King Saud University

Department of Mathematics

Tutorial 6 - Semester 461

ACTU 371 – Financial Mathematics

Exercise 1.

You are given the following information with respect to a bond:

(i) par value: 1000
(ii) term to maturity: 3 years
(iii) annual coupon rate: 6% payable annually

You are also given that the one, two, and three year annual spot interest rates are 7%, 8%, and 9% respectively.

Calculate the value of the bond.

Exercise 2

You are given the following information with respect to a bond:

(i) par value: 1000
(ii) term to maturity: 3 years
(iii) annual coupon rate: 6% payable annually

You are also given that the one, two, and three year annual spot interest rates are 7%, 8%, and 9% respectively.

The bond is sold at a price equal to its value.

Calculate the annual effective yield rate for the bond i.

Exercise 3

The current price of an annual coupon bond is 100. The yield to maturity is an annual effective rate of 8%. The derivative of the price of the bond with respect to the yield to maturity is -700.

Using the bond's yield rate, calculate the Macaulay duration of the bond in years.

Exercise 4

A common stock pays a constant dividend at the end of each year into perpetuity.

Using an annual effective interest rate of 10%, calculate the Macaulay duration of the stock.

(A) 7 years
(B) 9 years
(C) 11 years
(D) 19 years
(E) 27 years

Exercise 5

Kylie bought a 7-year, 5000 par value bond with an annual coupon rate of 7.6% paid semiannually. She bought the bond with no premium or discount.

Calculate the Macaulay duration of this bond with respect to the yield rate on the bond.

(A) 5.16
(B) 5.35
(C) 5.56
(D) 5.77
(E) 5.99

Exercise 6

Krishna buys an n-year 1000 bond at par. The Macaulay duration is 7.959 years using an annual effective interest rate of 7.2%.

Calculate the estimated price of the bond, using the first-order modified approximation, if the interest rate rises to 8.0%.

(A) 940.60
(B) 942.88
(C) 944.56
(D) 947.03
(E) 948.47

Exercise 7

Annuity A pays 1 at the beginning of each year for three years. Annuity B pays 1 at the beginning of each year for four years.

The Macaulay duration of Annuity A at the time of purchase is 0.93. Both annuities offer the same yield rate.

Calculate the Macaulay duration of Annuity B at the time of purchase.

Exercise 8

Cash flows are 40,000 at time 2 (in years), 25,000 at time 3, and 100,000 at time 4. The annual effective yield rate is 7.0%.

Calculate the Macaulay duration.

(A) 2.2
(B) 2.3
(C) 3.1
(D) 3.3
(E) 3.4

Exercise 9

Rhonda purchases a perpetuity providing a payment of 1 at the beginning of each year. The perpetuity's Macaulay duration is 30 years.

Calculate the modified duration of this perpetuity.

Exercise 10

An investor buys a perpetuity-immediate providing annual payments of 1, with an annual effective interest rate of i and Macaulay duration of 17.6 years.

Calculate the Macaulay duration in years using an annual effective interest rate of $2i$ instead of i.