EXAMINATION

28 September 2007 (am)

Certificate in Practical Financial Economics

Time allowed: Three hours

INSTRUCTIONS TO THE CANDIDATE

1. *Enter all the candidate and examination details as requested on the front of your answer booklet.*

2. *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. You then have three hours to complete the paper.*

3. *You must not start writing your answers in the booklet until instructed to do so by the supervisor.*

4. *Mark allocations are shown in brackets.*

5. *Attempt all 8 questions, beginning your answer to each question on a separate sheet.*

6. *Candidates should show calculations where this is appropriate.*

Graph paper is required for this paper.

AT THE END OF THE EXAMINATION

Hand in BOTH your answer booklet, with any additional sheets firmly attached, and this question paper.

In addition to this paper you should have available the 2002 edition of the Formulae and Tables and your own electronic calculator.

1 In the television programme "Do We Have A Deal?", there are a large number of boxes containing cheques for different amounts. The contestant knows the amounts that are written on the cheques but not which cheque is in which box. One box is allocated to the contestant. During the programme, the amounts within the other boxes are revealed one at a time. At regular intervals, Tricky Banker (who does not know which cheques are in which boxes) will offer the contestant a fixed amount of cash in return for the unknown amount of cash in the box.

You are Tricky Banker and it is your job to decide how much to offer each time. For the television program to be tense and exciting, your offers need to be high but not high enough for the contestant to accept them.

Today's contestant is Malcolm. You are just in time to catch the end of rehearsals, in which two boxes were left with £1,000 and £100,000 in them. Malcolm was offered £43,156 in return for his box (which contained either £1,000 or £100,000) and seemed indifferent to keeping his box or taking the £43,156.

You always assume that contestants have utility functions of the form

$$U(x) = \ln(a + x/1000)$$

where a is different for each contestant and reflects his or her individual risk aversion.

(i) Show how you would use the available information to derive 120 as your best estimate of Malcolm's "a". [2]

Having gained an understanding of Malcolm's risk preferences in rehearsals, filming starts on the show itself. Half an hour into the show, Malcolm is down to his last five boxes, containing £1, £50, £2000, £100,000 and £250,000.

(ii) Calculate the lowest offer that Malcolm would find acceptable. [2]

You make an offer lower than that calculated in (ii). Malcolm turns it down. The contents of three boxes are revealed. The two remaining boxes contain £2,000 and £250,000.

(iii) Calculate the lowest offer that Malcolm would find acceptable. [1]

The following week, Malcolm is a contestant on "The Million Dollar Question". He is asked a series of questions and his winnings increase with every correct answer. However, if he answers a question wrongly, his winnings are reduced to his latest locked in winnings.

Malcolm is doing well. He is one question away from the million. The question is:

"Who is the chief examiner for the Certificate in Practical Financial Economics?" and the answer is one of:

A Niall Franklin
B Mike Harrison
C Steve Mills
D Anthony Williams

Malcolm has the choice of either:

- Taking home the £500,000 that he has won so far, or
- Answering the question, in which case he wins:
  - £1,000,000 if he answers correctly
  - £32,000 if he is wrong

Malcolm does not know the answer to the question and thinks that A, B, C and D are equally likely.

(iv) Calculate how certain Malcolm needs to be of his answer before risking answering the question, and use this to determine his decision in the cases when:

(a) he has no further information

(b) his wife Penny is consulted and says that she is 80% sure that the answer is A

(c) he is told that the correct answer is either A or C with absolute certainty (but has no access to Penny)

[3]
[Total 8]

2 You work for a property company considering projects ranging from large construction projects through to internal improvement projects. You currently use NPV with a fixed hurdle rate to determine project acceptance. Your boss, reading your CPFE notes over your shoulder notes that "Some companies take a more relaxed view for small expenditures and demand a higher hurdle rate for large expenditures".

(i) Discuss the advantages and disadvantages of this proposition. [3]

(ii) Draft a memo to your boss recommending whether or not you should implement this change. [2]
[Total 5]

3 Describe briefly the key features of the following arrangements as forms of medium term company finance:

(a) hire purchase
(b) credit sale
(c) leasing — distinguishing between operating and financial leases

[6]

4 An investor can only invest in the shares of two companies — Alpha Co Ltd and Beta Co Ltd. The expected return on shares in Alpha is E_A and the expected return on shares in Beta is E_B. The variances of the returns are V_A and V_B respectively and C_{AB} is their covariance. A proportion x_A is invested in Alpha with x_B being invested in Beta.

(i) State the formulae for:

(a) the expectation return, and
(b) the variance of the return on the portfolio of the two shares

[2]

(ii) Prove that the minimum variance of the portfolio occurs when:

$$x_A = (V_B - C_{AB}) / (V_A - 2C_{AB} + V_B)$$ [4]

[Total 6]

5 The ABC insurance company has four business units:

- ABC Life, specialising in unit linked life insurance
- ABC General, specialising in car insurance
- ABC Health, specialising in health insurance
- ABC Solutions, the direct sales force

ABC currently evaluates the performance of its four business units by:

- calculating profits separately for each business unit
- calculating an economic capital requirement for each subsidiary, equal to the capital that needs to be held within each business unit, for the business unit to have a 95% probability of being able to meet all its liabilities
- calculating an economically adjusted profit (EAP) defined as:

  EAP = Profit – (Economic Capital * Cost of Capital %)

- where cost of capital % is specified by the ABC board and is the same for all business units

Tax can be ignored throughout this question.

(i) Explain ABC's rationale in using this methodology. [2]

A member of the ABC board has put forward the idea of calculating the EAP for the whole company.

(ii) (a) Explain why the EAP for the whole company is unlikely to be equal to the sum of the EAPs for the individual business units.

(b) Outline how the difference might be allocated across business units.

[3]

A firm of consultants is attempting to persuade ABC to abandon the concept of EAP and start calculating CAPM adjusted profits (CAPMAPs). CAPMAP is defined as:

$$\text{CAPMAP} = \text{Profit} - \text{Net Assets} * (r_f + \beta(r_m - r_f))$$

where r_f is the risk-free rate
r_m is the return on equities over the period in question
β is business unit-dependent
and net assets are those at the start of the year for the business unit in question

(iii) Describe the rationale behind this methodology, and in particular its treatment of non-market risks. [4]

(iv) Describe how the β parameters might be derived for each business unit. [2]

(v) Demonstrate the relationship between group level CAPMAP and the CAPMAPs for the four business units. [3]

(vi) Describe in broad terms the agency risk issues in switching from an EAP-based approach to a CAPMAP-based approach for evaluating the performance of the four business units. [2]

[Total 16]

6 It is the year 2022. The market for advising on pension scheme funding has been dominated by global banking groups since the transfer value mis-selling scandal in the early 21st century which led to the establishment of the Second Morris Review and the subsequent removal of the statutory role of actuaries to advise pension schemes and insurance companies.

On 16 April 2022, three actuaries, Chip Mercer, Dez Watson and Bob Hewitt met to celebrate the incorporation of their new company "Prescient Forecasting". Chip, Dez and Bob have pooled their redundancy payouts — a total of £600,000 — and have purchased one million shares in the new company.

The company's assets are the initial investment of £600,000 plus the *idea* for a new product — the "optical DNA lifestyle scanner". The actuaries have recognised the potential for applying the scanner as a tool to perfectly predict the future salary growth, career path, life expectancy and future marital status of pension scheme members accurate to within one billionth of one percent. It is predicted that the use of the scanner would cut the cost of advice to pension schemes and insurance companies by 90% giving the first entrant a virtual monopoly of the market within 5 years.

Twelve months later, after the initial investment has drained away during testing and legal discussions, and banks have refused to offer finance, the company is desperate for a transfusion of equity capital.

The Auger Close Venture Capital Club has been approached with a "once-in-a-lifetime" opportunity to purchase one million new shares in Prescient at a recommended price of £2 per share.

After reviewing the business plan in detail, the Club has concluded that for an initial investment of £2,000,000 they would anticipate being able to cash out in five years time for £14,000,000.

As a new member of the Club you have advised them that common stocks with the same risk as this investment offer a 50% per annum expected return.

(i) Explain why the Club should not invest at the price of £2 per share and calculate the price per share at which they should be willing to invest. [2]

Prescient agrees to the lower price that you have calculated and issues the Club with one million new shares.

(ii) (a) Calculate the paper gain made by the actuaries as a result of the capital injection based on this revised new investment amount.

(b) Describe the concept of agency theory using this refinancing as an example.

(c) Outline the terms which the Club may have required as a pre-condition for their investment to avoid or reduce agency risk. [6]

Following an initial public offering in 2027 which allowed the Auger Club to cash out its initial investment for a cool £57 million, Prescient has gone from strength to strength and at its peak in May 2030 the company is valued at £254 million. Then disaster strikes when the scanner is found to cause blindness in 20% of cases and to only be accurate to within 10%. The Prescient share price crashes.

The following tables show the balance sheets for Prescient after the news breaks:

Book values			
net working capital	£25,000,000	£50,000,000	bonds outstanding
Long term assets	£225,000,000	£200,000,000	common stock
	£250,000,000	£250,000,000	
Market values			
net working capital	£25,000,000	£15,000,000	bonds outstanding
long term assets	£10,000,000	£20,000,000	common stock
	£35,000,000	£35,000,000	

(iii) (a) Explain the implication of these balance sheets for Prescient's bondholders.

(b) Describe what actions might the owners of the business take at the expense of the bondholders assuming that the bonds do not mature for another two years and that the company has sufficient funds to continue for this period of time.

(c) List the direct and indirect costs associated with financial distress and bankruptcy.

[8]
[Total 16]

7 The TRIPE is a total return index of prices of equities, so includes the effect of dividends being reinvested. There is a liquid market in European options on the TRIPE for a variety of exercise prices and maturities.

Current market implied volatilities for call options are as follows:

		Exercise Price				
		4,500	*5,000*	*5,500*	*6,000*	*6,500*
	1	19.3%	16.6%	14.1%	12.0%	10.6%
	2	20.0%	18.0%	16.1%	14.4%	12.9%
Term	*3*	20.9%	19.3%	17.8%	16.3%	15.0%
	5	23.0%	21.7%	20.4%	19.2%	18.1%
	10	27.4%	26.5%	26.5%	25.6%	25.6%

The TRIPE currently stands at 5,000.

The current continuously compounded risk free rate is 5% per annum.

The Black-Scholes formula for the price of a European call option on a non-income producing asset is:

$$c = S\Phi(d_1) - Ke^{-rt}\Phi(d_2)$$

where $d_1 = \{\ln(S/K) + (r + 0.5\sigma^2)t\}/(\sigma t^{0.5})$ and $d_2 = d_1 - \sigma t^{0.5}$

You can ignore tax, expenses and profit margins in your calculations.

(i) Describe how the volatility matrix has been derived. [2]

(ii) Discuss whether this volatility matrix renders the Black-Scholes model redundant. [2]

You have been asked to calculate the price of a three-year call option on a basket of shares worth £1million with an exercise price of £1.25million, assuming that the shares closely match those that make up the TRIPE.

(iii) (a) Describe why 15.65% might be an appropriate volatility to use in your calculation.

(b) Calculate the price.

[6]

(iv) Describe with reasons how you would expect a volatility matrix for put options to look. [2]

(v) Calculate the price of a three-year put option on a basket of shares worth £1million with an exercise price of £1.25million, assuming that the shares closely match those that make up the TRIPE. [2]

A life office that, over the last ten years, has been writing ten-year investment bonds with maturity guarantees has built a model to calculate the market consistent value of the guarantees. The stochastic process for the TRIPE within the model is based on a single volatility parameter and has been constructed in such a way that, if used to calculate a variety of call option prices, it would result in a flat matrix of implied volatilities (i.e. one in which every cell was identical).

(vi) Describe the issues that the life office faces in choosing this single volatility parameter. [4]

A financial journalist claims that by writing calls and puts in the right proportion, market risk could be eliminated: they will move in opposite directions when the TRIPE moves, so provided the sensitivities are exactly balanced there should be no net exposure to the TRIPE.

(vii) Discuss your response to this claim. [2]

[Total 20]

8 You are the actuary of a small listed general insurer with responsibility for assessing the regulatory capital required. The insurer writes household and motor business and invests solely in bonds. The insurer also has a small service company that provides a house purchase inspection service.

The regulator requires insurers to consider the amount of capital required to protect against insolvency with a probability of 99.5% over 1 year.

There are two main methods of determining the capital required, "stress & scenario testing" and stochastic modelling:

(i) Draft a short note to the board recommending which method should be used. The note should include a brief description of each of the methods and their advantages and disadvantages. [14]

You decide to use a stress & scenario testing methodology to assess the capital required. The regulator describes six risk categories (insurance, market, credit, operational, liquidity and group) and, as an initial step in your work, you are considering the relative importance of these types of risk to your firm.

(ii) For each risk category, describe the level of risk to the company with a reason. [9]

[Total 23]

END OF PAPER