SOCIETY OF ACTUARIES
Quantitative Finance and Investment Advanced Exam

Exam QFIADV

AFTERNOON SESSION

Date: Thursday, October 30, 2014
Time: 1:30 p.m. – 3:45 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This afternoon session consists of 6 questions numbered 10 through 15 for a total of 40 points. The points for each question are indicated at the beginning of the question.

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. When you are asked to recommend, provide proper justification supporting your recommendation

5. When you finish, insert all your written-answer sheets into the Essay Answer Envelope. Be sure to hand in all your answer sheets because 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 QFIADV.

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 QFIADV-Front Cover

****BEGINNING OF EXAMINATION****
Afternoon Session
Beginning with Question 10

10. (*6 points*) According to Saunders and Allen the three phases that led to the 2008 Global Credit Crisis are:

Phase 1: Credit Crisis in the Mortgage Market
Phase 2: The Crisis Spreads – Liquidity Risk
Phase 3: The Lehman Failure – Underwriting and Political Intervention Risk

(a) (*3 points*) Describe and explain how the events within each of the above phases contributed to the 2008 Global Credit Crisis.

An economic futurist has issued a report describing a possible credit scenario that could take place in the future between January 1, 2016 and December 31, 2021. The key points from the report are:

- Terrorist attacks resulted in a significantly reduced supply of crude oil to the United States;
- Stock markets collapsed;
- Auto fuel rates skyrocketed;
- Consumer demand for hybrid and electric cars skyrocketed, driving the price of these vehicles upward from their already high rates;
- Automakers' leasing rates dropped to all-time lows and terms were extended from traditional 5 years to terms to greater than 10 years;
- Automakers' finance departments were collateralizing these loans as ABS and selling them in the open market;
- To manage inflation and liquidity, the Federal Reserve dropped the Federal Funding Rate to record lows.

Your manager has read this report and is concerned that a situation like the one described in the report will lead to a repeat global credit crisis.

(b) (*3 points*) Compare and contrast the futurist's scenario with the 2008 Credit Crisis.

11. (*8 points*) You have been asked to evaluate Model M for multi-period attribution, using your company's investment performance data.

You are given the following information:

- Your company manages its portfolio in a top-down fashion, and interaction return has been folded into asset allocation return.
- Scaling coefficients in Model M for each period are defined such that the sum of the scaled single-period outperformance is equal to the total multi-period outperformance.
- Model M follows the optimized linking coefficient approach (Jose Menchero), using the formulae below:

$$R^P - R^B = \sum_t \beta_t \left(R_t^P - R_t^B \right)$$

$$A = \frac{\left(R^P - R^B \right) / T}{\left(1 + R^P \right)^{1/T} - \left(1 + R^B \right)^{1/T}}$$

$$C = \frac{R^P - R^B - A \sum_{t=1}^{T} \left(R_t^P - R_t^B \right)}{\sum_{t=1}^{T} \left(R_t^P - R_t^B \right)^2}$$

$$\beta_t = A + C \left(R_t^P - R_t^B \right)$$

Investment performance data for your company:

1st Quarter

Credit Quality	Portfolio Weight (%)	Benchmark Weight (%)	Portfolio Return (%)	Benchmark Return (%)
AA	40	40	4	4
BB	30	20	6	5
B	30	40	10	8
Total	100	100	6.4	5.8

2nd Quarter

Credit Quality	Portfolio Weight (%)	Benchmark Weight (%)	Portfolio Return (%)	Benchmark Return (%)
AA	70	40	-3	-2
BB	20	30	-2	-3
B	10	30	-4	-3
Total	100	100	-2.9	-2.6

11. Continued

3rd Quarter

Credit Quality	Portfolio Weight (%)	Benchmark Weight (%)	Portfolio Return (%)	Benchmark Return (%)
AA	30	50	-2	-2
BB	50	40	-3	-3
B	20	10	-4	-4
Total	100	100	-2.9	-2.6

4th Quarter

Credit Quality	Portfolio Weight (%)	Benchmark Weight (%)	Portfolio Return (%)	Benchmark Return (%)
AA	30	40	4	2
BB	50	40	4	3
B	20	20	5	6
Total	100	100	4.2	3.2

Total multi-period return	Portfolio Return (%)	Benchmark Return (%)
	4.8	3.8

(a) (*1 point*) Calculate the asset allocation return and security selection return in Quarter 1 for the portfolio before any scaling coefficient is applied.

(b) (*3 points*) Calculate β for Quarter 1.

(c) (*1 point*) Describe the motivation for the β term in this model.

(d) (*1 point*) Calculate the scaled asset allocation and security selection in Quarter 1 for the portfolio.

Your company has specified the following criteria it requires for a return attribution model:

(i) The sum of the return splits remains equal to the total return

(ii) Order dependence (the ordering of the periods affects the cumulative attribution results)

(iii) Scaling factors are not greater than 1.01 for any period when the company's investment performance data is used

(e) (*2 points*) Assess whether Model M meets each criterion specified by your company.

12. (*7 points*) Balanced Life Insurance Company mainly writes Single Premium Immediate Annuities. In order to match the long term nature of its liabilities and to maximize the investment return, the company invests in "A" rating or higher corporate bonds. A simple internal Cox, Ingersoll and Ross (CIR) stochastic intensity model was developed to estimate the probabilities of default. The following defines the process used in the CIR stochastic intensity model:

$$d\lambda_t = \kappa\left(\theta - \lambda_t\right)dt + \sigma\sqrt{\lambda_t}\,dB_t$$

Where B_t is a standard Brownian motion under the risk neutral measure. The coefficients λ_0 (initial rate of the intensity), κ, θ and σ are all positive constants.

(a) (*1 point*) Express the probability of default before time *t* conditional on survival to time $s < t$.

Simulations based on the following parameters were generated:

Parameter	Parameter Set 1	Parameter Set 2	Parameter Set 3
λ_0	2%	2%	2%
θ	2%	2%	2%
κ	0.7	0.7	1.5
σ	10%	15%	10%

You are given the following:

$\mathrm{Var}\left(\lambda_t\right)$ = Variance of λ_t as seen from time 0

$\mathrm{LTE}\left(\lambda_t\right)$ = long-term mean of λ_t as *t* tends to infinity

$\mathrm{LTVar}\left(\lambda_t\right)$ = long-term variance of λ_t as *t* tends to infinity

12. Continued

Some of the results of the simulations were summarized in the following table:

	Parameter Set 1	Parameter Set 2	Parameter Set 3
$\text{Var}(\lambda_1)$	A	V	X
$\text{Var}(\lambda_9)$	0.014%	0.032%	B
$\text{LTE}(\lambda_t)$	Y	2%	C
$\text{LTVar}(\lambda_t)$	D	Z	0.007%

(b) (*3 points*) Calculate A, B, C and D in the above table.

(c) (*3 points*) Explain how changes to each of the following affect the distribution of forward default intensity based on the results obtained in part (b).

(i) Volatility Coefficient (σ)

(ii) Mean rate of reversion to the long-run mean (κ)

13. (*7 points*) You are the portfolio manager of XYZ Investment Management Services and have been asked to review the credit risk and liquidity risk of your client's portfolio. The following information was given to you to review the liquidity risk of the portfolio:

Bond	A	B	C	D	E
Issuer	I	II	III	IV	V
Option Adjusted Spread Duration (OASD)	6.7	5.9	6.3	4.6	5.4
Bid Price					99.2
Ask Price					108.4
Bid Spread in Basis Points	520	380	470	490	600
Ask Spread in Basis Points	475	330	410	436	
Benchmark?	Yes	Yes	No	No	Yes
Adjustment Factor			1.5	1.6	
Actual Weighting	15%	20%	22%	25%	18%

Client's Investment Policy constraints:

(i) Liquidity risks: LCS as a percentage of OASD must be less than 1.5% for each bond holding

(ii) Credit risks: Issuer's limit on the overall contribution to DTS must be 6 or less when based on Bid Spread

(a) (*3 points*) Determine whether each asset in the portfolio complies with the liquidity risk constraint in the Investment Policy.

(b) (*2 points*) Describe the advantages and disadvantages of establishing issuer limits based on spreads relative to ratings-based approach.

(c) (*2 points*) Determine whether the current portfolio complies with the credit risks requirement of the Investment Policy.

14. (*6 points*) You are a risk actuary at LifeCo. You are assigned to investigate the credit risk models in the market and identify an appropriate risk model for mortgage losses of LifeCo.

(a) (*2 points*) Describe briefly how credit losses are modeled for each of the 4 main types of credit risk models.

(b) (*1 point*) Explain the two modes of calibration that CreditPortfolio View (CPV) uses to simulate the segment-specific conditional default probabilities.

(c) (*2 points*) Compare and contrast the probability of default modeling approaches of KMV and CreditRisk+.

The mortgage default experience of LifeCo is calibrated in both KMV and CreditRisk+. The resulting parameters in two models have the same first and second moment. The default experience shows a fat tail of losses.

(d) (*1 point*) Recommend one of the two models for modeling mortgage defaults and explain the reason.

15. (*6 points*) Adam is a grade 5 student who just started at NuSchool Elementary School. At his previous school, OldSchool Elementary, he was an exceptional marble player and won lots of marbles. However, the students at OldSchool could not pay Adam his winnings right away which left Adam being owed marbles.

To encourage the OldSchool Elementary students to give Adam his marbles, Adam charges 1 marble for every 10 marbles owed for every week until the marbles are repaid in full.

The amount owed to Adam is given in the table below:

Grade	Number of Students Who Owe Adam Marbles	Total Number of Original Marbles Owed to Adam	Total Number of Extra Marbles Paid to Adam Weekly
1	6	400	40
2	4	200	20
3	8	500	50
Total	18	1100	110

Adam was not a people-person and had a difficult time managing and collecting on all the debts owed to him from the OldSchool Elementary students. Additionally, Adam did not like having these debts owed to him and just wanted his marbles.

Donald, a people-person from NuSchool Elementary grade 4 class, decided to help Adam and gave him 1000 marbles in exchange for the debts.

Donald was nervous about having all these debts and wanted to get some of his marbles back. Donald decided to offer some deals to Eric, Fred and George who each had 300 marbles. In exchange for their marbles Donald would give them some of the marbles being paid by the OldSchool students. Eric was a little nervous about the deal; George was very excited about the deal; and Fred was indifferent.

15. Continued

The details of Donald's deals with Eric, Fred and George are given in the table below:

	Eric	Fred	George	Donald's remaining piece
Amount of original marbles given to Donald upfront	300	300	300	
Amount of original marbles returned to Eric, Fred or George	300	300	300	After all original marbles are returned to Eric, Fred and George, the remaining marbles are Donald's
Calculation formula of extra marbles paid to Eric, Fred or George	1 marble for every 30 outstanding per week	1 marble for every 20 outstanding per week	1 marble for every 5 outstanding per week	None
Order in which marbles are paid to Eric, Fred or George	First	Second	Third	Last

If Donald does not recover all 900 marbles plus due extra marbles that he owes Eric, Fred and George by the end of week 3, then Bruno, Donald's Dad, has promised to replace any marbles Donald still owes at that point, up to a maximum of 100 marbles.

If OldSchool students move then the marbles that they owe to Donald will be assumed to never be repaid. Eric, Fred, and George will not receive extra marbles on these amounts.

QUESTION CONTINUED ON NEXT PAGE

15. Continued

(a) (*3 points*)

(i) Describe how asset securitization is being used in the elementary playground example provided above.

(ii) Sketch a diagram that displays the structure labeling all key participants and asset flows.

(b) (*2 points*)

(i) List the three key areas structured finance professionals focus on when evaluating an Asset-backed Security.

(ii) Critique the asset securitization represented in the elementary playground example provided above being sure to include each of the key areas.

(c) (*1 point*) List and describe the benefits and motivations of the elementary playground asset securitization above for each of the different participants:

(i) OldSchool Elementary students that are indebted to Adam

(ii) NuSchool Elementary students that deal with Donald

(iii) Donald

(iv) Adam

****END OF EXAMINATION****
Afternoon Session

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