to be very much larger; this reflects the fact that the cost of a guaranteed pension is an expensive thing to credibly offer. Whether current assets are nonetheless sufficient to make the risks of running out of funds acceptable is far from clear. It depends on the appetite to take risks of those who would face the consequences of returns on existing assets being insufficient to fund existing pension promises. At the moment, the risk of that happening is almost certainly substantially larger than the chances of losing a game of Russian roulette. This is not a sustainable position.

How can risks of assets being insufficient to pay promised pensions be brought down to more acceptable levels? We do not put forward a specific proposal. Instead we make three points that those who must negotiate a way forward should recognise:

1. If there is to be near certainty that existing pension promises can be fully met then more assets need to be accumulated. This will involve a rise in contributions from those who continue to make them and must be at a rate that is significantly in excess of what is needed to finance the new pension promises.

2. Conditional indexation, or a transition to a form of conditional defined contribution scheme, (where the generosity of newly accrued pension rights is conditional on future fund performance) can create an incentive for future contributors to opt out of the USS scheme and into an alternative savings scheme that has no overhang.

3. If risk is to be shared then it is desirable (and possibly only sustainable) if it is shared across all generations and not placed only on younger, contributing scheme members. That raises potential issues of legality if existing pension rights could be deemed to have been retrospectively altered.

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