SOCIETY OF ACTUARIES
Quantitative Finance and Investments

Exam QFI ADV

AFTERNOON SESSION

Date: Thursday, October 31, 2013
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 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 QFI ADV.
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.

475 N. Martingale Road
Schaumburg, IL 60173-2226

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Exam QFI ADV-Front Cover

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

10. (*4 points*) Consider the following Vasicek model:

$dr(t) = k\left[\theta - r(t)\right]dt + \sigma dW(t)$, where k, θ, σ and $r(0)$ are all positive constants.

(a) (*1 point*) Interpret each of the parameters in the model given above.

(b) (*1 point*) Explain why the Vasciek model is an affine term-structure model.

You are considering the following models to price a European swaption, in a country where negative interest rates are possible.

(i) Vasicek Model

(ii) Cox, Ingersoll and Ross Model

(iii) Gaussian Model G2++

(c) (*2 points*) Assess the appropriateness of each model.

11. (*7 points*) You have been asked by Millennium Corp. to develop a liquidity plan for a new block of individual life policies.

(a) (*1 point*) Discuss implications of permitting the policyholder to surrender with little or no penalty.

(b) (*1 point*) Discuss considerations when setting up back-stop liquidity lines.

Millennium Corp. projects that the new block would generate a total of $500 million in new premium on January 1 equally divided amongst the new policyholders.

Millennium Corp. intends to invest the premium in the following portfolio with income from these assets paid annually as follows:

Asset	Invested Amount ($million)	Income payable December 31 ($million)
Commercial Mortgages	$250	$11
AAA-rated CMBS	$125	$4
BBB-rated Corporate Bonds	$125	$5

Policyholders can surrender at any time and receive the initial premium back less a surrender charge determined as a sliding scale of initial premium beginning at 18% for the first year, grading down thereafter.

The CFO of Millennium Corp. is looking at two scenarios: base and stress.

Expected death benefits and expenses do not vary between the two scenarios in the first year and equal $10 million. No lapse is assumed in the base scenario.

The stress scenario is characterized by the following:

- A $5 million borrowing line from the parent is available and additional funding may be available
- None of the commercial mortgages can be sold
- All CMBS can be sold but with a 20% haircut
- All corporate bonds can be sold but with a 25% haircut
- 50% of the policyholders surrender

The CFO believes that cash flow cushion is a useful measure of liquidity risk and wants to target a ratio of at least 1.1 under all scenarios.

11. Continued

(c) (*2 points*) Calculate the cash flow cushion at the end of the first year under the base scenario and the stress scenario.

(d) (*1 point*) Determine the additional funding, if needed, under both scenarios to achieve the target ratio.

The investment policy of Millennium Corp. permits CMBS, commercial mortgages, CMO's, investment grade corporate bonds, cash, and U.S. Treasury bonds.

(e) (*2 points*) Recommend and justify changes to the asset portfolio to reduce liquidity risk given the investment policy.

12. (*7 points*) You are analyzing the log returns of 20 assets. Let the time series $\{r_{1t}\}, \{r_{2t}\}, \cdots, \{r_{20t}\}$ denote the past data of these 20 assets in an investment portfolio.

You are given the following:

- These time series are all weakly stationary.
- The concurrent coefficient $\rho_{25}(0) = 0.3$.
- The lag-3 cross-correlation coefficient $\rho_{25}(3) = 0.35$.

(a) (*1 point*) Determine the values of correlation coefficients $\rho_{22}(0)$, $\rho_{52}(0)$ and $\rho_{55}(0)$.

(b) (*1 point*) Explain whether $\rho_{52}(3)$ can be obtained using the same approach as for (a).

(c) (*1 point*) Describe the situation in which $\{r_{5t}\}$ and $\{r_{10t}\}$ are said to be uncoupled.

Assume that $\{r_{5t}\}$ and $\{r_{10t}\}$ are uncoupled.

(d) (*1 point*) Determine whether we can conclude that $\{r_{5t}\}$ and $\{r_{10t}\}$ have no linear relationship.

You plan to apply the multivariate Portmanteau test to confirm that there are no auto-correlations and cross-correlations at lag 1. You will be using a sample size of 500 and a significance level of 5%.

(e) (*1 point*) Outline the steps required to apply the multivariate Portmanteau test.

(f) (*1 point*) Identify the asymptotic distribution of the test statistic $Q_k(m)$, under the null hypothesis.

You have determined that the critical value of the test statistic is 9.488, and the ratio of the computed test statistic to the sample size is 0.02.

(g) (*1 point*) Conclude whether you can reject the null hypothesis of the test and justify your answer.

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13. (*7 points*) You are an Actuary working for Wrigley Invest Co. Ltd. where you are responsible for performance measurement and performance attribution.

(a) (*1 point*) Briefly describe Performance Attribution.

You have prepared the following exhibit for one of your client portfolios:

Breakdown of Local Performance per Local Market

	Euro	Indian Rupee	China Renminbi	US Dollar	Total
Portfolio Weight (%)	20%	40%	30%	10%	100%
Local Management (bps)	4	22	18	-9	35
Yield Curve	-5	16	14	3	28
Asset Allocation	3	3	-2	2	6
Security Selection	6	3	6	-14	1

(b) (*1 point*) Calculate the outperformance (in bps) for each of the following:

(i) The Indian Rupee portion of the portfolio versus the Indian Rupee portion of the index.

(ii) The China Renminbi portion of the portfolio versus the China Renminbi portion of the index.

(c) (*1 point*) Conclude whether your client's investments in the Indian Rupee outperformed their investments in the China Renminbi.

You performed a performance attribution for the same client using a Total Return attribution model, and have prepared the following exhibit:

Asset Allocation Using the Total Return Model

	Market Weight (%) Average		Return Ex Common Factors	
Partition Bucket	Portfolio	Benchmark	Portfolio	Benchmark
Total	100	100	175	124
Corporate Bonds	29	16	114	185

13. Continued

(d) (*1 point*) Calculate each of the following for the Corporate Sector:

(i) The outperformance due to asset allocation.

(ii) The outperformance due to security selection.

(e) (*1 point*) Assess the portfolio manager's decisions with respect to asset allocation and security selection for the Corporate sector.

Your client informs you that they would like their portfolio to be exposed to many risks, and to include mortgage backed securities and inflation-linked bonds. They would like to allocate their capital based on risk exposures.

(f) (*2 points*) Recommend an appropriate performance attribution distribution model for your client, and support your recommendation.

14. (*7 points*) You are an actuary working for the Miracle Mile Life Insurance company. Your manager has asked you to analyze an equity portfolio consisting of 4 stocks: VVV, WWW, YYY and ZZZ.

(a) (*1 point*) Interpret the first and second principal components in principal component analysis, and identify any constraints.

You have performed a principal component analysis of the estimated covariance matrix for the stock returns, and obtained the following results:

	Component 1	*Component 2*	*Component 3*	*Component 4*
Eigenvalue	2.374	1.584	0.041	0.001
Eigenvector	0.610	0.271	-0.165	-0.726
	-0.121	0.774	0.620	0.046
	0.602	0.291	-0.296	0.682
	0.501	-0.492	0.708	0.076

(b) (*2 points*) Recommend how many principal components should be used in your statistical factor analysis and justify your recommendation.

(c) (*2 points*) Estimate the communality and specific variance of the returns on stock VVV using the principal components recommended in (b).

You have performed a factor rotation of the factor loadings and obtained the following results for the first component:

Stock	*Un-rotated Factor Loadings Component 1*	*Rotated Factor Loadings Component 1*	*Rotated Factor Loadings Component 2*
VVV	0.939	0.998	-0.055
WWW	-0.188	0.210	*a*
YYY	0.928	0.998	-0.027
ZZZ	0.771	0.467	-0.873

(d) (*1 point*) Explain why the communality and specific variance is not affected by the rotation.

(e) (*1 point*) Determine the value of the missing rotated factor loading *a* for component 2.

15. (*8 points*) You are an investment risk manager newly hired at The Great Grant Investment Firm (TGGIF) by the Chief Risk Officer (CRO), also newly hired. Recently, TGGIF has had a run of mediocre results both in terms of its own investment earnings as well as lost income from fee-for-service client defections. One source of possible underperformance is believed to be the activity of the Investment Advisory Committee which consists of 15 trading professionals in the firm who were personally selected by the Chair of the Committee.

The company has hired an outside consultant to provide observations on the committee. The consultant has just issued a high level report on their findings. Given your recent exposure to behavioral finance, the CRO wants you to explain to him a few of the findings so that he can use this information to help guide changes to the Committee in an effort to get back to superior results.

In particular, the report goes over several cognitive biases with a particular emphasis on anchoring and misconceptions of randomness.

(a) (*3 points*) Describe two tests that will illustrate how the decisions of the investment committee are affected by these biases.

The report has the following comments about the recent Committee meeting that was observed:

> "Much of the time is spent reading and discussing a large volume of reports containing numerous ten-year historical analyses of a set of similar investment strategies, led by a rather tyrannical Chairman. The Chairman was observed on multiple occasions opining on companies based on his personal experience with the products they produced."

(b) (*2 points*) Identify and explain in detail four additional biases that are likely being introduced by the meeting structure and behaviors of the Chairman.

Finally, the CRO asks you to report on alternatives to the current structure. He has asked you to concentrate on membership, the ideal chairman, and composition of the meeting agenda.

(c) (*3 points*) Recommend modifications to the Investment Advisor Committee structure that could improve the Committee's performance in the three areas suggested by the CRO.

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

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