SOCIETY OF ACTUARIES
Exam AFE
Advanced Finance/ERM

Exam AFE

AFTERNOON SESSION

Date: Friday, April 30, 2010
Time: 1:30 p.m. – 4:45 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This afternoon session consists of 5 questions numbered 8 through 12 for a total of 60 points. The points for each question are indicated at the beginning of the question. There are no questions that pertain to the Case Study in the afternoon session.

2. Failure to stop writing after time is called will result in the disqualification of your answers or further disciplinary action.

3. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions on the exam booklet.

Written-Answer Instructions

1. Write your candidate number at the top of each sheet. Your name must not appear.

2. Write on only one side of a sheet. Start each question on a fresh sheet. On each sheet, write the number of the question that you are answering. Do not answer more than one question on a single sheet.

3. The answer should be confined to the question as set.

4. When you are asked to calculate, show all your work including any applicable formulas.

5. When you finish, insert all your written-answer sheets into the Essay Answer Envelope. Be sure to hand in all your answer sheets since they cannot be accepted later. Seal the envelope and write your candidate number in the space provided on the outside of the envelope. Check the appropriate box to indicate morning or afternoon session for Exam AFE.

6. Be sure your written-answer envelope is signed because if it is not, your examination will not be graded.

Tournez le cahier d'examen pour la version française.

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Exam AFE-Front Cover

****BEGINNING OF EXAMINATION****
AFTERNOON SESSION
Beginning with Question 8

8. (*10 points*) Olympic Life and Annuity has an inforce Single Premium Deferred Annuity (SPDA) block. The existing product is typical compared to other SPDAs in the market. You have decided to use Transfer Pricing to allocate performance across three areas:

I. SPDA liability performance

II. ALM with regard to managing interest rate risk

III. Credit risk and security selection

Olympic's income statement for the past year for the SPDA business:

Deposits	$5,000,000
Investment Income	7,000,000
Death Benefits	1,000,000
Surrender Benefits	10,000,000
Increase in Reserves	(1,450,000)
Expenses	500,000
Pre-Tax Net Income	$1,950,000

Average SPDA assets during the year were $100,000,000. Assets were invested entirely in investment grade domestic corporate bonds with varying maturities. The guaranteed minimum crediting rate did not come into play during the year. Olympic is rated AA.

You have developed two benchmarks in your efforts to attribute product performance:

- Benchmark #1 is the average historical return on the universe of investment grade domestic corporate bonds that have the same sensitivity to interest rates as the SPDA liability. It has been calculated to be 5%.

- Benchmark #2 is the average historical return on the universe of investment grade domestic corporate bonds that have the same sensitivity to interest rates as the actual investment portfolio held by Olympic that backs the SPDA. It has been calculated to be 6%.

8. Continued

(a) (*1 point*) List five benefits of Transfer Pricing for performance measurement and attribution for companies similar to Olympic.

(b) (*4 points*) For the Olympic SPDA:

(i) Use Transfer Pricing to allocate income for the SPDA across performance areas I, II and III. Show your work.

(ii) Identify the conclusions that can be drawn about the sources of profit for this typical SPDA from the results in (i) above.

(c) (*5 points*) Olympic is considering each of the following independent actions:

I. Expanding the investment universe to included non-investment grade corporate bonds.

II. Hedging interest rate risk by purchasing derivatives, resulting in lower expected net investment return, but significantly reduced volatility.

III. Increasing the crediting rate by reducing the crediting spread.

IV. Laying off administrative staff and increasing efficiency of the remaining staff.

V. Shortening the surrender charge period on new business. Assume the resulting new sales materially impact future total inforce.

Considering different future economic conditions where appropriate, analyze the implications of each proposed action on future Transfer Pricing allocations.

9. (*17 points*) You are hired to consult for Wigan Life, an insurance company focused primarily on selling fully underwritten individual universal life (UL) insurance products. Wigan is considering expanding into the group term life market. Wigan has designed a group term life product with the following features:

- Annually renewable term life insurance coverage offered to employee groups
- Payment of an annual, non-refundable premium by the employer at the beginning of the year with the benefits paid to the employee's beneficiary upon death
- Level commissions and negligible acquisition expenses

You are given the following standard normal distribution values:

x	$\Phi(x)$
-3.89	0.005%
-3.72	0.010%
-3.20	0.068%
-3.06	0.111%
-2.78	0.270%
-2.63	0.422%
-2.33	1.000%
-1.96	2.500%
-1.64	5.000%
0.00	50.000%

(a) (*1 point*) Contrast underwriting for the group term contracts with typical individual life underwriting.

(b) (*1 point*) Propose underwriting criteria that Wigan should use when issuing group term contracts.

(c) (*3 points*)

(i) Identify seven factors that would affect the lapse rate assumption for Wigan's individual UL policies.

(ii) For each of these factors, explain whether and how it would apply for the Wigan group term contracts.

(iii) Evaluate the relative importance of the lapse rate assumption of Wigan's individual UL policies compared to the group term contracts.

9. Continued

You are provided with the following statistics on the corporate clients that have expressed interest in purchasing group term coverage from Wigan:

Client Name		Home Office Location	Employee Count	Total Exposure ($ Millions)	Annual Probability of Terrorist Loss
Z_1	Walcott Industries	Capital City	400	450	0.010%
Z_2	Denilson & Sons	Beaverton	120	400	0.005%
Z_3	Hamsik & Co.	Capital City	200	300	0.010%
Z_4	Lavezzi Life Co.	Capital City	150	275	0.010%
Z_5	Inter Consulting	Ruviano	50	270	0.005%

Wigan assumes that all lives in any one group will be lost in the event of a terrorist act.

The probability of loss for any one employee group is a function of a common factor V (which is distributed according to the standard normal distribution) and an employee group specific factor U_i where the loss random variable is defined by:

$$Z_i = \alpha_i V + \beta_i U_i \text{ for } i = 1,2,3,4,5$$

You are given that the value of α_i equals 0.5 for employee groups situated in Capital City and 0.2 for groups situated elsewhere.

(d) (*7 points*) Assume Wigan has entered into an agreement to provide group term coverage to each of the five employer groups listed above.

Calculate the 97.5% VAR loss for terrorism-related losses for this portfolio of group term contracts using a one factor Gaussian copula model.

Show your work.

(e) (*3 points*) You are asked by Wigan to explain your use of the Gaussian copula model in your assessment above.

(i) Explain what the α values imply about the underlying risk of loss.

(ii) Justify your decision to not use the Archimedian copula model.

(iii) Describe the advantages and disadvantages of using a student-t copula.

(iv) Suggest two potential latent variables. Justify your choices.

(f) (*2 points*) Recommend actions that Wigan can undertake to manage the exposure to potential catastrophic losses on its group term portfolio due to terrorist acts.

10. (*12 points*) You are employed by Banca Napoli, a European bank, as the portfolio manager for the following trading book of assets currently valued at €1 billion. Projected daily return, standard deviation, and variance-covariance matrices for the portfolio, as well as historical return and standard deviation information, are provided below.

Daily Portfolio Information (Historical data for the most recent month - 20 trading days)

	Weight	Stock Ticker	Average Daily Return	Standard Deviation	Variance – Covariance Matrix		
					GSG	VNQ	EMB
Commodities Index	1/3	GSG	-1.47%	2.24%	0.0005	0.0001	0.0002
US Real Estate	1/3	VNQ	-0.84%	2.65%	0.0001	0.0007	0.0003
Emerging Markets Bonds	1/3	EMB	0.28%	1.73%	0.0002	0.0003	0.0003

Daily Portfolio Information (Historical data for the most recent year - 250 trading days)

	Weight	Stock Ticker	Average Daily Return	Standard Deviation	Variance – Covariance Matrix		
					GSG	VNQ	EMB
Commodities Index	1/3	GSG	-0.11%	2.83%	0.0008	0.0006	0.0008
US Real Estate	1/3	VNQ	-0.07%	4.80%	0.0006	0.0023	0.0017
Emerging Markets Bonds	1/3	EMB	0.01%	4.69%	0.0008	0.0017	0.0022

Daily Portfolio Information (Based on the previous 200 trading days)

5 Worst 1-Day Portfolio Returns	
1	-11.09%
2	-10.65%
3	-10.33%
4	-10.08%
5	-9.87%

	Historical Average Daily Return	Standard Deviation
Entire Portfolio	-0.12%	3.39%

Banca Napoli traditionally holds capital for the market risk associated with this portfolio equal to the 10-day VAR computed using the variance-covariance method at a 99% confidence level based on the yearly historical data. When converting 1-day VAR to 10-day VAR, Banca Napoli assumes markets are efficient and daily returns are independent and identically distributed. The table below shows historical capital levels for this portfolio.

Prior Year Capital Levels (per euro of exposure)	
Year	10-day VAR
2007	0.0577
2008	0.0766
2009	0.0676

10. Continued

You are given the following standard normal distribution values:

x	$\Phi(x)$	$\Phi(-x)$
2.17	0.985	0.015
2.33	0.990	0.010
2.58	0.995	0.005

(a) (*2 points*) Identify and describe four sources of market risk associated with this portfolio.

(b) (*4 points*) Calculate the 10-day VAR of the portfolio at the 99% confidence level using the following methods. Show your work.

(i) Variance-covariance method using each of the two sets of projection information above

(ii) Historical simulation method

(c) (*2 points*) Explain why the VAR amounts calculated above in (b)(i) and (b)(ii) differ.

(d) (*1 point*) Recommend the amount of capital to be held by Banca Napoli and identify the considerations taken in arriving at your recommendation.

(e) (*3 points*) You want to perform an Incremental VAR (IVAR) analysis for this portfolio. You plan to dispose of one of your three positions and allocate the proceeds evenly between the two remaining positions.

Using the variance-covariance method and the historical data for the most recent year, determine which asset should be eliminated from the portfolio based on 10-day IVAR calculated at a 99% confidence level.

11. (*11 points*) The following mathematical axioms have been proposed in relation to a risk measure $\rho(X)$, where X represents a loss random variable, and α and λ represent real numbers.

(A) $\rho(X) = \rho(\max(X, 0))$

(B) $\rho(\lambda X) = \lambda\rho(X)$, for $\lambda \geq 0$.

(C) $\rho(X_1 + X_2) \leq \rho(X_1) + \rho(X_2)$

(D) If $\Pr[X > 0] \neq 0$ then $\rho(X) > 0$

(E) $\rho(X + \alpha) = \rho(X) + \alpha$

(F) If X_1 is always less than or equal to X_2 then $\rho(X_1) \leq \rho(X_2)$

(a) (*1 point*) Associate each axiom (i) through (vi) below with the appropriate mathematical expression (A) through (F) above.

(i) Translation Invariance Axiom

(ii) Positive Homogeneity Axiom

(iii) Monotonicity Axiom

(iv) Relevance Axiom

(v) Conservatism Axiom

(vi) Subadditivity Axiom

(b) (*4 points*) Explain briefly in words the meaning of each of the axioms above, in the context of a risk measure used to determine capital adequacy.

(c) (*5 points*) Determine whether each of the axioms above is satisfied by the standard deviation principle:

$$\rho(X) = E[X] + \beta\sigma[X], \quad \beta > 0 .$$

Show your work.

(d) (*1 point*) State with reasons whether the standard deviation principle is coherent.

12. (*10 points*) You are the CFO of TelCo, a telecommunications company. You have been asked by the Board of Directors to consider alternatives to increase return on equity (ROE).

As of year-end 2009 TelCo has $100 million in capital with 80% equity and 20% debt. TelCo's 2010 interest expense will be $1 million for this capital structure.

As of January 1, 2010, you are considering issuing bonds and using the proceeds to retire outstanding shares so as to achieve a capital structure of 50% equity and 50% debt. The bonds would be issued at a 7% interest rate.

The following are projected income statement items for 2010 for both the current and proposed capital structures:

- Sales are $100 million
- Operating expenses are $80 million
- Corporate tax rate is 30%
- Dividends to shareholders are 25% of net income
- Debt servicing for 2010 is interest only

(a) (*4 points*) Calculate the impact on ROE resulting from the proposed change in capital structure. Show your work.

(b) (*4 points*) You are concerned that the proposed change in capital structure will affect TelCo's credit quality and ability to issue future debt at reasonable costs.

(i) Identify three additional financial ratios that you would consider in determining the effect of the change in capital structure on TelCo's credit standing.

(ii) Calculate the impact of the proposed change in capital structure on these ratios. Interpret your results.

(iii) Identify and describe two Comparative Ratio Analyses that you can use to evaluate TelCo's competitive credit position.

(c) (*2 points*) Recommend whether to adopt the proposed capital structure based solely on your analysis in parts (a) and (b) above. Justify your recommendation.

****END OF EXAMINATION****
AFTERNOON SESSION