
SOCIETY OF ACTUARIES

Exam AFE

Advanced Finance/ERM

Exam AFE

AFTERNOON SESSION

Date: Thursday, November 4, 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.

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

8. (11 points) Company XYZ, a large life insurance company, recently revamped its performance measurement and compensation framework to reflect managerial risk taking, in alignment with its ERM framework.

Mike Ashe, the vice president of one of XYZ’s divisions, has the following compensation package under the new framework:

I. Cash Compensation

- \$200,000 per year; plus
- 0.05% of the division’s year-end value in-force (VIF), where VIF is calculated using economic capital (EC) as its capital basis; plus
- 0.01% of the division’s distributable earnings for the year.

The total annual cash compensation cannot be less than \$150,000.

II. 750 shares of XYZ’s common equity at year-end.

Mike Ashe is considering a new project for his division. The project lasts for one year and has no additional income after it ends. The economy in the coming year is expected to be in one of two possible states, Good and Bad, with the impacts of each state on XYZ shown in the table below.

	Good	Bad
Project Distributable Earnings	\$25M	-\$15M
Distributable Earnings (in the absence of the project)	\$100M	-\$100M
Project Impact on PV of Division’s Cost of Capital	-\$60M	\$120M
Year-end VIF (in the absence of the project)	\$500M	\$400M
XYZ’s common share price at year end	\$24	\$16

8. Continued

In Mike Ashe's opinion, there is a 66% chance of the Good state occurring.

- (a) (2 points) Outline the considerations that XYZ needs to make when implementing EC for performance measurement and compensation, as in the case of Mike Ashe's compensation package.
- (b) (2 points) Evaluate the components of Ashe's compensation package with respect to its effects on his strategic risk-taking.
- (c) (7 points) Ashe's marginal utility function is $U=W^{0.8}$, where W is his compensation package. Ignoring the effects of taxes, determine whether or not Mike Ashe would accept this project. Justify your answer quantitatively.

9. (12 points) You are the appointed actuary for Bear Life (BL), a small life insurance company that had traditionally sold the following products in the central United States through a captive agency force:

- Smart Start UL – A product aimed at new parents who wish to purchase small amounts of life insurance for their young children and use accumulated cash values to help pay for college-related expenses.
- Safe Choice Term – A product aimed at individuals in their 30’s and 40’s who wish to purchase modest amounts of coverage on themselves to provide replacement income for their families in the event of premature death.

At the end of 2007, BL hired a new chief underwriter, Mr. Pato, who introduced a preferred underwriting class for both products. At the same time, BL initiated a new marketing agreement with a national brokerage firm, which agreed to distribute BL products.

You are reviewing the latest mortality experience studies for the entire product portfolio:

Experience Year	2006	2007	2008	2009
Net Amount at Risk (\$000)				
Standard Non Smoker	22,223	23,779	23,898	24,017
Standard Smoker	4,000	4,480	4,570	4,661
Preferred Non Smoker	-	-	2,378	2,853
Total Net Amount at Risk	26,223	28,259	30,845	31,532
Claims (\$000)	354	384	406	414
Claims Rate Per Thousand	13.5	13.6	13.2	13.1

- (a) (1 point) Regarding the new preferred risk class, Mr. Pato has stated, “The higher the level of mortality at the dividing line between standard and preferred risks, the higher the mortality for both groups.” Explain this statement.
- (b) (2 points) Mr. Pato argues that the decline in the aggregate mortality claims rate is indicative of the positive changes he has introduced since joining BL.
- Provide three examples of how Mr. Pato’s actions may have favorably influenced the aggregate mortality claims rate.
 - Provide three examples of other influences, not attributable to Mr. Pato’s actions, and briefly describe how they may have impacted the aggregate mortality claims rate.

9. Continued

- (c) (2 points) Recommend four improvements to BL's experience study methodology that could enhance BL's understanding of its mortality experience. Justify your recommendations.

Responding to demand from the national brokerage firm, BL is developing a new product:

- Smart End UL – A joint life second-to-die product aimed at retired couples who wish to purchase large amounts of coverage on themselves to provide a tax-efficient transfer of their wealth to their descendants.

You are currently developing pricing assumptions for this new product.

- (d) (1 point) You have been asked to consider a 3% reduction to all mortality rates in the pricing assumption. Evaluate the appropriateness of this assumption change.
- (e) (4 points) You are considering using one of the following two copulas to handle the correlated mortality expected with a joint life last-to-die product:

Clayton Copula: $C(u, v) = (u^{-\theta} + v^{-\theta} - 1)^{-1/\theta}$

FGM Copula: $C(u, v) = uv[1 + \theta(1-u)(1-v)]$

Hint: $F(x, y) = C(F_X(x), F_Y(y))$
 $= \text{Prob}(X \leq x, Y \leq y)$
 $u = F_X(x), v = F_Y(y)$

- (i) Explain how copulas simplify the task of creating a correlated mortality assumption.

Question 9 continued on next page

9. Continued

(ii) Using each of the two copulas with the following parameters:

- Clayton Copula with parameter $\theta = 0.3$
- FGM Copula with parameter $\theta = -0.1$

Calculate the probability of BL paying a death benefit in the ten-year period following the issue of a Smart End UL on two lives both age 75. The probability of survival for ten years for each life is ${}_{10}p_{75} = 0.56$. Show your work.

(iii) Recommend one of the copulas above by comparing the results to that when independent deaths are assumed.

(f) (2 points) Explain how the presence of the preferred class can affect the expense and lapse pricing assumptions.

THIS PAGE INTENTIONALLY LEFT BLANK

10. (15 points) You are a risk management actuary at Micro-Metro Insurance Company (MMIC). Recently, the company has been focusing its efforts on the effective management of credit migration risk. The Chief Risk Officer (CRO) of MMIC has asked you to look into implementing economic capital (EC) for credit migration risk.

A particular portfolio at MMIC has two assets:

- One A rated bond with \$1 million face value, 6% annual coupon, and 4 years to maturity.
- One BB rated bond with \$1 million face value, 8% annual coupon, and 4 years to maturity.

The investment area has provided the following information:

One-Year Transition Matrix:

Initial Rating	Rating at end of the year					
	AAA	AA	A	BBB	BB	Default*
AAA	91%	7%	3%	0%	0%	0%
AA	2%	91%	5%	2%	0%	0%
A	1%	10%	79%	9%	1%	0%
BBB	0%	1%	6%	86%	4%	3%
BB	0%	0%	4%	12%	74%	10%

*Bond recovery rate = 40% of face value

One-Year Forward Zero Curve:

Category	Year 1	Year 2	Year 3
AAA	4.25%	5.00%	5.25%
AA	4.60%	5.25%	5.55%
A	4.65%	5.35%	5.75%
BBB	5.00%	5.80%	6.30%
BB	5.45%	6.15%	6.95%

- (a) (2 points) The CRO is not familiar with the concept of credit VaR, which is used by CreditMetrics. However, he is somewhat familiar with the concept of market VaR.
- Explain the calculation challenges that credit VaR poses relative to market VaR.
 - Outline the steps used to calculate credit VaR for a single bond instrument under the CreditMetrics framework.

10. Continued

(b) (4 points) Assume:

- The credit migration component of EC is defined to be the 99.9% one-year VaR of the change in the value of the asset portfolio due to credit migration.
- The credit qualities of the two bonds in the MMIC portfolio are not correlated.

Calculate the year-end credit migration component of EC for the MMIC portfolio. Show your work.

(c) (6 points) To manage its credit migration risk exposure, MMIC is considering the purchase of a two-year credit default swap (CDS) on the BB-rated bond above. In the event of default of the underlying BB-rated bond, the counterparty would pay MMIC the face value of the bond in return for a payment from MMIC representing the recovery value of the BB-rated bond. If default does not occur, the CDS pays nothing. (Assume a non-default credit rating downgrade does not qualify as default). Assume the following:

- The CDS writer does not default on its obligation;
- The one year transition matrix remains constant over the two years;
- The cost of the swap can be ignored.

(i) Calculate the expected value of the CDS's net payoff amount for MMIC at the end of each year.

(ii) Calculate the reduction in the credit migration risk EC at the end of the first year that would be gained from purchasing the CDS.

(d) (3 points) Assume:

- The probability of the CDS writer defaulting on its obligation to MMIC at the end of first year is 10% and at the end of the second year is 15%.
- At issue, the counterparty provides 12% of face value in collateral to MMIC in the form of government securities earning 3% per annum. The collateral is forfeited to MMIC in the event of the counterparty's default on the swap payment.
- The counterparty exposure to the CDS writer is uncorrelated with the credit rating migration of either bond.

Determine the mark-to-market value of the CDS at time 0 using a discount rate of 4.50% for each year.

11. (15 points) Hamsik Life and Annuity is reviewing its variable annuity product, which has the following features:

- The policyholder can allocate the account value between the separate account and the general account.
- For funds in the separate account, the policyholder may allocate funds among several fund options.
- The general account credits the portfolio earned rate less a 75 basis point spread, subject to a guaranteed minimum crediting rate of 3%.
- Transfers from the general account to the separate account do not have a market value adjustment.
- There are no surrender charges.
- The current M&E charge, assessed on the total account value, is 100 basis points and is guaranteed not to exceed 175 basis points.
- There are no restrictions on premium deposit amounts or timing.
- Maturity is 20 years from policy issue.
- At issue, the policyholder can elect one of the following maturity options:
 - I. Annuitize the maturing account value using a guaranteed annuity option (“GAO”) where the policyholder will receive a 15-year term-certain immediate annuity based on the long term interest rate either at issue or maturity whichever produces larger benefit payments.
 - II. Receive a guaranteed minimum maturity benefit (“GMMB”) payout equal to the greater of the account value at maturity and the cumulative premiums paid.

The current long-term interest rate is the same as it was at issue, 7%. You are given the annuity factors $\ddot{a}_{\overline{15}|5\%} = 10.90$, $\ddot{a}_{\overline{15}|7\%} = 9.75$, and $\ddot{a}_{\overline{15}|9\%} = 8.78$.

- (a) (2 points) Briefly describe the options granted:
- (i) By Hamsik to the policyholder;
 - (ii) By the policyholder to Hamsik.

11. Continued

- (b) (2 points) Provide a formulaic expression for the projected random payoff amount of the following options at maturity as described above, defining your terms:
- (i) GMMB option
 - (ii) GAO option
- (c) (4 points) For each expression in part (b):
- (i) Rate the components as high, medium or low in terms of their relative impact on the projected payoff of the option. Justify your rating.
 - (ii) Determine the direction for each of these components that would increase the projected payoff of the option, and explain why this is the case.
- (d) (5 points) Hamsik is determining the investment strategy for assets backing the guarantees for each maturity option. The two investment choices are:
- Invest solely in long-term bonds, earning 7% for 20 years.
 - Invest solely in the same underlying funds as the policyholder.

Assume all premiums are paid at issue, the policyholder puts all funds in the separate account option, and total decrements realized from issue to maturity are 3% per year.

Given the following scenarios, complete the table below with the dollar investment required at issue to fund each liability at maturity using each investment strategy. Show your work.

- Scenario 1: Initial fund: 1,000; Underlying fund at maturity: 10,000; Long-term interest rate at maturity: 5%
- Scenario 2: Initial fund: 1,000; Underlying fund at maturity: 1,000; Long-term interest rate at maturity: 9%

Question 11 continued on next page

11. Continued

Scenario #	Option	Investment Strategy	Dollar Investment Required
1	GMMB	Long-term Bonds	
		Underlying Funds	
	GAO	Long-term Bonds	
		Underlying Funds	
2	GMMB	Long-term Bonds	
		Underlying Funds	
	GAO	Long-term Bonds	
		Underlying Funds	

- (e) (1 point) Recommend a general investment strategy for each maturity option and explain your reasoning.
- (f) (1 point) Suggest improvements in the analysis in part (d) regarding the decrement assumption.

12. (7 points) Consider the following:

Case 1: A US bank's risk management team includes the CRO, one FSA and two entry-level actuarial students.

Case 2: A cutting-edge Canadian bank that is consistently first to market new products approves risk management initiatives within six months of releasing the product.

Case 3: Due to staffing cuts, a US financial conglomerate now reviews its internal controls over interest rate risk processes on an ad hoc basis, with reviews expected to take place every three to five years.

(a) (2 points) For Case 1:

- (i) Identify concept(s) from the G-30 framework which apply to this case.
- (ii) Identify concept(s) from the Basle framework which apply to this case.
- (iii) Describe how the case is deficient relative to these frameworks and propose one corrective action.

(b) (3 points) For Case 2:

- (i) Identify concept(s) from the COSO framework which apply to this case.
- (ii) Identify concept(s) from the OSFI framework which apply to this case.
- (iii) Identify concept(s) from the Basle framework which apply to this case.
- (iv) Describe how the case is deficient relative to these frameworks and propose two corrective actions.

(c) (2 points) For Case 3:

- (i) Identify concept(s) from the COSO framework which apply to this case.
- (ii) Identify concept(s) from the Basle framework which apply to this case.
- (iii) Describe how the case is deficient relative to these frameworks and propose one corrective action.

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

USE THIS PAGE FOR YOUR SCRATCH WORK

USE THIS PAGE FOR YOUR SCRATCH WORK

USE THIS PAGE FOR YOUR SCRATCH WORK