Financial Markets & Risk

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Session 6

Understanding the liabilities
Scheme assets & contribution/asset allocation strategy
Introducing VaR
Understanding the risks
Dealing with

- interest rate risk
- inflation risk
- longevity risk

Summary

May, 25th, 2014

The defined benefit pension promise

There are thousands of occupational pension plans in the UK

The defined pension benefit is a pre-defined amount. It is generally based upon:

- the number of years that someone has been a member of the scheme;
- the value of the member's 'final pensionable salary' just before they retire;
- and a pre-specified accrual rate.

For example:

$$\text{Annual pension} = \frac{Number\ of\ Years\ in\ Scheme}{80} \times Final\ Pensionable\ salary$$

$$Annual\ Pension = \frac{20}{80} \times £30{,}000 = £7{,}500$$

$$Tax\ Free\ Lump\ Sum = \frac{3}{80} \times 20 \times £30{,}000 = £22{,}500$$

The risks inherent in liabilities

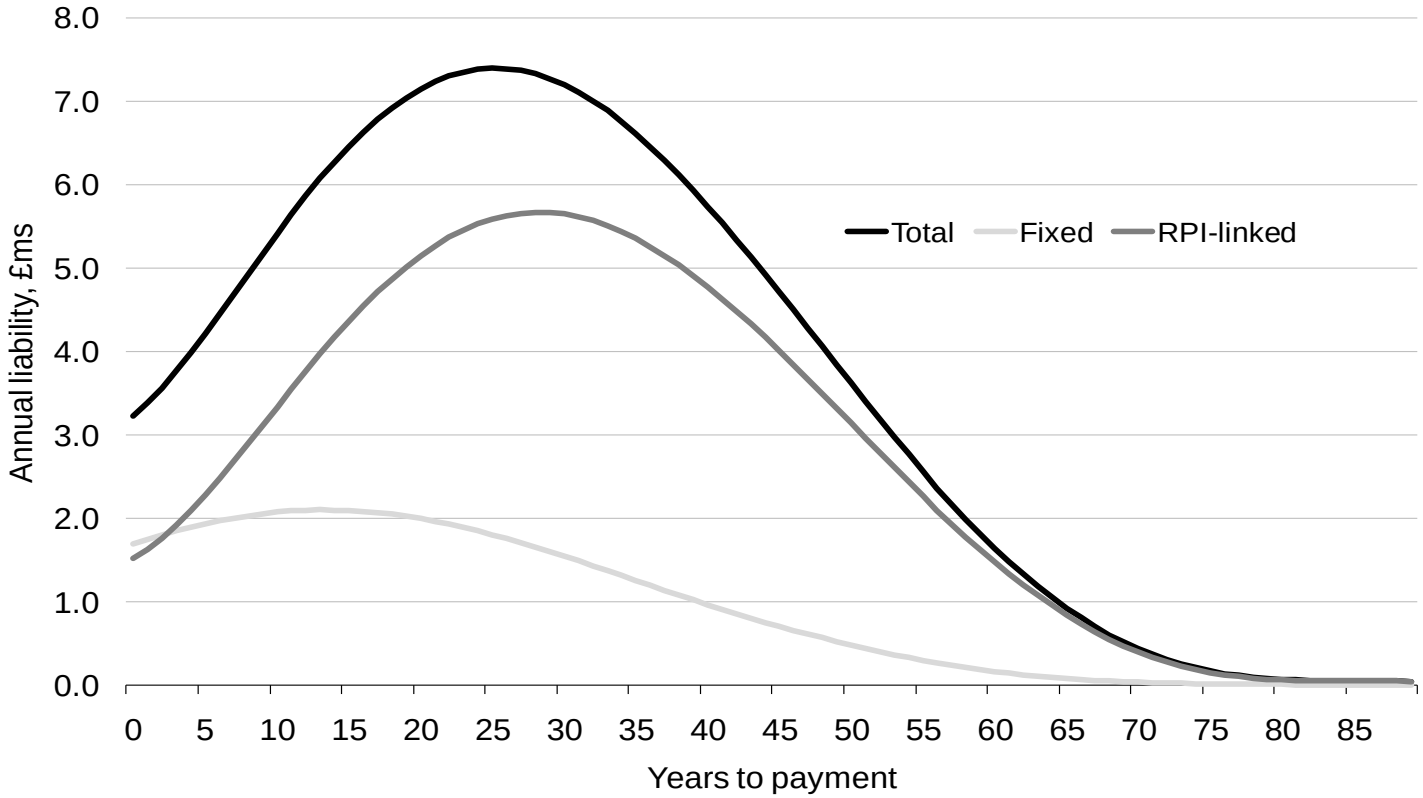
The pension promise:

- payment of pension until death (or the death of your dependents')
- a fixed pension promise: like issuing a conventional bond
- an inflation-linked pension promise: like issuing an index-linked bond

The members:

- Actives
- Deferreds
- Pensioners

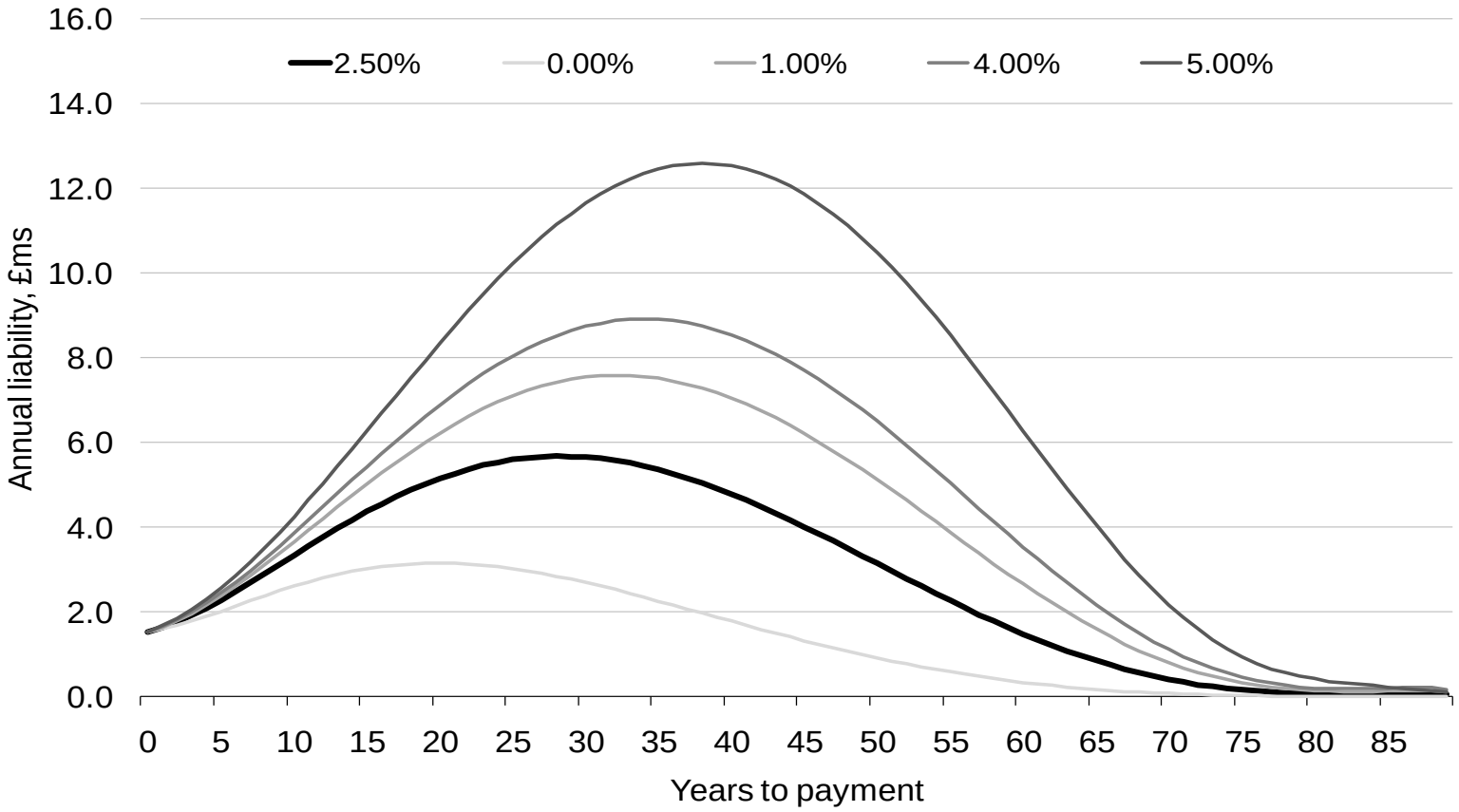
Fixed v inflation-linked cash flows



Pension promise prior to 1997 fixed, after 1997 LPI(0,5), Limited Price Indexation s the Retail Prices Index (RPI) capped at 5%

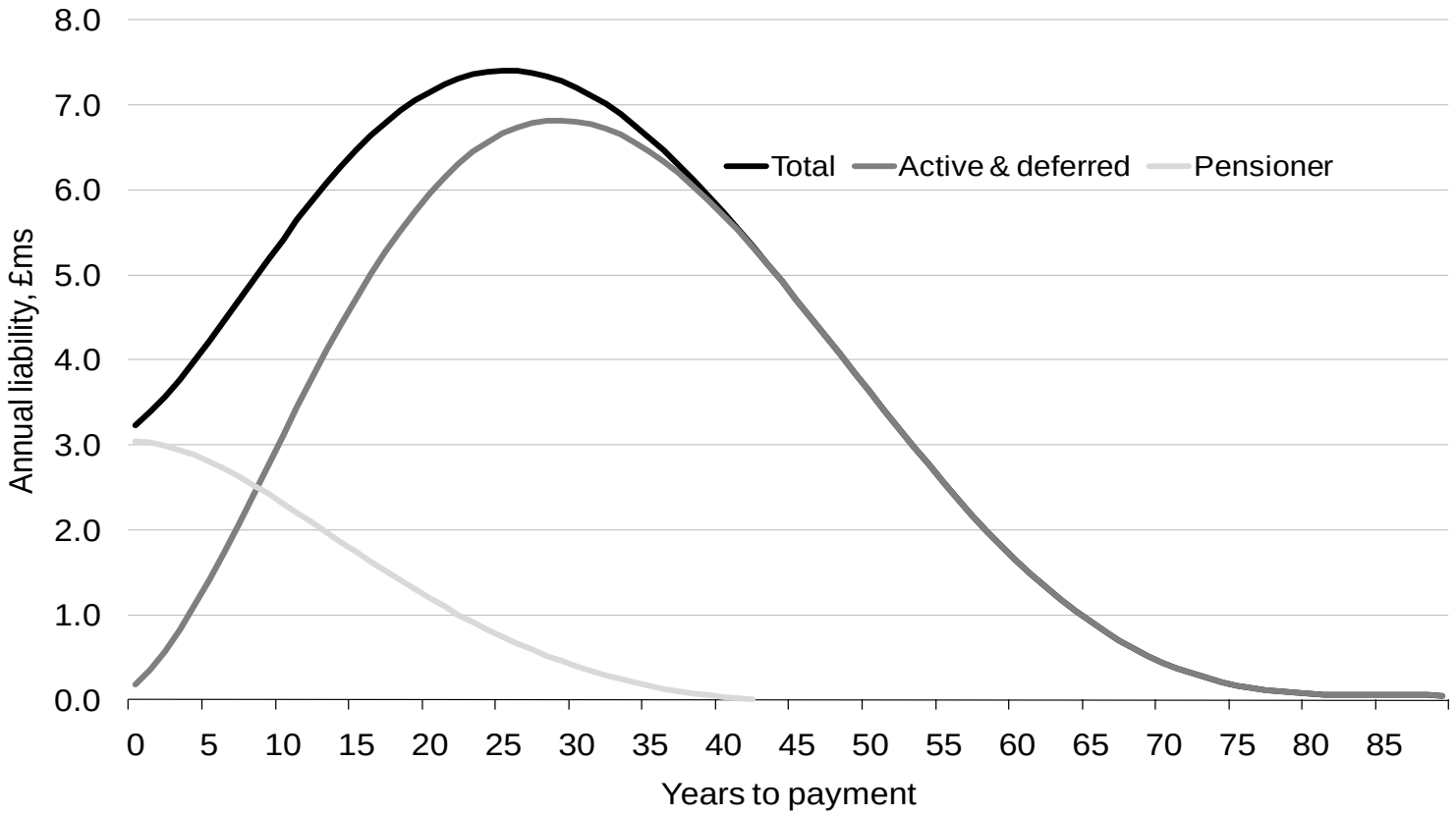
Significant inflation exposure in this scheme

The impact of inflation



Changing the assumption with regard to the inflation component of wage growth can have a big impact on future inflation-linked pension promises

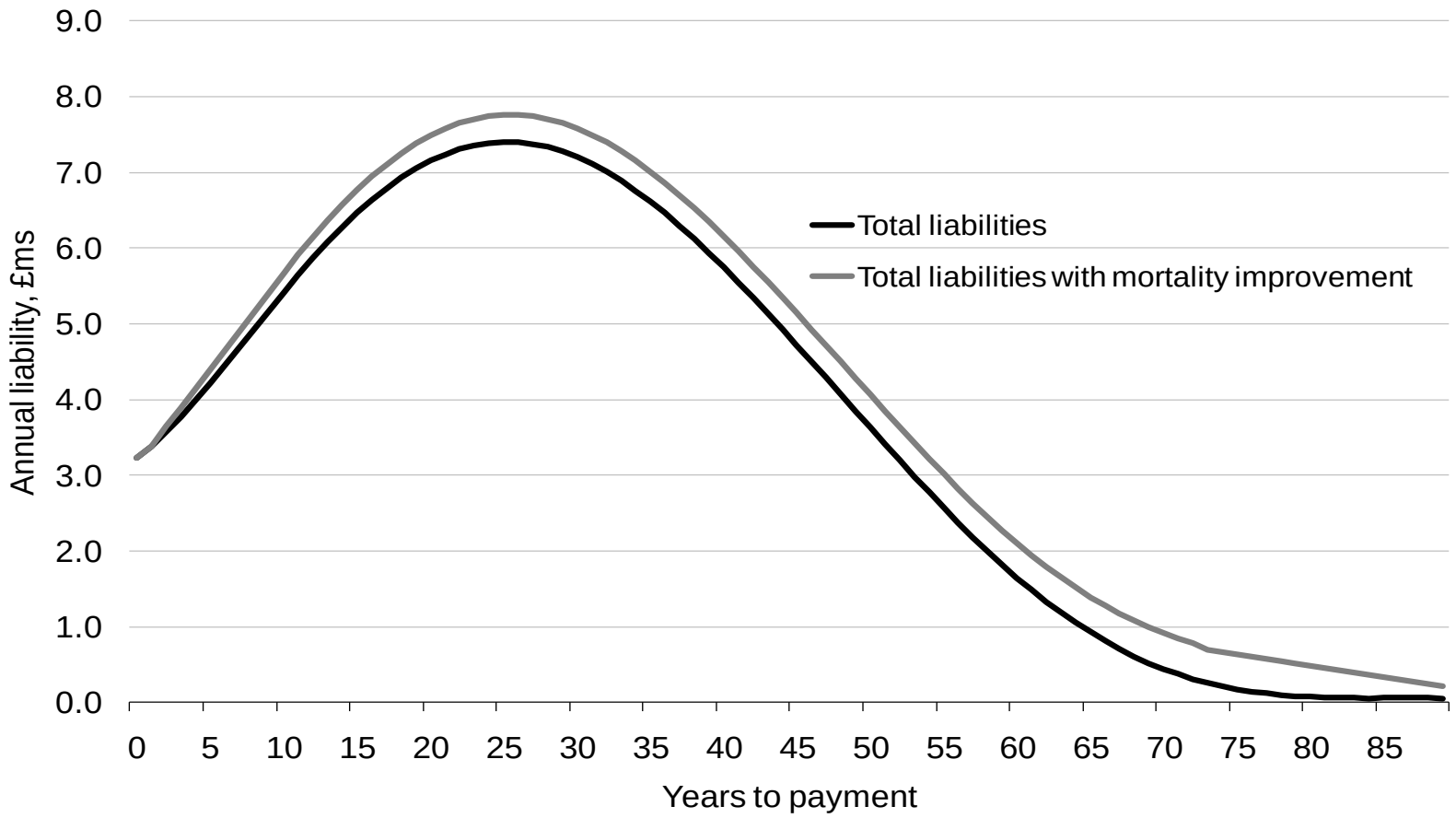
Make up of membership



Deferred and active members represent the bulk of pension fund liabilities

This is typical of many schemes

Till death us do part …



If we increase membership life expectancy by 1 year the PV of liabilities rises by 5%!!

Discounting the liabilities

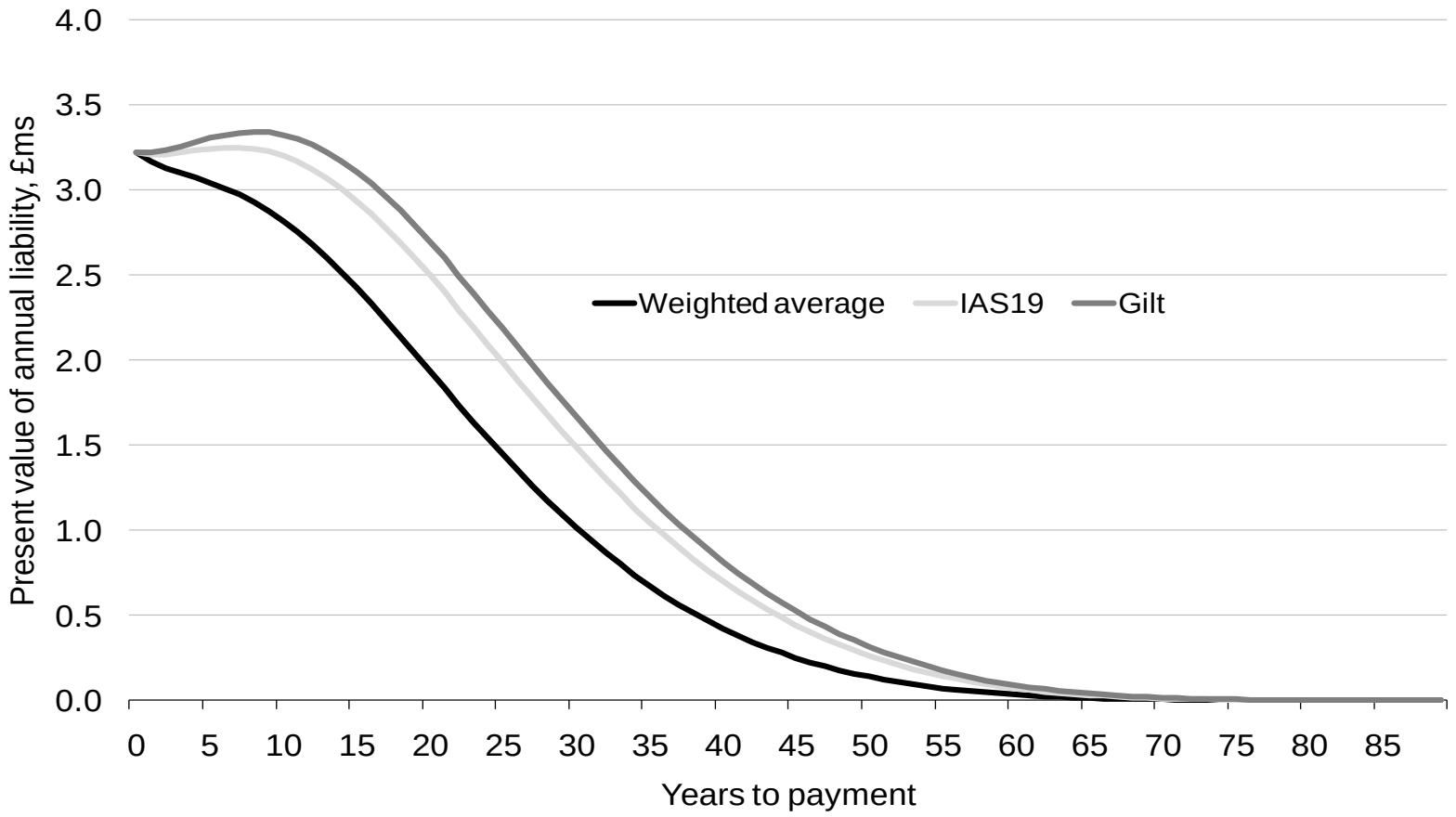
Why do we discount pension liabilities?

The multi-billion pound question: what discount rate should we apply ?

- weighted average return on assets
- ‘AA’-rated bond yields (FRS17/IAS19)
- gilt yields

Does the discount rate represent yet another source of risk?

What difference does it make …



Should the chosen discount rate affect investment policy ?

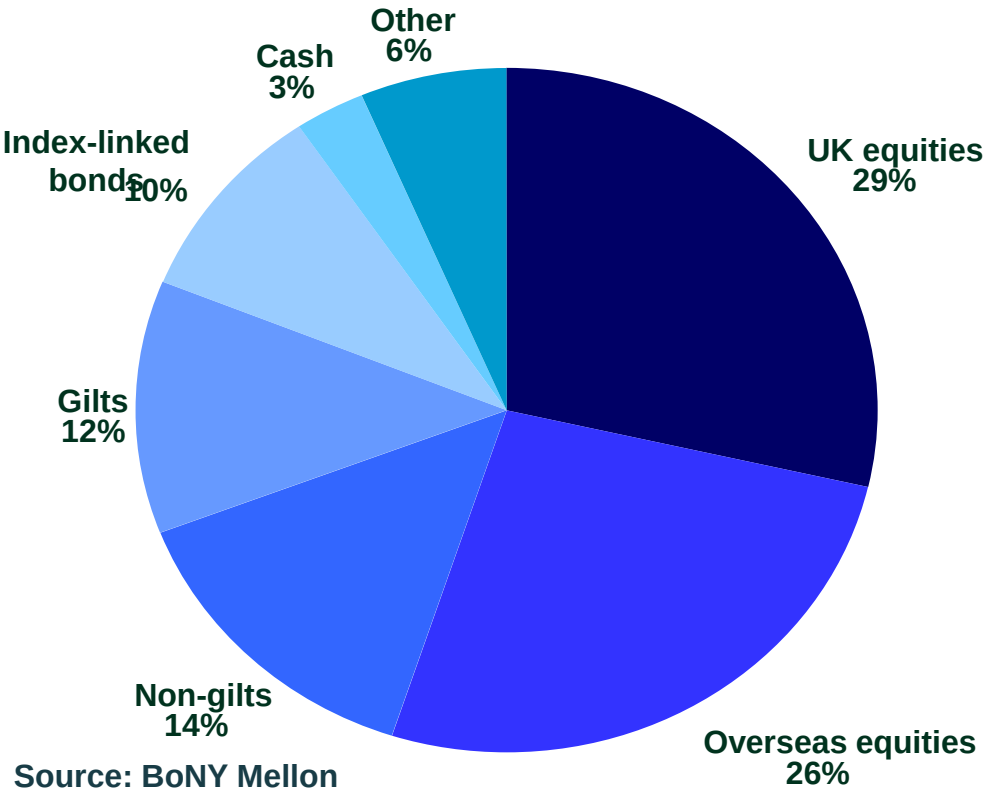
Scheme assets & contribution/asset allocation strategy

The risks inherent in scheme assets

Asset allocation:

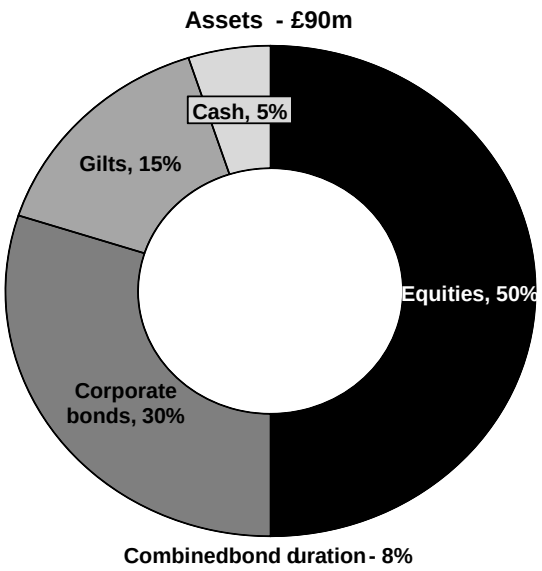
- what return will the assets produce … over the next few decades ?
- how volatile will these returns be ?
- how correlated will the returns be ?
- should asset allocation be static, or dynamic ?

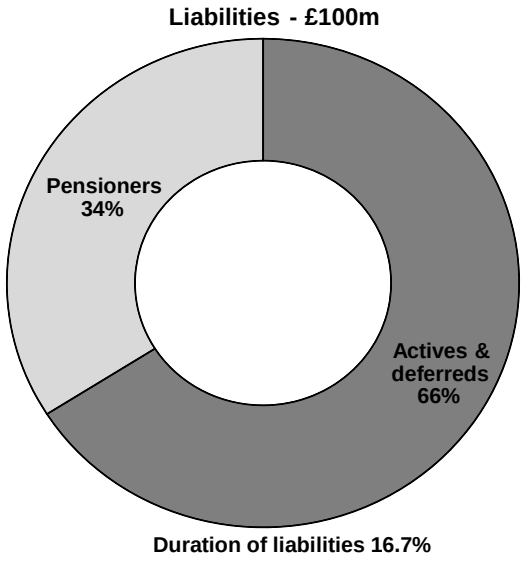
UK DB pension assets



Equities still comprise the majority of scheme assets, though UK equities now represent a much smaller proportion of total equity holdings

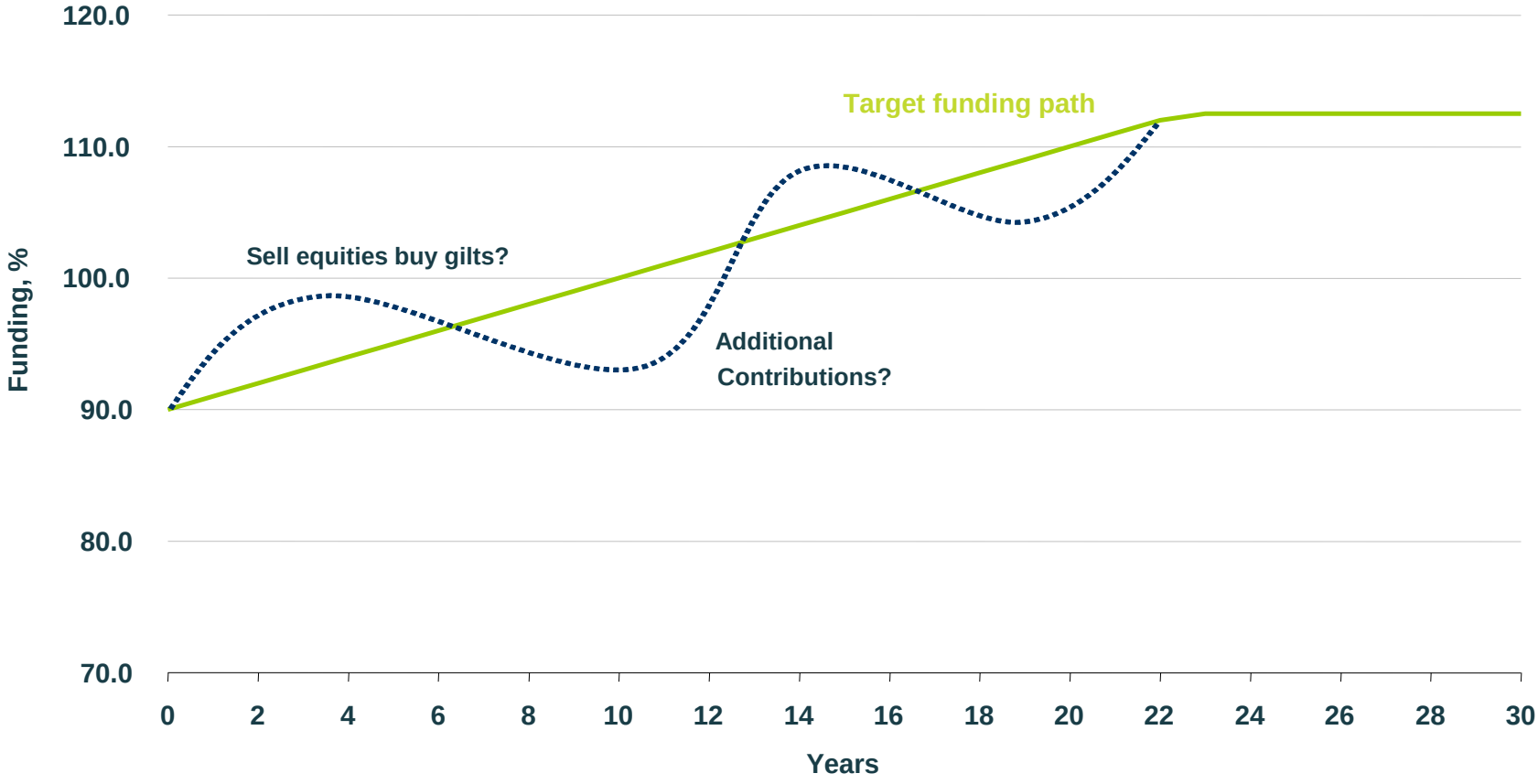
Scheme assets v scheme liabilities





There is a clear duration discrepancy. This is not untypical.

Contribution/asset allocation strategy



Fail to plan, plan to fail

What happens when the scheme is above or below its path?

Introducing VaR

What is risk ?

Relates to uncertainty about future outcomes based around some expectation

In the context of pension schemes we now realise that we need to understand the risks surrounding:

- liabilities
- Assets
- sponsor contributions and
- the correlations between all of these elements

There are a number of ways of quantifying risk, VaR is one of the more popular techniques

What is VaR ?

Introduced by JP Morgan in the 1980s

VaR is the maximum percentage loss (or £ amount) that a portfolio may be expected to suffer over a defined future holding period at a given probability (confidence level)

VaR is a widely applied risk management technique

"*There is no more than a 5% chance that a loss of greater than $10m will be experienced over the next twelve months*"

Why is VaR so popular?

It asks the simple question: "*How bad can things get ?*"

It captures an important aspect of risk in a single number

It is easy to interpret – makes simple statements

It applies to all financial instruments/positions – including the funding position of a pension scheme – for example …

"*There is no more than a 5% chance that the funding ratio will be lower than 75% in ten year's time*."

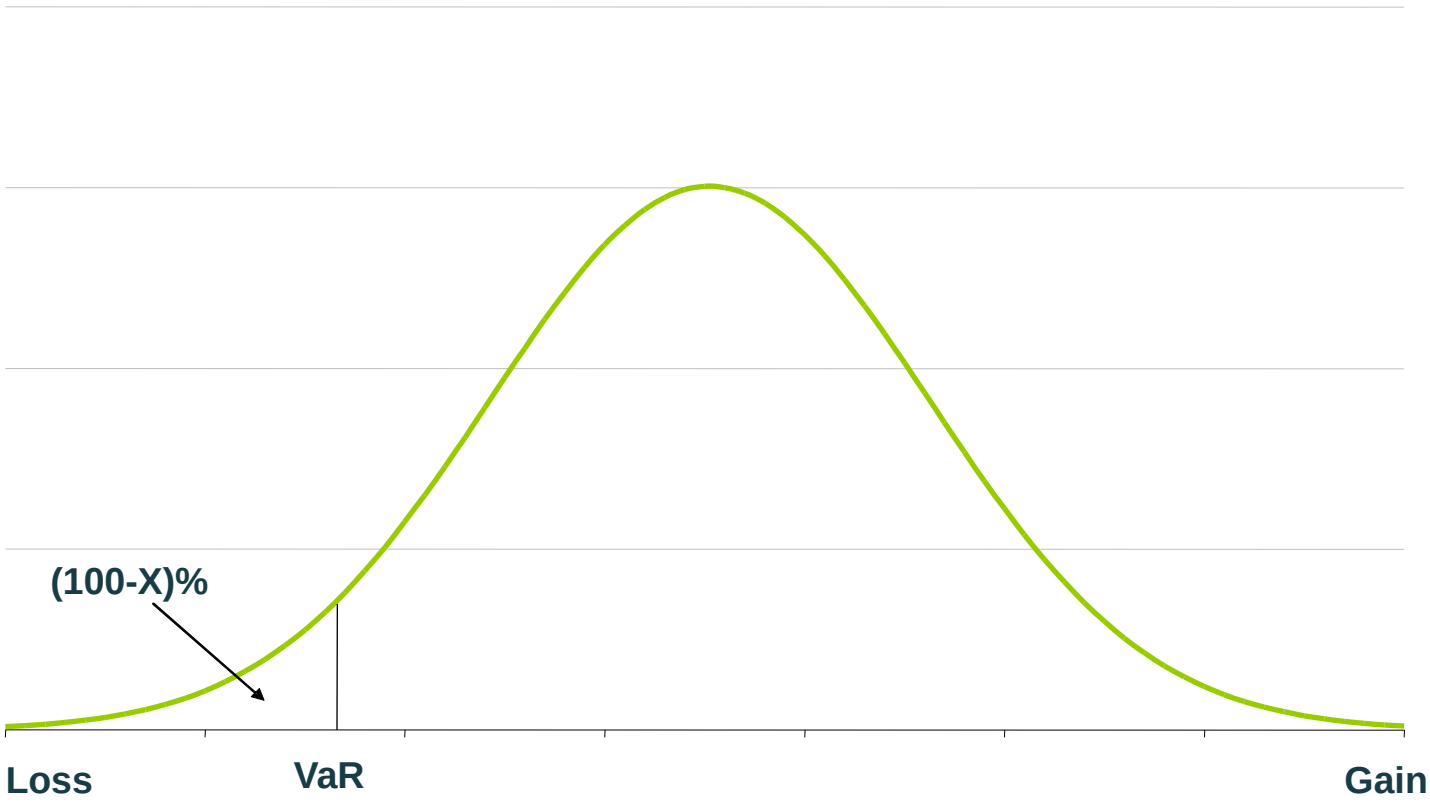
VaR depends on…

- The holding period (T):
  - usually one day, one week or one month, depending on liquidity of relevant markets (time required to liquidate portfolio)
  - but for pension funds one year is often used

- The confidence level (P):
  - typically in the range of 95-99%, so that VaR measures extreme losses that can occur with a small probability of say 1%-5%

- Composition of asset portfolio

A picture of VaR



Here we assume that the return distribution of the portfolio is “normal”

Historical v Monte Carlo simulation

Historical simulation

- Take periods in past and test the assumptions of the model
- Make sure VaR is not violated

Monte Carlo simulation

- A more sophisticated, forward looking approach
- Assume distribution for asset class returns/correlations
- Simulate scenarios
- Then recalculate the VaR

Historical Simulation to Calculate the One-Day VaR

Suppose we use 501 days of historical data (Day 0 to Day 500)

Let v_i be the value of a variable on day i

There are 500 simulation trials

The ith trial assumes that the value of the market variable tomorrow is:

$$v_{500}\frac{v_i}{v_{i-1}}$$

Example:

Calculation of 1-day, 99% VaR for a Portfolio on Sept 25, 2008

Index	*Value ($000s)*
DJIA	4,000
FTSE 100	3,000
CAC 40	1,000
Nikkei 225	2,000

Date	*DJIA*	*FTSE 100*	*CAC 40*	*Nikkei 225*
Sep 25, 2008	11,022.06	5,197.00	4,226.81	12,006.53

Data After Adjusting for Exchange Rates

Day	*Date*	*DJIA*	*FTSE 100*	*CAC 40*	*Nikkei 225*
0	Aug 7, 2006	11,219.38	6,026.33	4,345.08	14,023.44
1	Aug 8, 2006	11,173.59	6,007.08	4,347.99	14,300.91
2	Aug 9, 2006	11,076.18	6,055.30	4,413.35	14,467.09
3	Aug 10, 2006	11,124.37	5,964.90	4,333.90	14,413.32
…	……	…..	…..	……	……
499	Sep 24, 2008	10,825.17	5,109.67	4,113.33	12,159.59
500	Sep 25, 2008	11,022.06	5,197.00	4,226.81	12,006.53

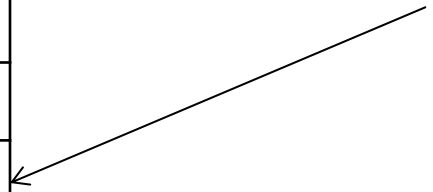
Scenarios Generated

Scenario	*DJIA*	*FTSE 100*	*CAC 40*	*Nikkei 225*	*Portfolio Value ($000s)*	*Loss ($000s)*
1	10,977.08	5,180.40	4,229.64	12,244.10	10,014.334	−14.334
2	10,925.97	5,238.72	4,290.35	12,146.04	10,027.481	−27.481
3	11,070.01	5,118.64	4,150.71	11,961.91	9,946.736	53.264
…	…….	…….	…….	……..	…….	……..
499	10,831.43	5,079.84	4,125.61	12,115.90	9,857.465	142.535
500	11,222.53	5,285.82	4,343.42	11,855.40	10,126.439	−126.439

Example of Calculation: $11{,}022.06 \times \frac{11{,}173.59}{11{,}219.38} = 10{,}977.08$

Ranked Losses

Scenario Number	*Loss ($000s)*
494	477.841
339	345.435
349	282.204
329	277.041
487	253.385
227	217.974
131	205.256



99% one-day VaR

The N-day VaR

The *N*-day VaR for market risk is usually assumed to be $\sqrt{N}$ times the one-day VaR

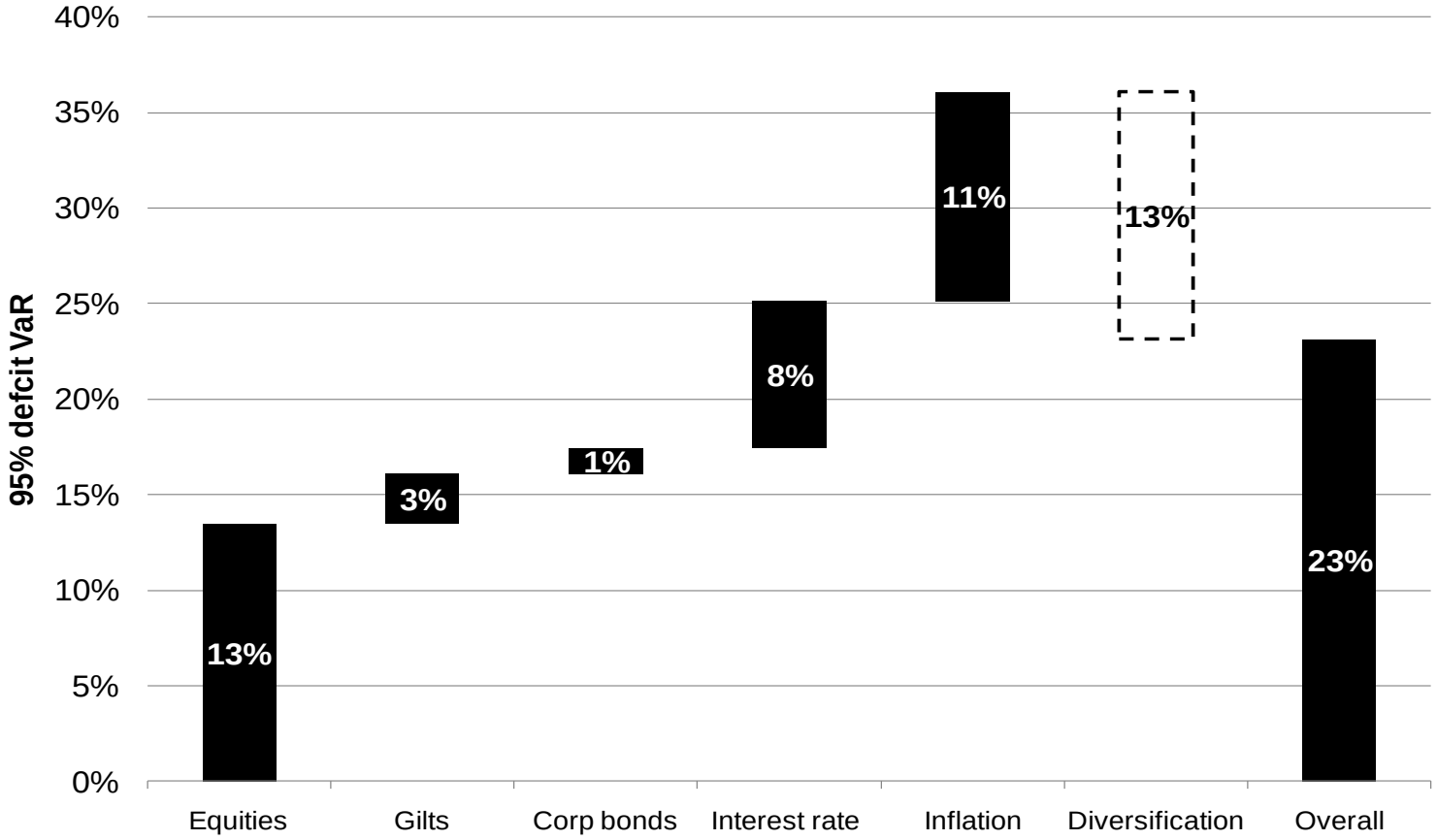
In our example the 10-day VaR would be calculated as:

$$\sqrt{10} \times 253{,}385 = 801{,}274$$

This assumption is in theory only perfectly correct if daily changes are normally distributed and independent

Breaking VaR down

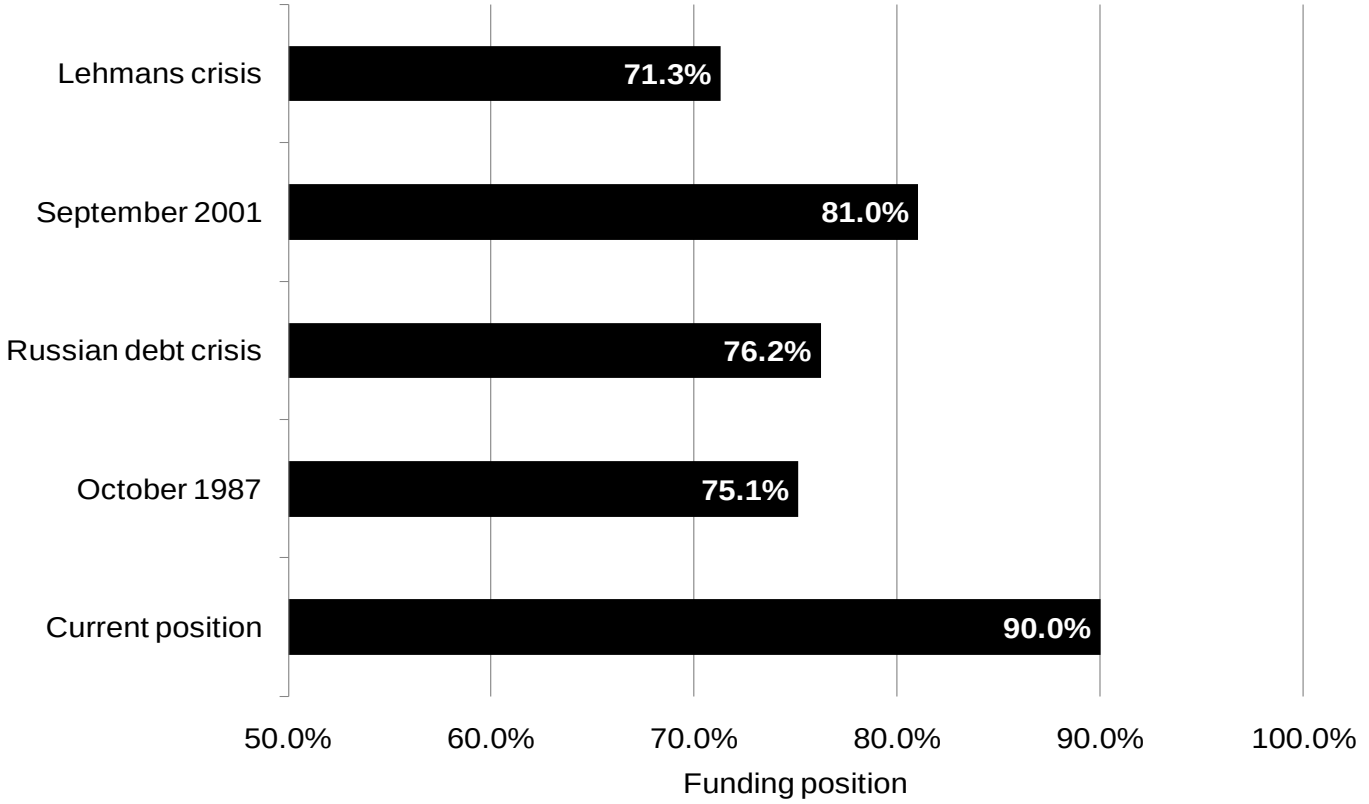
We can calculate the overall VaR (95%) of the scheme, but we can also break down that VaR into its component parts



Understanding the risks

Looking at the VaR of the scheme and of its component parts is certainly helpful but other metrics and types of analysis can also be helpful:

Scenario analysis



Most scheme's could not survive another Lehmans, because of the 'dead weight loss' involved

Reducing scheme risk

Remember that a significant component of the deficit VaR of the scheme (13%) comes from equities

So why not sell equities to reduce it ?
The answer is that this would reduce the "expected return on the scheme's assets, possibly capitalising the deficit

This is why scheme's now categorise their assets as:

- matching assets
- growth, or return seeking assets

It also means that they seek other ways of reducing the risk, in particular the use of interest and inflation swaps

Some risks may not be worth taking

There are clearly many elements to the risks faced by a typical scheme, but investment is always about risk

Equity risk may well be worth taking

However, there are some 'unrewarded' risks that might be worth avoiding:

- interest rate risk
- inflation risk
- longevity risk

Arguably these risks are "not rewarded"

Dealing with interest rate risk

Swaps and interest rate risk

Interest risk can be better managed by choosing an appropriate bond portfolio and duration matching

Dealing with inflation risk

Incorporating an inflation swap

The problem: meeting RPI (Retail Price Index) payments in the future and the uncertainty related to the future size of those payments

The solution: get someone else to commit to making the payments

So…

receive RPI cash flows equivalent to RPI-related liabilities in return pay an equivalent fixed rate of interest

Dealing with longevity risk

Longevity the real risk

In the late 1940s the average UK male would have been lucky to make it to 72, and many never made it to 65, but:

- according to the ONS, in 2009 the average 65 year old male in the UK was expected to live for 17.8 years and female 20.4 years
- the difference between the life expectancy of a 65 year old male living in Kensington and Chelsea compared to a 65 year male living in Glasgow is 9.8 years
- in January 2011, the DWP (Department for Work and Pensions) estimated that nearly 11 million people alive today, around 17 per cent of the population, would live to 100
- by 2066 the UK could be home to half a million centenarians