
SOCIETY OF ACTUARIES
Quantitative Finance and Investment Advanced Exam

Exam QFIADV

AFTERNOON SESSION

Date: Thursday, October 29, 2015

Time: 1:30 p.m. – 3:45 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This afternoon session consists of 6 questions numbered 11 through 16 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.

****BEGINNING OF EXAMINATION****

Afternoon Session
Beginning with Question 11

11. (6 points) You have been asked to evaluate the performance of a group of 6 hedge fund managers hired by your company. Your first idea is to rely on publicly available indices to assess the performance of the different managers.

(a) (1 point) Describe four of the main differences in the constructions of the major manager-based hedge fund indices.

The different managers under evaluation claim that such indices present many biases.

(b) (2 points) Describe four different biases that an index may present including commentary on the direction of the bias.

You ask the different fund managers to report on their respective Sharpe ratio. You also calculate Sharpe ratios for the same funds; however, in most cases calculate different values.

There are no concerns surrounding the quality of the data used in either calculation, and in some cases it is exactly identical. You are also sure that there are no calculation errors.

(c) (2 points) Explain why different fund managers may obtain different results than you in this context.

A different manager points out to you that it's the downside risk that matters, not just the total volatility. Thus, they suggest you to use the Sortino ratio instead of the Sharpe ratio. The manager of Fund 2 sent you his quarterly return for the last year in order to compute the Sortino ratio:

Quarter	Q1	Q2	Q3	Q4
Annualize return %	1.00	4.35	2.00	5.05

Risk free return: 3.00%

(d) (1 point) Describe the formula and calculate the Sortino ratio for this fund

12. (8 points) You, an investment actuary at ABC Life, are modeling equity smiles in the U.S. market.

- (a) (1 point) Identify four basic facts of equity smiles.
- (b) (1 point) Discuss whether you would expect changes in implied volatility to be positively or negatively correlated with the level of the underlying and whether you would expect this correlation to be stronger with longer or shorter options.

You are considering different approaches for fitting equity smiles.

- (c) (1 point) Describe and compare a fully-stochastic-volatility model and a local volatility model.
- (d) (1 point) Explain the cause of the smile effect with a fully-stochastic-volatility model.
- (e) (1 point) Identify a problem surrounding using a diffusion-based fully-stochastic-volatility model to model smiles for short maturities and explain what could lead to such a problem.
- (f) (2 points) Explain two possible solutions to solve the problem in (e).
- (g) (1 point) Recommend one of the solutions in (f) and justify your recommendation.

13. (6 points) You are studying a number of different return series based on appraised prices of real estate properties. Some of the return series exhibit delayed response and smoothed prices.

(a) (1 point) List the four primary explanations for delayed price changes and smoothed prices.

You are given the following information for five different return series:

Series Name	Tradable or Non-Tradable	Transaction Cost Level	First-order autocorrelation (ρ)	Other information
A	Tradable	High	0.4	None
B	Tradable	High	0.6	None
C	Tradable	Zero, no trading barrier	N/A	None
D	Non-tradable	N/A	N/A	Volatility of smoothed returns is 1/3 of volatility of unsmoothed returns.
E	Non-tradable	N/A	0.65	Volatility of smoothed returns is 1/2 of volatility of unsmoothed returns.

(b) (3 points) Rank the five return series in order of increasing delay in price response and justify your ranking.

You are given the following information for a new return series:

Variance of the return series: 0.045

Variance of the one-period lagged returns: 0.04

Covariance of the returns series and the one period lagged returns: 0.024

The current period's reported return is 3% and previous period's reported return is 10%.

(c) (1 point) Estimate the unsmoothed return for the current period using first-order autocorrelation.

(d) (1 point) Describe potential issues with using smoothed returns when calculating risk or performing asset allocation.

- 14.** (6 points) PBJ Bank primarily conducts typical bank deposit business but has also recently become involved in small off-balance sheet activities.

One bank rating agency has recently downgraded two of PBJ’s competitors with liquidity ratios less than 15%.

The Enterprise Risk Management (ERM) VP of PBJ Bank has proposed the following annual liquidity measurement framework to you, a Senior VP of PBJ Bank. You are reviewing his approach using the following information provided by him:

Monitoring	<ul style="list-style-type: none"> Calculate the Liquidity Ratio as of the current valuation date (Performed quarterly) Liquidity Ratio = Cash & Short Term Assets / Demand Liabilities Demand Liabilities = surrender probability * net surrender value
Scenarios	<ul style="list-style-type: none"> Going Concern: Reflect the normal business but with management’s best estimate as to sales or cash flows. Panic Scenario: Reflect assumptions intended to cover a “run on the bank.” Situation.

Product Line:	Net Surrender Value (in millions)	Going Concern Surrender rate	Panic Scenario Surrender rate
GIC type (I)	5,000	0%	10%
GIC type (II)	1,000	5%	90%
GIC type (III)	3,500	10%	80%

Asset type	Market value (in millions)
Cash	360
Short Term Bonds	500
Long Term Bonds	2,500
Commercial Mortgages	1,000
Real Estate	5,300

- (a) (2 points) Calculate PBJ’s Liquidity Ratio under both the going concern scenario and the panic scenario.
- (b) (1 point) Describe the problems with the ERM VP’s proposed liquidity management approach.

The Chief Investment Officer (CIO) has recommended moving the cash position to mortgage-backed securities to increase the portfolio earned rate.

- (c) (1 point) Critique the CIO’s recommendation including consideration of the change in liquidity ratio.

14. Continued

The regulator is proposing a 3% limit on the raw leverage ratio which equals Tier 1 capital/Total exposure.

- (d) (2 points) Explain both the rationale for, and criticism against, a raw leverage constraint.

15. (8 points) You are an investment actuary at ABC Life and decide to use a two-factor short rate model to produce interest rate scenarios for liability valuation. You are considering real-market at-the-money cap volatilities and swaption volatilities to calibrate the model.

- (a) (2 points) List the considerations to determine the appropriate instruments for two-factor short rate model calibration.

You have produced forward rate scenarios based on the following Hull-White two-factor model parameters from calibration. You want to validate the scenarios by comparing scenario statistics with what the model implies.

\bar{a}	0.7
\bar{b}	0.1
σ_1	0.015
σ_2	0.01
$\bar{\rho}$	-0.2

The G2++ model is represented as follows:

$$r_t = x_t + y_t$$

$$\{r_t, t \geq 0\}$$

where the two factors are given by

$$dx_t = -ax(t)dt + \sigma dW_1(t)$$

$$dy_t = -by(t)dt + \eta dW_2(t)$$

and $\{W_1(t), t \geq 0\}$ and $\{W_2(t), t \geq 0\}$ are correlated Brownian motions with $dW_1(t)dW_2(t) = \rho dt$.

- (b) (1 point) Calculate the G2++ parameters equivalent to the parameterization of the Hull-White two-factor model above.
- (c) (2 points) Calculate the instantaneous correlation between 1-month forward rates and 10-year forward rates at time 0.

15. Continued

- (d) At time 0, the 1-month forward rate $f^M(0, 1/12)$ is 0.5%.
- (i) (1 point) Determine the formula for calculating the expected short rate at time $t = 1/12$.
- (ii) (1 point) Determine the formula for calculating the variance of the short rate at time $t = 1/12$.

You are given the expected short rate and variance of the short rate at time $t = 1/12$ in (d) are 0.44% and 0.1367%, respectively.

- (e) (1 point) Calculate the probability that the short rate at time $t = 1/12$ is negative.

16. (6 points) You are an investment actuary at SG Fund Investment (SG).

You are given the following information:

- SG invests entirely in various fixed income securities.
- SG tracks its portfolio performance against a benchmark portfolio.
- This year, SG outperformed the benchmark by 87 bps.

	Allocation		Excess Return (bps)		Outperformance (bps)	
	Portfolio	Bench.	Portfolio	Bench.	Asset Allocation	Security Selection
Treasury Bills	38%	33%	442	326	N/A	N/A
Government Bonds	28%	21%	354	268	N/A	N/A
Municipal Bond	12%	23%	<i>X</i>	321	N/A	<i>Z</i>
Corporate Bond	21%	15%	237	162	<i>Y</i>	N/A
Cash	1%	8%	0	0	N/A	N/A

- (a) (0.5 points) Describe how SG's excess return can be broken down by return factors.
- (b) (3 points) Calculate the following using the total return method:
- (i) *X*, *Y* and *Z* in the above table
 - (ii) The top-level exposure

SG has added inflation-linked securities and mortgage-backed securities to its portfolio.

- (c) (1 point) Identify risk factors that result from these additions to the portfolio.
- (d) (1.5 points) Assess whether each of the following performance attribution methods is appropriate for this portfolio:
- (i) The Total Return Method
 - (ii) The Excess Return Method
 - (iii) The Fully Analytical Method

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

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