Chartered Institute of Stockbrokers

QUESTION & ANSWERS

Examination Paper 2.3

Derivatives Valuation Analysis
Portfolio Management
Commodity Trading and Futures

Professional Examination
March 2021

Level 2

<u>Question 2</u> – <u>Derivative Valuation and Analysis</u>

Define delta and gamma of an option and briefly discuss the advantage in creating a portfolio which is simultaneously delta and gamma neutral. (3 marks)

Solution to Question 2

Delta (Δ) of an option measures the rate of change in the price of the option with respect to the price of the underlying asset and the Gamma (I) of an option measures the rate of change in the delta of the option with respect to the price of underlying asset.

(1½ marks)

Creating a portfolio which is simultaneously delta and gamma neutral can hedge the risk of small or large price movement. (1½ marks)

<u>Question 5</u> – <u>Derivative Valuation and Analysis</u>

5a) A dividend paying stock is trading at ₦37 and the term structure of interest rates is flat at 6% which is continuously compounded. Assume that a dividend of 0.50 is expected after six months. A European call option on this stock with strike ₦40 expiring in 18 months is trading at ₦2. A European put option with the same strike and maturity is trading at ₦1.25. How can you make a riskless profit? (9 marks)

5b) Explain what is meant by a perfect hedge. Does a perfect hedge always lead to a better outcome than an imperfect hedge? Explain your answer. (2 marks)

5c) State 4 reasons that company might have for entering into an interest rate swap

(3 marks)

(Total: 14 marks)

Solution to Question 5

5a) Put-call parity:

$c + Ke^{-rT} = 2 + 40\ e^{-0.06 \times 18/12}$ = ₦38.5573 (½ mark)

$p + S_0 - D = 1.25 + 37 - 0.4852$ = ₦37.7648 (½ mark)

₦38.5573 (overvalued) < ₦37.7648 (undervalued) (½ mark)

Difference = ₦0.7925 (½ mark)

There is an arbitrage opportunity. A risk-less profit of ₦0.7925 can be made today.

(1 mark)

Today:

- Borrow ₦36.25 (= 37 + 1.25 – 2) at 6% for 18 months to (½ mark)
- Buy the stock at ₦37 (½ mark)
- Buy the put option for ₦1.25 (½ mark)
- short the call option for ₦2 (½ mark)

After six months:

Receives the dividend of ₦0.50 and invest it for 1 year at 6% (1 mark)

After 18 months:

- If S > ₦40, the short call is in-the-money, the long put is out-of-the-money, thus have the obligation to sell stock at ₦40. (½ mark)

If S < ₦40, the long put is in-the-money, the short call is out-of-the-money, thus have the right to sell stock at ₦40. (½ mark)

- Collect dividend investment of ₦0.50 $e^{0.06 \times 1}$ = ₦0.5309 (½ mark)

- Repay the loan
  ₦36.25 $e^{0.06 \times 18/12}$ = ₦39.6638 (½ mark)

- Thus: net profit = ₦0.8671 (40 + 0.5309 - 39.6638) (in T = 18 months) or ₦$0.8671e^{-0.06 \times 18/12}$ = ₦0.7925 (today) (1 mark)

5b)

A perfect hedge is one that completely eliminates the hedger's risk. A perfect hedge does not always lead to a better outcome than an imperfect hedge. It just leads to a more certain outcome. Consider a company that hedges its exposure to the price of an asset. (1 mark)

Suppose the asset s price movements prove to be favorable to the company. A perfect hedge totally neutralizes the company's gain from these favorable price movements. An imperfect hedge, which only partially neutralizes the gains, might well give a better outcome. (1 mark)

5c)

1) To obtain a lower rate of interest on its preferred type of debt by exploiting the quality spread differential between two counterparties
2) To achieve a better match of assets and liabilities
3) To access interest rate markets that might otherwise be closed to the firm (or only accessible at excessive cost)
4) To hedge interest rate exposure by converting a floating rate commitment to a fixed rate commitment (or vice versa)
5) To restructure the interest rate profile of existing debts (avoiding new loans/fees)
6) To speculate on the future course of interest rates.

(1 mark each, maximum 3 marks)

Question 3 – Portfolio Management

Explain the difference between systematic and unsystematic risk in relation to portfolio theory and the capital asset pricing model. (4 marks)

Solution to Question 3

Portfolio theory suggests that the total risk of a portfolio of investments can be reduced by diversifying the investments held in the portfolio, e.g, by investing capital in a number of different shares rather than buying shares in only one or two companies. (1 mark)

Even when a portfolio has been well-diversified over a number of different investments, there is a limit to the risk-reduction effect, so that there is a level of risk which cannot be diversified away. This undiversifiable risk is the risk of the financial system as a whole, and so is referred to as systematic risk or market risk. (1 mark)

Diversifiable risk, which is the element of total risk which can be reduced or minimized by portfolio diversification, is referred to as unsystematic risk or specific risk, since it relates to individual or specific companies rather than to the financial system as a whole. (1 mark)

Portfolio theory is concerned with total risk, which is the sum of systematic risk and unsystematic risk. The capital asset pricing model assumes that investors hold diversified portfolios, and so is concerned with systematic risk alone. (1 mark)

Question 6 – Portfolio Management

6a) Your colleague argues:
"Younger people invest more in equities and less in bonds". Do you agree with this assertion? Explain. When would you propose to your younger clients a less risky investment? (3 marks)

6b) Consider that you are a portfolio manager within a wealth management company and a client has approached you for the creation of his portfolio. However to avoid too many assets in his portfolio, he wishes to have only three assets. From your research team you have managed to get details of the following three assets that meet your client's needs. Assume that all the values tabulated below are annualized as is also the risk free interest rate prevailing in the economy at 3.0%.

Assets	**Expected Return**	**Standard Deviation**	**Beta**
Stock A	12.8%	17.8%	0.75
Stock B	15.2%	25.4%	1.12
Stock C	5.6%	12.6%	0.22
Market Index	15.0%	21.2%	1.0

6b1) Using the CAPM theory and the above tabulated data, calculate the correlation coefficient with the market index for each of the three stocks. (3 marks)

6b2) Assuming that the stocks are correctly priced in accordance with the CAPM theory, what will be the required returns for each of the three stocks? (4 marks)

6b3) Your client wants to invest 10% in stock B irrespective of it being overvalued or not and the rest in stock A and C as suggested by you. Also he wants to have a market exposure of 1 (i.e. a portfolio beta of 1). Calculate what will be the investments in the other two assets to reach the client's objective.
Assume you can sell short any quantity of any stock. (4 marks)

6b4) Based on portfolio weights as calculated in (iii) above, calculate the expected portfolio return. (1 mark)

6c) An investor considers investing in one of two risk free investment options. Option A gives the investor 2.5% return every three months for the next 5 years, when he would get back his principal. Every semester the investor can reinvest the returns in the same scheme. Option B guarantees a return of 62.9% to the investor after 5 years.

6c1) The investor wants to opt for option B. Is it the right option? Calculate the holding period returns for each option and justify your answer. (2 marks)

6c2) Calculate the annual average arithmetic, geometric and continuously compounded returns for the two options. Does the decision change based on the calculations of annual average returns? (4 marks)

(Total: 18 marks)

Solution to Question 6

6a)

Younger people invest more in equities because

1. They usually have a long term horizon and over long-term horizons, equines tend to outperform bonds (the risk premium for equities should be larger than the risk premium for bonds). In addition, the short-term uncertainty associated with stock returns tends to be reduced on the long run. This comes from the fact that returns increase in proportion to the time elapsed, while volatility increases in proportion to the square root of time. Therefore, risky investments become relatively more attractive as the investment horizon lengthens. This is also called time-diversification. (1½ marks)

2. Risk aversion is usually smaller for younger people than it is for older people.

However, if a younger client plans some important investment (for the purchase of a house for example) in a close future, you should propose him to invest in a less risky asset. Only the wealth which is not planned to be used in a close future should be invested in stocks. (1½ marks)

6b)

6b1) We have data for

Beta (σ_i) of each of the stock,

Standard deviation (σ_i) of the each of the stock,

Standard deviation (σ_m) of the market.

Now, to calculate the correlation coefficient of stock with the market (R_{im}), we need a relation between it and the above given values.

$$\beta_i = \frac{\sigma_{i,m}}{\sigma_m^2} = \frac{Cov(R_i, R_m)}{\sigma_m^2} = \frac{(R_{i,m} \cdot \sigma_i \cdot \sigma_m)}{\sigma_m^2}$$

$$\text{Hence } R_{i,m} = \frac{\beta_i \cdot \sigma_m}{\sigma_i}$$

Hence, the coefficient of correlation for each of the stocks is

$$\text{For Stock A: } R_{A,m} = \frac{0.75 \cdot 21.2\%}{17.8\%} = 0.89$$ (1 mark)

$$\text{For Stock B: } R_{B,m} = \frac{1.12 \cdot 21.2\%}{25.4\%} = 0.93$$ (1 mark)

$$\text{For Stock C: } R_{C,m} = \frac{0.22 \cdot 21.2\%}{12.6\%} = 0.37$$ (1 mark)

6b2) As per the CAPM theory, the expected returns is given by the following equation:

$E(R_i) = R_F + \beta_i \cdot (E(R_m) - R_f)$

Hence the required returns for the stocks are given as:

For Stock A: $E(R_A) = 3\% + 0.75(15\% - 3\%) = 12.0\%$ (1 mark)

For Stock B: $E(R_B) = 3\% + 1.12(15\% - 3\%) = 16.4\%$ (1 mark)

For Stock C: $E(R_C) = 3\% + 0.22(15\% - 3\%) = 5.6\%$ (1 mark)

6b3) The client wants a 10% investment in stock B, thus the remaining 90% should be invested in stock A and/or stock C. The client also wants his portfolio beta (βP) to be 1

$B = \sum w_i . \beta_p = 1$

and $w_A \cdot \beta_A + w_B \cdot \beta_B + w_c \cdot \beta_C = 1$

Now, let x be invested in stock A. Hence (0.9 - x) will be invested in stock C.

$x \times 0.75 + 0.1 \times 1.12 + (0.9 - x) \times 0.22 = 1$

Hence x = 130.19% and (0.9 - x) = -40.19% (1 marks)

Hence the effective investments to meet the client's objective will be,

Stock A = 130.19% (1/3 mark)

Stock B = 10% (1/3 mark)

Stock C = -40.19% (1/3 mark)

The client will have to short sell asset C to meet his objective.

6b4) Now since the beta of the portfolio is 1 which could also be checked from,

$\beta_p = \sum w_i . \beta_p = 130.19\% \times 0.75 + 10\% \times 1.12 - 40.19\% \times 0.22 = 1.0$

The expected return of the above weighted portfolio would be the same as that of the market index = 15.0%, which also can be checked from below:

$E(R_P) = \sum w_i . E(R_i) = 130.19\% \times 12\% + 10\% \times 16.4\% - 40.19 \times 5.6\% = 15.0\%$ (1 mark)

6c)

6c1) The holding period returns for option A are as follows:

$(1.025)^{20} - 1 = 63.9\%$ (1 mark)

The holding period return for option B is 63.9% (½ mark)

Option A therefore offers a higher return and should be selected. (½ mark)

6c2) **Arithmetic annual return:**

Option A = 63.9/5 = 12.7%

Option B = 62.9/5 = 12.6% (½ mark)

Option A offers a higher return

Geometric annual return

Option A = $(1.639)^{1/5} - 1 = 10.4\%$ (½ mark)

Option B = $(1.629)^{1/5} - 1 = 10.3\%$ (½ mark)

Option A offers a higher return (½ mark)

Continuously annual return

Option A = ln(1.104) = 9.9% (2/3 mark)

Option B = ln(1.103) = 9.8% (2/3 mark)

(Note: Alternative methods are available).

Option A offers a higher return. (2/3 mark)

Question 4 – Commodity Trading and Futures

A trader enters into a short cotton futures contract when the futures price is 50 cents per pound. The contract is for the delivery of 50,000 pounds. How much does the trader gain or lose if the cotton price at the end of the contract is

a) 48.20 cents per pound? (1½ marks)

b) 51.30 cents per pound? (1½ marks)

Solution to Question 4

a) The trader sells for 50 cents per pound something that is worth 48.20 cents per pound.

Gain = (₦0.5000 – ₦0.4820) × 50,000 = ₦900. (1½ marks)

b) The trader sells for 50 cents per pound something that is worth 51.30 cents per pound.
Loss = (₦0.5130 – ₦0.5000) × 50,000 = ₦650. (1½ marks)

Question 7 – Commodity Trading and Futures

7a) On July 15 Roger had taken a long position in 50 October gold futures contracts, while Novak took the corresponding short position on those contracts. On August 3 Roger decides to fully close out his position. Describe what will happen to Roger's position on August 3 following Roger's decision. (3 marks)

7b) Suppose that on the 1st of December, we observe that the spot gold price is $900 per ounce. The future price of gold expiring in one year is quoted at $943 and interest rate for financing is 4% p.a (on simple interest basis). It costs $0.50 to store gold per quarter, payable at the end of the year.

7b1) Determine the theoretical future price (3 marks)
7b2) Explain how you will trade to make riskless profit (5 marks)
7b3) Compute and interpret the implied repo-rate. (5 marks)

(Total: 16 marks)

Solution Question 7

7a)

The main point here is that Roger's position is independent of Novak's. That is because in actuality there exist two separate contracts: one between Roger and the exchange (clearinghouse), the other between Novak and the clearing house. Regardless of what Roger does, on August 3 (and on any date until the expiration of the contracts, for that matter), Novak may decide to: (½ mark)

a) keep his short position intact
b) close out his short position by going long 50 October contracts
c) reduce his short position by going long less than 50 October contracts
d) increase his short position by going short additional contracts
e) take a net long position by going long more than 50 October contracts

(½ mark for each)

7b1) The theoretical future price is given by:

F = So (I + R) + FV (SC) (1 mark)

Where
So = spot price of the asset = 900

R = risk-free rate = 4%
FV(SC) = future value of storage costs = 0.50 × 4 = 2
F = 900(1.040) + 2 = 938 (2 marks)

7b2) The futures contract is selling at 943. It is over-priced. Investors will engage in cash- and-carry arbitrage involving the following steps. (2 marks)

Today (Time 0)

		$	
1.	Buy gold at the sport market	-900	
2.	Finance the purchase of gold by borrowing at 4% p.a	+900	
3.	Sell one future contract at the current price of 943 (no cash flow today)	0	
	Net	0	(1 mark)

Expiration (Time T)

		$	
1.	Value of gold	S_T	
2.	Repay loan plus interest = 900(1.04) =	- 936	
3.	Pay storage costs	- 2	(1 mark)
4.	Value of futures (deliver the underlying asset to liquidate the futures contract)	$+943 - S_T$	
	Net = arbitrage profit	5.00	

Note that the arbitrage profit of $ 5.00 is the difference between the market price of the futures and the theoretical price, i.e, 943 – 938 = 5 (1 mark)

7b3) The implied repo-rate is the interest rate which makes the sport price of the underlying asset to grow and equal the current market price of the futures. It is the annualized gross rate of return that can be earned by buying the spot asset and simultaneously selling a futures contract on this asset; it can also be seen as the annualized borrowing rate at which the net return to a cash and carry arbitrage transaction will be zero (a no-arbitrage borrowing rate). On annualized basis, the implied repo-rate (IRR) is computed as follows: (1 mark)

$IRR = (F_m/S_0)^{1/T} - 1$, where
F_m = current market value of the futures contract
S_o = current price of the spot asset
T = expiration time (in years) of the futures contract (1 mark)

Thus:
$IRR = (943/900)^{1/1} - 1 = 4.78\%$ (1 mark)

Comparing implied repo-rate with actual borrowing rates is equivalent to comparing theoretical and actual futures prices.

An implied repo-rate above the actual borrowing rate indicates that futures are over-priced. When this is true, a cash-and-carry arbitrage is profitable. (1 mark)

Similarly, an implied repo-rate below the actual lending rate indicates that futures are underpriced and reverse cash-and-carry arbitrage will be profitable. (1 mark)