INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

10th November 2008

Subject CT8 – Financial Economics

Time allowed: Three Hours (14.30 – 17.30 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. However, answers to objective type questions could be written on the same sheet.*

4) *In addition to this paper you will be provided with graph paper, if required.*

AT THE END OF THE EXAMINATION

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

Q 1) a) Describe the form of below mentioned activities according to Efficient Market Hypothesis (EMH) in an idealistic world.

- Stock prices traded in a regulated stock exchange
- Merger activities
- Lottery system

(3)

b) Semi-strong form of EMH suggests that an investor can't beat the market in long term. Suggest some reasons if a particular investor outperforms the market systematically over long period. (2)

[5]

Q 2) a) Describe any five measures of investment risks. (10)

b) Assuming the historical one year default probability for AA rated bonds has mean of 0.1% and standard deviation of 0.09%. Calculate the value at risk for a portfolio of Rs. 5,000 crores in 1 in 400 years. Assume default probability to be normally distributed. (2)

[12]

Q 3) a) Define

- Opportunity set
- Efficient frontier
- Optimal portfolio

(3)

b) Derive the equation of the efficient frontier in expected return-standard deviation space for a portfolio consisting of two stocks with standard deviations σ_1 and σ_2 and are perfectly correlated. (5)

c) A risk-averse and non-satiated person has been offered a job by a highly reputed IT company. His fixed salary was Rs. 50 lakhs p.a. while he will be paid Rs. 30 lakhs as bonus if the company exceeds its annual growth target. The probability of company exceeding its growth target is:

Probability of exceeding growth target	GDP growth
100%	>10%
60%	5%-10%
0%	<5%

All the three GDP scenarios are equal probable.

(1) The utility function of the person is $U(x) = 0.9x^2 - 0.4x^3$ (x represents a proportion of Rs. 80 lakhs). Derive a salary range according to the utility function. (4)

(2) The expected utility offer by the job. (2)

[14]

Q 4) a) A model was developed to explain the historical returns on Reliance Industries (RIL) stock over the last one year. The model is:

Returns on RIL stock = $a + b_1I_1 + b_2I_2 + c$

Where:

- a & c are the constant and random parts respectively of the component of returns unique to RIL.
- I_1 is the movement in the petrochemical industry index (an industry to which RIL belongs)
- I_2 is the movement in the stock market index
- b_1 & b_2 are the sensitivities of RIL stock returns to I_1 & I_2 respectively.

Some analysts pointed out that because two indices are correlated and after regressing I_1 on I_2 obtained a best fit equation.

$I_1 = x + y*I_2$

By using this information, re-express the returns on RIL stocks in terms of two orthogonal factors. (4)

b) A portfolio contains 350 securities. Calculate the number of required data items in order to apply:
- Mean-variance theory
- Single index model (4)

c) What is security market line under CAPM?
The below table depicts the annual returns of a security and of the market.

Security Returns	Market returns
7%	5%
10%	7%
-3%	-6%
1%	-2%
20%	22%
4%	7%
5%	5%
9%	6%
4%	1%

The correlation between the security's returns and that of the market is 0.8.

The risk-free rate is 8% and equity risk premium of the market is 5%.

- Calculate the expected returns of the security. (7)

[15]

Q 5) Compare the lognormal model and the Wilkie model with respect to consistency with market efficiency. **[5]**

Q 6) a) Please state the assumptions underlying the Black-Scholes model (3)

b) Derive the put-call parity relation for European options on a dividend paying stock, which will pay a dividend X just before the expiration of the options. (5)

c) An European call and put option on a dividend paying stock both have a strike price of Rs. 50 and expire in 3 months. Both of them are available for Rs 10 each. The stock is currently trading at Rs 50 and is expected to pay a dividend of Rs 5 in three month's time just before the expiration of the options. Is there an arbitrage opportunity available? If yes, what trades should the trader execute to benefit from the opportunity? (5)

[13]

Q 7) The price of a stock on which a call option is traded is Rs 100. Use a 1 period binomial tree to calculate the price of a call option with a strike price of Rs. 100. The volatility of the stock over this one period is 22.35% and it does not pay dividends. A zero coupon risk free bond with a face value of Rs 100 maturing at the end of this period is currently trading at Rs. 90. **[5]**

Q 8) A life insurance company offers a 5-year term single premium unit-linked product that invests the unit funds in the Nifty index. There is a 10% allocation charge, i.e. for a premium of Rs 100, the company levies a charge of Rs 10 and invests Rs 90 in the unit fund. There are no other charges applicable on the product. The amount invested in the unit funds moves as per the movements in the Nifty index. On maturity, the policyholder gets the higher of the allocated amount (i.e. Rs 90 for Rs 100 premium) or the value of units. For the rest of the question, please assume that there are no dividends on the Nifty index.

a) Draw the payoff diagram for a policyholder who pays a premium of Rs 100, when the value of Nifty is 90. (2)

b) How can the insurance company hedge the risk on the guarantee that it has provided? (2)

c) An investment bank offers to sell a derivative to the insurance company to hedge the risk. What should the insurance company offer to pay to buy the derivative? (6)

The Black-Scholes formula for a call and put option on a non-dividend paying security is

$$c_t = St \times \Phi(d_1) - K \times (\exp(-r \times (T-t))) \times \Phi(d_2)$$
$$p_t = K \times (\exp(-r \times (T-t))) \times \Phi(-d_2) - St \times \Phi(-d_1)$$

where $d_1 = \{\log(St/K) + (r + (\frac{1}{2}\sigma^2)) \times (T-t)\} / (\sigma \times \sqrt{(T-t)})$

$$d_2 = d_1 - (\sigma \times \sqrt{(T-t)})$$

and St = current price
σ = volatility
$T - t$ = time to expiry
K = strike price
r = risk free rate

The risk free rate is 10% and the volatility of Nifty is 30% p.a.

d) Suppose, the insurance company collects Rs 10 crores as premium on a single day and invests Rs 9 crores in Nifty. The value of Nifty on that day is Rs 100. It also buys derivatives to hedge the entire investment of Rs 9 crores from an investment bank. The investment bank now wants to delta hedge the risk. How many units of Nifty should it buy / sell. Assume the bank can borrow/lend money at risk free rates and also go long / short on Nifty. The risk free rate is 10%. (4)

[14]

Q 9) a) Compare the one factor Vasicek model and the Cox-Ingersoll-Ross model? (3)

b) At time zero, the price of a 3 year zero coupon bond with a face value of 100 is 83.53 and that of a 4 year zero coupon bond is 75.58. What is the forward rate F(0,3,4). (2)

[5]

Q 10) a) Name three types of credit risk models. Which type is the Merton model? (2)

b) Explain briefly how the Merton model can be used to calculate credit spreads. Also, state the assumptions that are made. (4)

c) A company is set up with both debt and equity as capital to execute a special project and will be wound up after the project is over in 5 years time. The company has issued zero-coupon bonds which have a redemption value of Rs. 2 million. The current value of assets is Rs 4 mn and the assets are expected to grow at 15% p.a. with an annual volatility of 30%. The spot rate for a 5 year zero-coupon bond issued by the government is 8%. What is the credit spread on the corporate bond?
(Hint: Use Merton's model) (6)

[12]

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