

# INSTITUTE OF ACTUARIES OF INDIA

## EXAMINATIONS

**05<sup>th</sup> May 2016**

**Subject CT8 – Financial Economics**

**Time allowed: Three Hours (10.30 – 13.30 Hrs.)**

**Total Marks: 100**

### INSTRUCTIONS TO THE CANDIDATES

- 1. Please read the instructions on the front page of answer booklet and instructions to examinees sent along with hall ticket carefully and follow without exception.*
- 2. Mark allocations are shown in brackets.*
- 3. Attempt all questions, beginning your answer to each question on a separate sheet.*
- 4. Please check if you have received complete Question Paper and no page is missing. If so, kindly get new set of Question Paper from the Invigilator.*

**AT THE END OF THE EXAMINATION**

**Please return your answer book and this question paper to the supervisor separately.**

- Q. 1)** Comment on which form of market efficiency is supported/contradicted by the following scenarios:
- i) Market over reacts to the news and corrects itself over couple of trading sessions. (1)
  - ii) An investor earns returns that are significantly higher than those predicted by a log-normal model fitted for a particular index using technical analysis. (2)
  - iii) Equity yields are correlated with the yields implied in the last three trading sessions and show an element of mean revision over a 4-5 year timeframe. (2)
- [5]**
- Q. 2)**
- i) A stock price is currently Rs. 400. Assume that the expected return from the stock is 17% and that its volatility is 30%. Derive and determine the probability distribution for the rate of return (with continuous compounding) earned over a period of two years? State your assumptions. (4)
  - ii) Derive the differential equation of stock price S on the basis of your assumption in part 2(i). (3)
  - iii) Suppose that F is a function of a stock price S. Let  $\sigma_S$  and  $\sigma_F$  are the volatilities of S and F respectively. Show that when the growth rate on S increases by  $\pi \sigma_S$ , the growth rate of F increases by  $\pi \sigma_F$ , where  $\pi$  is a constant (5)
- [12]**
- Q. 3)** There are two equity stocks with correlation coefficient of '-0.6' listed in a market with the share price, mean return and variance as shown in the following table. Short-selling is not permitted in the market and one cannot have infinitely divisible holdings:

	Share Price (Rs.)	Returns	Volatility
Share A	100	10%	10%
Share B	200	12%	25%

An investor wants to invest Rs. 10000 for one year in the market and approached you for advice.

- i) Calculate the proportion of funds that you will advise the investor to invest in Share A if the variance on the portfolio is to be minimized. Hence calculate the expected return on the portfolio. (*Hint:  $x_A = \frac{V_A - C_{AB}}{V_A + V_B - 2C_{AB}}$* ) (3)
  - ii) How would your answer change if the correlation coefficient is +0.6 (2)
  - iii) Comment on risk appetite of the investor for whom the above advice would be appropriate. (1)
- [6]**

- Q. 4)** A financial advisory company is conducting a survey to check applicability of behavioural finance theories to a particular population and has devised the following questionnaire. According to you which theme of behavioural finance is the advisory trying to survey by asking each of the following questions?
- i) Would a prior investment decision that resulted in a loss stop you from making a similar decision, even if the new investment appears to be the best alternative? (1)
  - ii) How frequently do you review your investment portfolio? (1)
  - iii) A popular analyst has commented that markets are expected to provide returns in excess of 15% in the coming year. Will you invest in equities with a hope to earn atleast 15% for next year? (1)
  - iv) Would you prefer to manage your portfolio yourself or rely on views of expert analysts? (1)
- [4]**

- Q. 5)** A portfolio manager has recently announced a derivative which would pay off  $S_T^K$  at time T where  $S_T$  is the stock price at time T and K is constant. It is known to the investors that stock price follows Geometric Brownian motion with drift  $\mu$  and volatility  $\sigma$  and the price of the derivative at time t is  $f(t, T)S_t^K$
- i) Using Black Schole's PDE, derive a differential equation satisfied by  $f(t, T)$ . (4)
  - ii) Determine boundary condition satisfied by  $f(t, T)$ . (2)
  - iii) Show that  $f(t, T) = \exp\left(\left(-r(K - 1) - \frac{1}{2}\sigma^2 K(K - 1)\right)(T - t)\right)$  where r is the risk free rate of interest rate. (4)
  - iv) Show that the process is a martingale if  $\mu = r(K - 1)/K$  (4)
- [14]**

- Q. 6)** An individual has disclosed the level of premiums he is prepared to pay to secure against the following events:
- i) Property insurance = Rs. 300,000 against total loss of property and contents including cash amounting to Rs. 10, 00,000. (Probability of event = 25%)
  - ii) Property insurance = Rs. 150,000 against total loss of property but without contents amounting to Rs. 500,000 (probability of event = 15%)

The individual has also stated that he would prefer to take a certain Rs. 500,000 than take a gamble which pays Rs.1,000,000 with 60% probability.

Sketch a graph of investor's utility function for the region (Rs. 500,000 to Rs. 1,000,000)

**[5]**

- Q. 7)** i) The price of a stock currently stands at Rs. 250. The stock price is expected to be either Rs. 400 or Rs. 200 after a 3 months period. The risk free rate of interest with quarterly compounding is 8% per annum. Given that the strike price is Rs. 250, calculate the value of the three month European put option. (3)
- ii) Verify that the no-arbitrage argument and risk neutral valuation gives the same answer. (4)
- [7]

- Q. 8)** A portfolio manager is managing a well-diversified portfolio of Rs. 50cr which closely follows the BSE Sensex. He has been given a mandate to hedge the portfolio from a potential reduction in value by more than 10% in the next 6 months to come.

The current value of the BSE Sensex is 25,000, risk free rate is 6.0% per annum and dividend yield on the portfolio he is managing is 4% per annum whereas that of the Sensex is 3% per annum, volatility of the index is 30% and Beta of the portfolio is 1.5

- i) How much cost would the portfolio manager incur if he decides to hedge the portfolio by buying appropriate European options? (7)
- ii) Suggest and quantify an alternative strategy for the portfolio manager resulting into the same hedge (3)
- iii) Determine the delta of the portfolio and the amount of risk free securities he needs to hold to delta hedge the portfolio (5)
- [15]
- Q. 9)** List the desirable characteristics of term structure model and confirm whether these are met by Cox-Ingersoll-Ross model. [6]

- Q. 10)** Currently a company has the following position:

Asset	= Rs. 100 crore
Volatility of its assets	= 25.00 %
Risk free rate	= 8.00 %

Company is in need of fresh capital for its projects and wishes to raise the same by issuing zero coupon bonds that will mature after 5 years. The amount to be paid on redemption would be Rs. 90 crore.

- i) Under Merton Model, determine the probability of default on the debt raised by the company clearly stating the assumptions made. (10)
- ii) Determine the annualized yield on the zero coupon bonds. (1.5)
- iii) Determine the recovery ratio based on 2 state model assuming probability of default same as that calculated in (i) but the company wants to maintain the credit spread at 25 basis points. (2.5)
- iv) Describe different types of models that can be used to model Credit Risk. (5)
- [19]

**Q. 11) i)** State the difference between Capital Market Line and Security Market Line (2)

**ii)** Show that a portfolio p which lies on security market line (SML) is not an efficient combination of the riskless asset and the market portfolio if  $\rho(r_p, r_m) < 1$  where  $\rho$  is the correlation coefficient of the portfolio and the market returns  $r_p$  and  $r_m$  respectively. (5)

[7]

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