KEELE UNIVERSITY

DEGREE EXAMINATIONS, 2008

P3/T3 (PRINCIPAL COURSE)

MONDAY 21st APRIL 2008, 14.30-16.30

FINANCE
MANAGEMENT SCIENCE
BUSINESS ECONOMICS

ECO-30004

OPTIONS AND FUTURES

Candidates should attempt **all** questions from Section A (**40 marks**), and **two** questions from Section B (**30 marks each**).

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SECTION A

*Candidates should attempt to answer **ALL** questions from this section (40 marks)*

1. In February 2008 the forward price of oil for delivery in March 2008 is $96.27 per US barrel. The contract size is 1,000 barrels of oil. The spot price in March turned out to be $92.27 per US barrel. Which party, the one who bought the forward or the one who sold the forward contract, made a profit? How much profit was made per contract? **[5 marks]**

2. In February 2008 you write a call option on ITV stock with a strike price of 74 and expiry date in March 2008. The price of this option is 8.25. At the expiry date in March 2008, ITV stock trades at 85. What gain or loss have you made? (Ignore interest carrying costs). **[5 marks]**

3. A September put option with a strike price of 680 on United Utilities has a current price of 58. If you buy and hold the put option until September, sketch the profit diagram at maturity. (Ignore interest carrying costs). **[5 marks]**

4. Briefly explain the similarities and differences between call and put options. **[5 marks]**

5. Briefly explain the similarities and differences between forward and futures contracts. **[5 marks]**

6. For a given strike price, briefly explain why the prices of American puts and calls rise with the length of time until maturity. **[5 marks]**

7. For a given maturity date, briefly explain why the prices of the calls fall with a rise in the strike price. **[5 marks]**

8. What is a 1x7 FRA? Explain whether it is the buyer or the seller of an FRA who profits if the interest rate falls. **[5 marks]**

*Candidates should attempt to answer **TWO** questions from this section (30 marks each)*

9.   Adopting standard notation the Black-Scholes option pricing formula for the price of a European put option on a non-dividend paying stock is

$$p = e^{-rT}\left(KN(-d_2) - S_0 e^{rT} N(-d_1)\right)$$

$$d_1 = \frac{\ln(S_0/K) + (r + \frac{\sigma^2}{2})T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

where $N(x)$ is the cumulative probability distribution for a standard normally distributed variable.

(*a*)   Outline the assumptions behind the Black-Scholes formula. **[7 marks]**

(*b*)   Explain each of the terms in the Black-Scholes option pricing formula and give a brief intuitive explanation of the formula. **[15 marks]**

(*c*)   Explain what happens to the put price as $T \to 0$ and as $\sigma \to 0$?
       [8 marks]

10.   Suppose the current spot £/$ exchange rate is 0.65 and the one year forward rate is 0.6. Further suppose that the UK interest rate over the year is 1/4 and the US interest rate is 1/9.

(*a*)   If a UK bond with a face value of £60,000 with maturity in one year is available and has an interest rate of 1/4, what is the current price of the bond? **[6 marks]**

(*b*)   Suppose there is a US bond with a face value of $100,000 with maturity in one year and an interest rate of 1/9. Outline all the relevant cash flows if you buy the US bond at the spot £/$ exchange rate and sell $s forward equal to the face value of the bond. **[6 marks]**

(*c*)   Calculate the implied repo rate on the transaction carried out in part (*b*).
       [6 marks]

(*d*)   How can the arbitrage opportunity be exploited? Explain what must happen to the forward rate if there is to be no arbitrage opportunity.
       [6 marks]

(*e*)   Suppose S is the current exchange rate, r the domestic interest rate and r^* the foreign interest rate. What is the theoretical forward price? Explain your answer. **[6 marks]**

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11. ABC stock either rises by 25% with probability 2/3 or falls by 20% with probability 1/3. The current price of ABC is 1000 and the one-period risk free rate of return is 2.5% (1/40). The expected one-period rate of return on the market portfolio is 15%. There is a call option on ABC stock with a strike price of 881 that expires after one period.

   (*a*)   What is the beta of ABC? What does beta measure? **[6 marks]**

   (*b*)   Calculate the risk neutral probabilities and use these probabilities to price the call option. Why is the risk-neutral probability for the up-state less than the true probability? **[8 marks]**

   (*c*)   Create a risk-less portfolio by writing the call and going long in the stock. What proportion of the stock is bought? Use this delta-hedged portfolio to price the call option. **[10 marks]**

   (*d*)   Use the value of the delta-hedge calculated in part (*c*) to calculate the elasticity of the call option. Calculate the call option beta. Briefly explain why the call option elasticity is larger than one. **[6 marks]**

12. Northern Rock stock is currently trading at 104. A September European call option on Northern Rock with a strike price of 100 currently trades at 46.5. The equivalent European put option currently trades at a price of 42.

   (*a*)   Explain how to create a synthetic forward contract by buying the call and selling the put. Sketch the payoffs to both the put and the call options at maturity. **[6 marks]**

   (*b*)   Suppose there is a risk-free bond with face value of 100 also with maturity in September (same date as the options) and which trades at a current price of 99 (i.e. the interest rate between now and September of 1/99 or 1.010101.%). Consider selling the bond and taking a long position in the stock. Calculate the cash flows from this portfolio both now and at the maturity date in September. **[6 marks]**

   (*c*)   Using your answers to (*a*) and (*b*), identify an arbitrage opportunity. Provide the details of all the relevant cash flows from the arbitrage portfolio. **[6 marks]**

   (*d*)   Use your answer to part (*c*) to establish the put-call parity condition for European options. Explain the circumstances under which the call and put prices are equal. **[6 marks]**

   (*e*)   Derive the lower bound for a European put option. **[6 marks]**