

Birla Institute of Technology and Science, Pilani

MID SEMESTER EXAMINATION, II SEMESTER 2016-17 PART A (Closed Book)

Course Number : ECON F354/ FIN F311

Maximum Marks /Weight: 40 / 20%

ID Number: 2015B3A352SP

Course Title: Derivatives and Risk Management

Time: 60 minutes

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(34)

## Use annual compounding only

1. If the current or spot market gold price is \$ 400 per ounce, the forward market price with one year delivery is \$450 per ounce and the one-year interest rate In US dollar is 4 percent, is there any possibility of arbitrage profit? Will the answer be different if forward market price \$ 400 per ounce? If there exist an arbitrage opportunity, how will you exploit? Give all the calculations to justify your answer. (12 Marks)

We can buy the stock at market spot price of \$ 400, and then take a short position in a future forward with market value = \$ 450 per ounce.

To buy we borrow at the market at 4% interest.

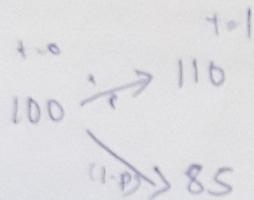
So at  $t=1$  the cost of buying at  $t=0$  is  $= 400 \times (1.04)$

$= \$416$  per ounce.  
So there exists an arbitrage profit  $= \$ (450 - 416)$  per ounce  
 $= \$ 34$  per ounce.

If the forward market price = \$ 400 per ounce there will be no arbitrage opportunity as \$ 400 at  $t=0 \neq$  \$ 400 at  $t=1$ .

\$ 400 at  $t=0$  +  $= \$416$  at  $t=1$  which is  $>$  than \$ 400 so we will incur loss.

A stock currently trades at a price of \$100. The stock price can go up 10% or go down 15%. The risk free interest rate is 6.5%. Use a one-period binomial model to calculate the price of a call option with an exercise price of \$90. (12 Marks)

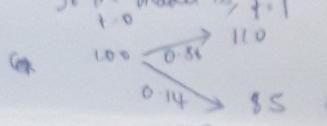


$$\text{at } t=1 \quad \text{Expected value of stock} = 100 \times (1.065) = 106.5 \\ = 110 \times p + 85(1-p)$$

$$\Rightarrow 106.5 = 25p + 85$$

$$\Rightarrow p = 0.86 \quad \frac{21.5}{25} = 0.86$$

So the model is at  $t=1$



~~Given  $C_b > 90$~~   $100 \xrightarrow{0.86} 110 \rightarrow IV \rightarrow 20 \quad (110 - 90)$   
 $\xrightarrow{0.14} 85 \rightarrow IV \rightarrow 0$

At  $t=1$ , Time value = 0 and Intrinsic value = 20. ( $t \rightarrow 2$ )  
Lower branch will not be exercised so its value = 0.  
 $E[t=1]$  of option:  $0.86 \times 20 = \$17.2$

To find the present value we discount at rate of 6.5%.

So the price of call option:  $\frac{17.2}{(1.065)} = \$16.15$  ✓

(12)

The bond prices of zero coupon bonds are given as follows:

- a.  $B(0,1)$  94.34
- b.  $B(0,2)$  87.34
- c.  $B(0,3)$  79.38

$\checkmark \rightarrow \checkmark \checkmark$

Calculate the forward rates for the period of  $1 \times 2$  and  $2 \times 3$ . If a person holds one bond of  $B(0,1)$ , two bonds of  $B(0,2)$  and three bonds  $B(0,3)$ , what will be the portfolio duration? Give all the calculations. (16 Marks)

$$B(0,1) = \frac{100}{(1+y_1)} = 94.34 \Rightarrow y_1 = 5.7\% \approx 6\%$$

$$B(0,2) = \frac{100}{(1+y_2)^2} = 87.34 \Rightarrow y_2 = 7\%$$

$$B(0,3) = \frac{100}{(1+y_3)^3} = 79.38 \Rightarrow y_3 = 8\%$$

Now for  $f_{1 \times 2}$

$$100 \times (1+y_1)(1+f_{1 \times 2}) = 100(1+y_2)^2$$

$$\Rightarrow (1.06)(1+f_{1 \times 2}) = (1.07)^2$$

$$\Rightarrow 1+f_{1 \times 2} = 1.08$$

$$\Rightarrow f_{1 \times 2} = 8\% \text{ (Ans)}$$

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Now for  $f_{2 \times 3}$

$$100 \times (1+y_1)(1+f_{1 \times 2})(1+f_{2 \times 3}) = 100 \times (1+y_3)^3$$

$$\Rightarrow 1+f_{2 \times 3} = \frac{(1.08)^2}{(1.08) \times (1.08)}$$

$$\Rightarrow 1+f_{2 \times 3} = 1.10$$

$$\Rightarrow f_{2 \times 3} = 10\% \text{ (Ans)}$$

Term Structure			
Period	Zero Rates	Forward Rates Period	Forward rates
0 - 1	6%	0 - 1	6%
0 - 2	7%	0.1 - 2	8%
0 - 3	8%	2 - 3	10%

### Duration Calculation

$$\begin{aligned} \text{Price of Portfolio} &= 1 \times B(0,1) + 2 \times B(0,2) + 3 \times B(0,3) \\ &= 94.34 + 2 \times 87.34 + 3 \times 79.38 \\ &= 507.16 \end{aligned}$$

$$\text{Weightage of } B_1 = \frac{94.34}{507.16} \approx 0.186$$