TUTORAL ASSESSMENT TASK 4 – INTEREST RATE RISK MEASUREMENT USING DURATION AND CONVEXITY MEASURES

You have just purchased option-free bonds issued by James Technology Limited at a market price of $97.18 per bond. The purchased bonds have a 6.80% per annum coupon interest rate, with coupon interest payments made semi-annually, a $100 par value and a 10-year maturity term. Based on the $97.18 purchase price, the bonds are currently trading at a bond-equivalent (annual) yield of 7.20%. Historical volatility estimates indicate that interest rates are likely to vary by at least 150 basis points during the 10-year maturity term, and you have calculated that a 50 basis point increase and decrease in the current yield will lead to changes in the bond price to $93.80 and $100.72, respectively.

1) Calculate the modified duration of the James Technology Limited bond based on a 50 basis point (Δy) change in yield. (2 marks)

$V_0 = \$97.18$
$V_- = \$100.72$
$V_+ = \$93.80$
$\Delta y = 0.0050$

$$Duration = \frac{\$100.72 - \$93.80}{2(\$97.18)(0.0050)} = 7.1208\%$$

2) Calculate the modified convexity adjustment for the James Technology Limited bond based on a 150 basis point (Δy_*) change in yield. (3 marks)

$$C = \frac{\$93.80 + \$100.72 - (2 \times \$97.18)}{2(\$97.18)(0.0050)^2} = 32.9286$$

Convexity adjustment $= 32.9286 \times (0.0150)^2 \times 100 = 0.7409\%$

3) Using your answers to parts 1) and 2) above, calculate the approximate percentage price change in the James Technology Limited bond for a 150 basis point increase in yield using the convexity-adjusted duration approach. (2 marks)

Expected change based on modified duration $= -7.1208 \times 0.0150 \times 100 = -10.6812\%$
Convexity adjustment $= 0.7409\%$
Approximate percentage price change $= -10.6812\% + 0.7409\% = -9.9403\%$

4) James Technology Limited also has callable bonds on issue. These bonds also offer a 6.80% per annum coupon interest rate (with semi-annual payments) and have a 10-year maturity term. The bonds are callable at the $100 par value at any point during the maturity term. The bonds are currently trading at $95.81, which represents a market required bond-equivalent yield of 7.40% per annum. Explain whether modified or effective duration would be the preferred method to use to determine the interest rate risk of these callable bonds, and outline the yield outcomes that will result in both methods providing identical duration approximations. (3 marks)

As these bonds are callable, it is possible that cash flow outcomes may differ at different underlying yield levels, and the nature of the price-convexity curve may also change as a result of the call option effects. In this situation, the modified duration method is inappropriate as it assumes that yield changes do not impact on a bond's expected cash flows. Effective duration is the preferred method to apply, as it takes into account both the discounting effect of yield changes and also any changes in underlying cash flows as a result of the yield change.

Both the modified and effective duration methods should provide identical duration approximations at yield levels greater than the bond coupon rate (greater than 6.80%). This is because the call option is 'out of the money' within this range and not worth exercising, resulting in an option value of zero and the callable bonds exhibiting the same price volatility and convexity characteristics as the equivalent option-free bond.