

**ADVANCED CERTIFICATE IN DERIVATIVES:
THE MATHEMATICS, PRINCIPLES AND PRACTICE**

Examination Paper

April 1997

Paper Two

Time allowed: Three hours

INSTRUCTIONS TO THE CANDIDATE

1. *You have 15 minutes at the start of the examination in which to read the questions. You are strongly encouraged to use this time for reading only but notes may be made.*
2. *You must not start writing your answers in the booklet until instructed to do so by the supervisor.*
3. *Write your surname in full, the initials of your other names and your Candidate's Number on the front of the answer booklet.*
4. *Mark allocations are shown in brackets.*
5. *Attempt all 5 questions leaving sufficient space between each answer.*

AT THE END OF THE EXAMINATION

Hand in BOTH your answer booklet and this question paper.

*In addition to this paper you should have available
actuarial tables and an electronic calculator.*

1 (i) Discuss the possible benefits to a tax-paying investment fund of using derivatives for managing tax liabilities. [9]

(ii) (a) List the problems that arise for a large unit linked life fund in moving monies between the major equity markets by buying and selling the underlying stocks.

Your answer should address both short term switches which are intended to be reversed and long term strategic asset allocation switches.

(b) Describe how the problems in (a) can be overcome using equity index futures contracts. [10]

[Total 19]

2 Consider the Hull & White (1990) model with parameters $\sigma = 0.01$ and $a = 0.08$.

Assume that the term structure of interest rates is flat at 10% p.a.

Calculate the price of a 1 year European call option on a zero-coupon bond that will mature in 5 years where the bond has a face value of £100 and the strike price of the option is £68.

[16]

3 (i) Explain the credit risks involved in dealing in FTSE futures contracts and the means by which these are minimised. [6]

(ii) Discuss the operation of margin payments on LIFFE under the following headings:

(a) factors that determine the size of the initial margins

(b) the margining system used by LIFFE and how it would apply to a portfolio of derivative contracts with the exchange

(c) the form which initial margin can take [8]

(iii) You are the head of derivatives trading at a UK fund management firm. You are approached by a single A rated counterparty with which neither you nor any member of the firm are familiar. This counterparty is willing to enter into a one year swap in which it will pay the fund the total return on a suitable basket of UK gilts in return for the fund paying it the total return on a suitable basket of UK equities plus (or possibly minus) an adjustment to reflect the “market rate” for such a swap in the market.

Discuss how in theory would you estimate the appropriate size of the adjustment.

[11]

[Total 25]

- 4** (i) Discuss, using the Vasicek (1977) and the Hull & White (1990) models as examples, the main difference between equilibrium interest rate models and arbitrage free interest rate models. [5]

- (ii) You have been asked to construct a trinomial lattice for valuing interest rate derivatives under the Hull-White (1990) model. To do this you decide that you will first build a trinomial tree for a variable x which follows the process (where a and σ are positive constants, $x(0) = 0$ and dz is a Weiner process):

$$dx = -axdt + \sigma dz$$

Discuss the formulae that you would use to construct such a lattice giving reasons for their use and taking into account any alterations to the lattice if x is large and positive or large and negative. You may assume that the length of each time step is Δt (constant) and the spacing between consecutive values of x within the lattice is Δx (also constant). [13]

- (iii) Explain in general terms how you would convert this lattice into one that could be used to value derivatives under the Hull-White model (on the assumption that you did not know the analytic formula for the term structure under this model). [5]
- (iv) Describe briefly how this lattice could be used to value an American style bond option? [1]
- (v) Describe how the accuracy of the lattice calculation could be improved if you knew the analytic formula for a European bond option? [2]

[Total 26]

- 5** Consider an option on a non-dividend paying stock when the stock price is \$30, the exercise price is \$29, the continuously compounded risk free rate of interest is 5% p.a., the volatility is 25% p.a. and the time to maturity 4 months.

- (i) Calculate the price of the option if it is:
- (a) a European call
 - (b) an American call
 - (c) a European put
- [5]

(ii) Verify that put-call parity holds. [2]

(iii) If the stock goes ex-dividend in 1.5 months time and the expected dividend is \$0.5 recalculate the prices in (i)(a) and (i)(c).[7]

[Total 14]