

INSTITUTE OF ACTUARIES OF INDIA

EXAMINATIONS

06th May 2016

Subject ST6 – Finance and Investment B

Time allowed: Three Hours (10.15* – 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. ** You have 15 minutes at the start of the examination in which you are required to read the questions. You are strongly encouraged to use this time for reading only, but notes may be made. You have then three hours to complete the paper.*
3. *You must not start writing your answers in the answer sheet unless instructed to do so by the supervisor.*
4. *The answers are not expected to be any country or jurisdiction specific. However, if Examples/illustrations are required for any answer, the country or jurisdiction from which they are drawn should be mentioned.*
5. *Attempt all questions, beginning your answer to each question on a separate sheet.*
6. *Mark allocations are shown in brackets.*
7. *Please check if you have received complete Question paper and no page is missing. If so, kindly get a 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) A trader observed the following quoted prices for the 6 different interest rate derivative contracts mentioned below. The prices are: Rs. 0; Rs. 10,000; Rs. 22,000; Rs. 23,000; Rs. 28,000 and Rs. 40,000 and the contracts are.

- a) A 4% cap on quarterly interest payments
- b) A 4% cap on monthly interest payments
- c) A 4% floor on quarterly interest payments
- d) A 5% floor on quarterly interest payments
- e) A 2.5% / 4% collar on quarterly interest payments
- f) A fixed – for – floating 4% swap on quarterly interest payments

All contracts have a 5-year term and the principal and all other details for each of the 6 alternate contracts mentioned above are the same. Also, the quoted interest rates are compounded with the same frequency as the payments and the current continuously compounded short rate is 3% per annum.

You know that the prices are correct but they are not necessarily reported in the same order as the contracts are mentioned.

Given this information, match each price with a contract and explain you rationale.

[15]

Q. 2) Kotak Bank has an exposure to \$100 million of debt issued by a company X. Kotak Bank enters into a CDS transaction with Yes Bank to hedge its debt exposure to company X. Yes Bank would fully compensate Kotak Bank if company X defaults in exchange for a premium. Assume that probabilities of default for Kotak Bank, Yes Bank and company X are 0.3%, 0.5% and 3.6% respectively. Further, defaults of the two banks and the company are independent of each other. Given this information,

- i) What is the probability that Kotak Bank will suffer a credit loss in its exposure to company X? (3)
- ii) Assuming Kotak Bank suffers a credit loss, how much is the expected credit loss that it would be exposed to? (2)

[5]

Q. 3) A trading book of a bank looks as follows:

| Asset | Expected Return (Per Annum) | Annual Volatility | Value (in millions) |
|-------|--------------------------------|-------------------|---------------------|
| A | 10% | 25% | Rs. 100 |
| B | 20% | 20% | Rs. 50 |

Assume a correlation coefficient between the returns of assets A and B to be 0.2, a normal distribution and 250 trading days.

How would the daily VaR at the 99% level change if the bank sells Rs. 50 million worth of asset A and buys Rs. 50 million worth of asset B?

[7]

- Q. 4)** Let S_t be a stock price process which follows a geometric Brownian motion with parameters μ and σ^2 , and with stochastic differential equation:

$$dS_t = \left(\mu + \frac{\sigma^2}{2} \right) S_t dt + \sigma S_t dW_t$$

where W_t is a standard Brownian motion.

Let B_t be a risk free asset whose price grows deterministically according to the formula $B_t = e^{rt}$ and also let $Z_t = B_t^{-1} S_t$ be the discounted stock price process.

Consider a dynamic portfolio (ϕ_t, ψ_t) consisting of ϕ_t units of S_t and ψ_t units of B_t , and let $X = f(S_T)$ be a path-independent claim on S_T .

Based on this information, answer the following:

- i) Derive the stochastic differential equation for Z_t . (6)
 - ii) Explain what is meant by a self-financing and replicating strategy for X . Give the mathematical expressions wherever applicable. (6)
 - iii) Explain how the Cameron – Martin – Girsanov (also referred to as Girsanov's) theorem and the Martingale Representation theorem can be used to construct a replication strategy for X . (8)
 - iv) Derive an expression for the stochastic differential equation for the value of the claim. (3)
- [23]

- Q. 5)** An Indian pension fund holds NSE Nifty index stocks and Ibovespa Brasil Sao Paulo (IBSP) Stocks with 50% exposure to each with the current market value of portfolio of Rs 100 crores, given the following current market information.

NSE Nifty index: 7000 and
 IBSP: 40,000
 1 Brazil Real = Rs 20

The board of the pension fund wants to purchase insurance against a reduction of more than 5% in the value of the portfolio over the next 6 months.

- i) Calculate the cost of the portfolio insurance using options on NSE Nifty index, IBSP and Brazil Real for 5% fall in each market (NSE Nifty index and IBSP) and Brazil Real. (10)

Use the following information, please state any assumptions that you use.

Implied volatility for NSE Nifty Index – 25% per annum
 Implied volatility for IBSP – 35% per annum
 Implied volatility of Rs/Real - 15% per annum
 Risk-free rate of interest in India – 7% per annum (with continuous compounding)
 Risk-free rate of interest in Brazil - 10% per annum (with continuous compounding).

The investment analyst suggested that the above strategy would lead to excessive insurance cost than necessary due to inherent diversification in the portfolio.

The investment analyst came up with the following approach to reduce the insurance cost

- a) Estimate the portfolio loss after a 5% fall in each market (NSE Nifty index and IBSP) and the Brazil Real.
- b) Use the correlation matrix (given below) to estimate overall risk.
- c) Calculate the percentage diversification.
- d) Increase the required stress by dividing it by diversification ratio (Rounding to nearest 1%)

The following correlation matrix is given

| | NSE Nifty Index | IBSP | Brazil Real |
|------------------------|------------------------|-------------|--------------------|
| NSE Nifty Index | 100% | 50% | 0% |
| IBSP | 50% | 100% | 0% |
| Brazil Real | 0% | 0% | 100% |

Using the above approach estimate

- ii) Diversification based on the above correlation matrix. (5)
- iii) New insurance cost with updated stress to the individual risk. (8)

[23]

Q. 6) Answer the following:

- i) State the risks faced by the writer of an unhedged delta neutral option where the gamma of the option is large and negative. (3)
- ii) Derive an expression for the gamma and the vega of a European call option on a stock index that pays a continuous dividend at rate q . (5)

[8]

Q. 7) Capital requirement is estimated as the difference between the market value and theoretical value of an investment portfolio calculated under the given stress scenario. The regulator is considering two approaches to estimate the capital requirement on a bond.

Approach 1:

1. Estimate the default adjusted cashflows.
2. Calculate the yield to maturity based on the default adjusted cashflows.
3. Increase the default by 100%.
4. Use the yield to maturity from step 2 to estimate loss in the market value.

Approach 2:

1. Double the spread over risk free rate of the bonds and estimate the market value.

- i) Define the factors which contribute to the credit riskiness and pricing of the bond. (3)
- ii) Discuss the above approaches and which risk do they address and discuss advantages and disadvantages of each approach. (3)

Assuming the following information for a 3 year bond.

| | |
|---|---|
| Coupon Rate | 5% per annum (Coupons are paid once in a year) |
| Face Value | Rs. 10,000 |
| Best estimate default probability each year(conditional on no earlier default) | 2% |
| Market price | Rs. 10,000 |
| Spread over risk free bond | 2% per annum |
| Recovery Rate | 50% |

- iii) Estimate the yield to maturity based on pre and post default adjusted cashflows. (5)
- iv) Calculate the capital requirement based on first approach (market value after allowing for 100% increase in the default). (4)
- v) Calculate the capital requirement based on the second approach (doubling the spread). (4)

[19]
