Quantitative Finance Investment Advanced Exam

Fall 2016/Spring 2017

Important Exam Information:

Exam Registration	Candidates may register online or with an application.
Order Study Notes	Study notes are part of the required syllabus and are not available electronically but may be purchased through the online store.
Introductory Study Note	The Introductory Study Note has a complete listing of all study notes as well as errata and other important information.
Case Study	There is no case study for this examination.
Past Exams	Past Exams from 2000-present are available on SOA website.
Updates	Candidates should be sure to check the Updates page on the exam home page periodically for additional corrections or notices.
Formula Package	A Formula Package will be provided with the exam. Please see the Introductory Study Note for more information.
Table	A Cumulative normal distribution table will be provided with the exam.

1. **Topic: Advanced Option Pricing**

Learning Objectives

The candidate will understand the standard yield curve models, including:

- One and two-factor short rate models
- LIBOR market models

The candidate will understand approaches to volatility modeling

Learning Outcomes

The Candidate will be able to:

a) Identify and differentiate the features of the classic short rate models including the Vasicek and the Cox-Ingersoll-Ross (CIR) models.

b) Understand and explain the terms *Time Homogeneous Models, Affine Term Structure Models and Affine Coefficient models and explain their significance in the context of short rate interest models.*

c) Explain the dynamics of and motivation for the Hull-White extension of the Vasicek model.

d) Explain the features of the Black-Karasinski model

e) Understand and explain the relationship between market-quoted caplet volatilities and model volatilities.

f) Explain how deterministic shifts can be used to fit any given interest rate term structure

g) Demonstrate an understanding of the CIR++ model.

h) Understand and explain the features of the G2++ model, including: The motivation for more than one factor, calibration approaches, the pricing of bonds and options, and the model's relationship to the two-factor Hull-White model

i) Explain the set up and motivation of the lognormal Forward LIBOR Model (LFM)

j) Describe the calibration of the LFM to Cap and Floor prices

k) Explain the LFM drift terms and their dependence on the calibration and choice of numeraire

l) Define and explain the concept of volatility smile and some arguments for its existence

m) Calculate the hedge ratio for a call option given the dependency of the Black-Scholes volatility on the underlying

n) Compare and contrast "floating" and "sticky" smiles

o) Calculate the risk-neutral density given call option prices

p) Identify several stylized empirical facts about smiles in a variety of options markets

q) Describe and contrast several approaches for modeling smiles, including: Stochastic Volatility, local-volatility, jump-diffusions, variance-gamma and mixture models.

r) Describe and explain various issues and approaches for fitting a volatility surface

Resources
Interest Rate Models - Theory and Practice: With Smile, Inflation and Credit, Brigo, D. & Mercurio F., 2nd Edition   - Ch. 1-2 (background only)   - Ch.3 (3.1-3.3, 3.5-3.6, 3.8-3.9)   - Ch. 4 (4.1-4.2 - excl. appendices)   - Ch. 5 (5.1-5.2 - background only)   - Ch. 6 (6.1-6.4)   *Volatility Correlation – The Perfect Hedger and the Fox,* Rebonato, R., 2nd Edition   - Ch. 6   - Ch.7   - Ch. 8 (8.1-8.5)   - Ch. 9 (9.1-9.9)   - QFIA-121-16: Companion Note to Brigo & Mercurio: Interest Rate Models - Theory and Practice: With Smile, Inflation and Credit

2. **Topic: Credit Risk**
Learning Objectives
The candidate will understand and be able to apply a variety of credit risk theories and models.
Learning Outcomes

The Candidate will be able to:

a) Demonstrate an understanding of events and causes of the recent global credit crisis.

b) Demonstrate an understanding of the basic concepts of credit risk modeling such as probability of default, loss given default, exposure at default, and expected loss.

c) Demonstrate an understanding of credit valuation models.

d) Demonstrate an understanding of Merton asset value models in the context of credit risk.

e) Demonstrate an understanding of the term structure of default probability.

f) Demonstrate an understanding of modeling approaches for correlated defaults.

g) Demonstrate an understanding of, and be able to apply the concept of Duration Times Spread (DTS.)

h) Demonstrate an understanding of credit default swaps (CDS) and the bond-CDS basis, including the use of CDS in portfolio and trading contexts.

i) Demonstrate an understanding of CDS valuations

j) Demonstrate an understanding of mortgage default models in the valuation of MBS.

k) Demonstrate an understanding of measuring and marking-to-market counterparty credit risk in credit derivatives.

l) Understand and apply various approaches for managing credit risk in a portfolio setting.

m) Understand the rationale, markets and risks of structured finance.

Resources

- *Handbook of Fixed Income Securities,* Fabozzi, F.J., 8th Edition, 2012 ,
  - Ch. 66 and 67
- *Introduction To Credit Risk Modeling,* Bluhm, Christian, 2nd Edition,
  - Ch. 1-3 and 6
- *Quantitative Credit Portfolio Management,* Ben-Dor, et. al.
  - Ch. 1 -4

- QFIA-100-13: Modeling of Mortgage Defaults, Jan 22, 2008, pp. 5- 38 (pp. 13-25 background only)
- QFIA-101-13: *Managing Credit Risk: The Great Challenge for Global Financial Markets,* Caouette, John B., et. al., 2nd Edition, 2008, Ch. 20 & 24
- QFIA-103-13: Bond-CDS Basis Handbook, pp. 3-48
- QFIA-104-13: *Asset/Liability Management of Financial Institutions,* Tilman, Leo M., 2003, Ch.9
- QFIA-122-16: Recent Advances in Credit Risk Modeling

3. **Topic: Liquidity Risk**

Learning Objectives

Candidate will understand the nature, measurement and management of liquidity risk in financial institutions.

Learning Outcomes

The Candidate will be able to:

a) Understand the concept of liquidity risk and the threat it represents to financial intermediaries and markets.

b) Measure and monitor liquidity risk, using various liquidity measurement tools and ratios.

c) Understand the levels of liquidity available with various asset types, and the impact on a company's overall liquidity risk.

d) Understand liability termination provisions such as book-value surrender and the impact on a company's overall liquidity risk.

e) Apply liquidity risk models, including modeling cashflow of various types of assets (e.g. indeterminate maturity assets) and liabilities.

f) Apply liquidity scenario analysis with various time horizons.

g) Understand and apply techniques to manage stress liquidity risk.

h) Create liquidity risk management plans and procedures, including addressing appropriate product design, investment guidelines, and reporting given a desired liquidity risk level.

Resources

- *Quantitative Credit Portfolio Management,* Ben-Dor, et. al., 2012,
    - Ch. 5

- QFIA-105-13: Report of the Life Liquidity Work Group of the American Academy of Actuaries to the Life Liquidity Risk Working Group of the NAIC (final)

- QFIA-106-13: *Liquidity Risk: Measurement and Management - A Practitioner's Guide to Global Best Practices,* Matz, Leonard & Neu, Peter, 2006, Ch. 3

- QFIA-117-13: Reflections on Northern Rock: The Bank Run that Heralded the Global Financial Crisis

- QFIA-123-16: Liquidity Risk Management

4. **Topic: Additional Quantitative Techniques**

Learning Objectives

The candidate will understand important quantitative techniques relating to financial time series,

performance measurement, performance attribution and stochastic modeling

Learning Outcomes

The Candidate will be able to:

a) Understand the concept of a factor model in the context of financial time series.

b) Apply various techniques for analyzing factor models including Principal Component Analysis (PCA) and Statistical Factor Analysis.

c) Describe and assess performance measurement methodologies for assets portfolios.

d) Describe and assess techniques that can be used to select or build a benchmark for a given asset, portfolio.

e) Recommend a benchmark for a given asset or portfolio.

f) Calculate and interpret performance attribution metrics for a given asset, portfolio.

g) Explain the limitations of attribution techniques.

h) Understand and apply various techniques of adjusting autocorrelated returns for certain asset classes

i) Demonstrate an understanding of the general uses and techniques of stochastics modeling

j) Describe and apply techniques for economic scenario generation

Resources

- *Handbook of Fixed Income Securities,* Fabozzi, F.J., 8th Edition, 2012,
  - Ch. 69-70

- QFIA-110-13: *CAIA Level II, Advanced Core Topics in Alternative Investment,* 2nd Edition, 2012, Ch. 16

- QFIA-119-14: *Analysis of Financial Time Series,* Tsay, 3rd edition, Ch. 9

- QFIA-124-16: IAA, *Stochastic Modeling, Theory and Reality from and Actuarial Perspective,* sections I-1 to I-29 and II-1 to II-24

- QFIA-125-16: *Market Models: A Guide for Financial Data Analysis,* Ch. 6, Principal Component Analysis

5. **Topic: Behavioral Finance**

Learning Objectives

The candidate will understand the behavior characteristics of individuals and firms, and be able to identify and apply concepts of behavioral finance.

Learning Outcomes

The Candidate will be able to:

a) Explain how behavioral characteristics of individuals or firms affect the investment or capital management process.

b) Describe how behavioral finance explains the existence of some market anomalies.

c) Identify and apply the concepts of behavioral finance with respect to individual investors, institutional investors, portfolio managers, fiduciaries and corporate managers.

Resources

- QFIA-108-13: Behavioral Finance and Investment Committee Decision Making, by A. Wood, CFA Institute Conference Proceedings, December 2006

- QFIA-109-13: A Survey of Behavioral Finance, by Barberis & Thaler

6. **Topic: Alternative Assets**

Learning Objectives

The candidate will understand and be able to describe the variety and assess the role of alternative assets in investment portfolios.

The candidate will demonstrate an understanding of the distinguishing investment characteristics and potential contributions to investment portfolios of the following major alternative asset groups:
- Real Estate
- Private Equity
- Commodities
- Hedge Funds
- Managed Futures
- Distressed Securities
- Farmland and timber

Learning Outcomes

The Candidate will be able to:

a) Demonstrate an understanding of the types of investments available in each market, and their most important differences for an investor.

b) Demonstrate an understanding of the benchmarks available to evaluate the performance of alternative investment managers and the limitations of the benchmarks.

c) Demonstrate an understanding of the investment strategies and portfolio roles that are characteristic of each alternative investment.

d) Demonstrate an understanding of the due diligence process for alternative investments.

e) Demonstrate an understanding of infrastructure investments.

Resources

- QFIA-111-13: Maginn & Tuttle, *Managing Investment Portfolios,* 3rd Ed. 2007, Ch. 8

- QFIA-112-13: *Commercial Real Estate Analysis & Investment,* Chapter 12

- QFIA-113-13: Secular and Cyclic Determinants of Capitalization Rates: The Role of Property Fundamentals, Macroeconomic Factors and "Structural Changes"

- QFIA-126-16: Infrastructure as an Asset Class

7. **Topic: Liability Manufacturing/Management**

Learning Objectives

The candidate will understand various investment related considerations with regarded to liability manufacturing and management.

Learning Outcomes

The Candidate will be able to:

a) Identify and evaluate the impact of embedded options in liabilities, specifically variable annuities guaranteed riders (GMAB, GMDB, GMWB and GMIB)

b) Demonstrate understanding of risks associated with guarantee riders including: market, insurance, policy holder behavior, basis, credit, regulatory and accounting

c) Demonstrate understanding Risk management and dynamic hedging for existing GMXB and its embedded options – including:
   i. Hedgeable components include equity, interest rate, volatility and cross Greeks
   ii. Partially Hedgeable or Unhedgeable components include policyholder behavior, mortality and lapse, basis risk, counterparty exposure, foreign bonds and equities, correlation and operation failures
   iii. Static vs. dynamic hedging

d) Demonstrate understanding of Target Volatility Funds and their impact on option costs.

e) Demonstrate an understanding of how differences between models of markets and actual market and policy-holder behaviors affect the risks associated with equity linked guarantees

f) Demonstrate understanding of projection methods of Greeks (for embedded options in variable annuities) based on:
   i. Fully nested stochastic simulation
   ii. Fitted proxy functions based on the Least Square Monte Carlo method

Resources

- QFIA-115-13: IAA, *Stochastic Modeling, Theory and Reality from and Actuarial Perspective* IV.A.1-8.

- QFIA-116-13: The Impact of Stochastic Volatility on Pricing, Hedging and Hedge Efficiency of Withdrawal Benefit Guarantees in Variable Annuities

- QFIA-120-15: Guarantees and Target Volatility Funds

- QFIA-127-16: Proxy functions for the projection of Variable Annuity Greeks

- On the Importance of Hedging Dynamic Lapses in Variable Annuities, , Risk and Rewards, 2015 issue 66, pp 12-16.