

CPD Quiz

Spotlight on Value Sensitivity in Pensions

Question 1

A zero coupon bond with a 5 year maturity, is trading at 78.35 on a yield of 5.00%.

What is the percentage value change if rates change and the bond's yield moves to 4.5%?

- (a) 10%
- (b) 4.8%
- (c) 2.4%
- (d) 1%
- (e) Don't know

Answer

The right answer is (c) 2.4%

Recalculation gives a new value for the ZCB of 80.25, a change in price of 2.42%. Using modified duration would be perhaps easier – the duration of the ZCB is 5 years and the modified duration is $5/(1+5\%) = 4.76$. This is the proportional movement in price, so price change = original price \times Dmod \times rate change – putting in the numbers, $78.35 \times 4.76 \times 0.005 = 1.86$, predicting that the new price should be 80.21. Or simply take the modified duration to be the proportional change for 1% movement, and halve it for a 0.5% movement.

Question 2

You have been asked about the investment portfolio of your pension fund. The trustees have recently attended a seminar run by investment consultants who have persuaded them that the fund's value sensitivity can be reduced by careful attention to the correlation coefficient between the assets chosen as investments.

Which gives the least value sensitivity?

- (a) +1, perfect correlation
- (b) +0.5, some relationship but not that close
- (c) 0, no correlation
- (d) -1, perfectly negatively correlated
- (e) Don't know

Answer

The right answer is (d) -1, perfectly negatively correlated

Portfolio theory tells us that we can improve our portfolio risk / return trade off through diversification. This reduces risk without affecting return, the least effect is achieved by spreading the portfolio across similar, or highly correlated investments. The greatest effect is achieved by spreading the portfolio across very dissimilar investments, i.e. those which are perfectly negatively correlated.

While the portfolio return is given by the weighted average of returns of the components, risk is given by combining standard deviations. For two assets the formula is:

$$\text{Portfolio SD} = \sqrt{a^2\sigma_a^2 + b^2\sigma_b^2 + 2\rho a\sigma_a b\sigma_b}$$
 where
a is the proportion of asset a
 σ_a is the SD of asset a
b is the proportion of asset b
 σ_b is the SD of asset b
 ρ is the correlation coefficient of a with b

As can be seen, the value is least when ρ is at its maximum negative value, -1.

Question 3

You have a significant portfolio of financial assets whose value at risk has been quoted as x at 95% confidence level. If you increase the confidence level to 99% what is the likely impact on the value at risk?

- (a) an increase of 61%
- (b) an increase of 43%
- (c) an increase of 21%
- (d) a reduction of 21%
- (e) don't know

Answer

The right answer is (b) an increase of 43%

For a one-tailed distribution (normally used in VaR analysis) the 5% probability is given by a movement of 1.65 standard deviations from the mean. The 1% probability, used to determine the 99% confidence is given by a movement of 2.33 standard deviations from the mean. So increasing the confidence level from 95% to 99% requires a shift from 1.65 standard deviations to 2.33 standard deviations. This is an increase of 43%

Question 4

As the time of your annual pay reviews is approaching you have been giving a talk to the various managers within your organisation. You want them to understand the true cost of giving above average pay rises to people in your defined benefit scheme just before their retirement.

Mr J Jones will retire in a few months aged 60 on a salary of £45,000. His life expectancy is 24 years and, under the terms of the pension he will receive a pension of 30 / 60ths of his final salary with no inflationary increases. As he has been a faithful servant to the company over his 30 years service it has been proposed to indicate gratitude with a final 12% salary increase in the final month of his service. The increased salary will be the effective final salary for pension calculation.

What is the increase in liability to cover Mr Jones's pension due to this salary increase if discount rates are 5%?

- (a) £25, 103
- (b) £37,256
- (c) £48, 877
- (d) £61,749
- (e) don't know

Answer

The right answer is (b) £37,256

Currently, the liability for Mr Jones's pension is given by the annuity of 30/60th of his current salary for 24 years. The annuity factor (at 5% discount rate) is 13.80 so the liability is £22,500 × 13.80 = £310,500.

If his salary increase is 12% then his pensionable final salary is £50,400 and 30/60th is £25,200. The new liability is £25,200 × 13.80 = £347,760 i.e. an increase of £37,260. (The numbers here include a small amount of rounding).

Alternatively cheat and use the simple pre-formatted worksheet for annuities at

http://www.formularium.org/en/_fm/40/_ma/60/10.html

Question 5

You have become aware that proposals by the ASB in January 2008 take the view that the fairest value of pension liabilities is given by using the gilt yield as the discount rate, rather than the AA bond rate. Unfortunately this gives a higher value for those liabilities.

Your pensions fund has a duration of 30 years. If the difference between the AA corporate bond rate, currently 5%, and the relevant gilt yield is 30 basis points, what is the increase in value of pension liabilities?

- (a) 2%
- (b) 5%
- (c) 9%
- (d) 12%
- (e) don't know

Answer

The right answer is (c) 9%

If the duration of liabilities is 30 years, then the liability behaves like a 30 year zero coupon bond. At 5% discount rate a 30 yr ZCB is valued at 23.14% of its redemption value.

Discount factor for a cash flow in 30 years is $= \frac{1}{(1 + 0.05)^{30}} = 23.14\%$

If the rate were to fall by 30 bp to 4.7% then the value of the ZCB would rise to 25.21% of redemption value. This is an increase of 8.95%

Question 6

At present the longevity assumption used by many pension schemes is that a pensioner retiring at age 65 will live for a further 23 years. Your pension fund has made this assumption with further assumptions being that annual inflationary pension increases will be 2.5% per annum and that the relevant discount rate is 5%.

For a pensioner retiring now, what percentage increase in the pension liability will result from increasing the longevity assumption by 1 year to 24 years?

- (a) 8.1%

- (b) 4.6%
- (c) 3.2%
- (d) 1.4%
- (e) Don't know

Answer

The right answer is (c) 3.2%

The answer can be found either by calculating the value of a growing annuity (difficult) or by the difference between two growing perpetuities (easier). This answer details the easier method below.

The value now (Year 0) of a growing perpetuity starting at 100 in Year 1 with a 5% discount rate and 2.5% growth is given by
$$\frac{\text{cash flow}}{(\text{discount rate} - \text{growth rate})}$$

From this we can subtract the value of the future perpetuity, starting in Year 24, to leave the residual cash flows from Year 1 to Year 23 inclusive. The future perpetuity, starting in year 24 will be given by the same formula, but the initial cash flow will be different (it will have grown), and it must be discounted back to present value to be comparable with the first perpetuity value.

The sums go as follows:

$$\text{Initial Perpetuity} = \frac{100}{5\% - 2.5\%} = 4,000$$

$$\text{Future Perpetuity} = \frac{100 \times (1 + 2.5\%)^{23}}{(5\% - 2.5\%)} = 7,058$$

$$\text{PV of future perpetuity} = 7,058 \times (1 + 5\%)^{-23} = 2,298$$

So the PV of the set of growing cash flows from Year 1 to Year 23 inclusive = 4,000 – 2,298 = 1,702

Increasing the length of time for which the cash flows are paid to 24 years, using the same logic, gives the results:

$$\text{Initial perpetuity} = 4,000$$

$$\text{Future Perpetuity} = 7,235$$

$$\text{PV of future perpetuity} = 2,243$$

$$\text{PV of liability} = 1,757$$

i.e. an increase of 55 over the original value, or 3.2%

Alternatively, cheat as before, and use the simple pre-formatted worksheet for annuities at http://www.formularium.org/en/_fm/40/_ma/60/10.html