

# Quantitative Finance Investment Advanced Exam

Fall 2017/Spring 2018

## Important Exam Information:

<a href="#">Exam Registration</a>	Candidates may register online or with an application.
<a href="#">Order Study Notes</a>	Study notes are part of the required syllabus and are not available electronically but may be purchased through the online store.
<a href="#">Introductory Study Note</a>	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.
<a href="#">Past Exams</a>	Past Exams from 2000-present are available on SOA website.
<a href="#">Updates</a>	Candidates should be sure to check the Updates page on the exam home page periodically for additional corrections or notices.
<a href="#">Formula Package</a>	A Formula Package will be provided with the exam. Please see the Introductory Study Note for more information.
<a href="#">Table</a>	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:

- Identify and differentiate the features of the classic short rate models including the Vasicek and the Cox-Ingersoll-Ross (CIR) models.
- 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.
- Explain the dynamics of and motivation for the Hull-White extension of the Vasicek model.
- Explain the features of the Black-Karasinski model
- Understand and explain the relationship between market-quoted caplet volatilities and model volatilities.
- Explain how deterministic shifts can be used to fit any given interest rate term structure
- Demonstrate an understanding of the CIR++ model.
- 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
- Explain the set up and motivation of the lognormal Forward LIBOR Model (LFM)
- Describe the calibration of the LFM to Cap and Floor prices
- Explain the LFM drift terms and their dependence on the calibration and choice of numeraire
- Define and explain the concept of volatility smile and some arguments for its existence
- Calculate the hedge ratio for a call option given the dependency of the Black-Scholes volatility on the underlying
- Compare and contrast "floating" and "sticky" smiles
- Calculate the risk-neutral density given call option prices
- Identify several stylized empirical facts about smiles in a variety of options markets
- Describe and contrast several approaches for modeling smiles, including: Stochastic Volatility, local-volatility, jump-diffusions, variance-gamma and mixture models.
- Describe and explain various issues and approaches for fitting a volatility surface

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**Resources**

- *Interest Rate Models - Theory and Practice: With Smile, Inflation and Credit*, Brigo, D. & Mercurio F., 2<sup>nd</sup> 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., 2<sup>nd</sup> 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*

<b>2. Topic: Credit Risk</b>
<b>Learning Objectives</b>
The candidate will understand and be able to apply a variety of credit risk theories and models.
<b>Learning Outcomes</b>
The Candidate will be able to: <ul style="list-style-type: none"><li>a) Demonstrate an understanding of events and causes of the 2008 global credit crisis.</li><li>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.</li><li>c) Demonstrate an understanding of credit valuation models.</li><li>d) Demonstrate an understanding of Merton asset value models in the context of credit risk.</li><li>e) Demonstrate an understanding of the term structure of default probability.</li><li>f) Demonstrate an understanding of modeling approaches for correlated defaults.</li><li>g) Demonstrate an understanding of, and be able to apply the concept of Duration Times Spread (DTS.)</li><li>h) Demonstrate an understanding of credit default swaps (CDS) and the bond-CDS basis, including the use of CDS in portfolio and trading contexts.</li><li>i) Demonstrate an understanding of CDS valuations</li><li>j) Demonstrate an understanding of mortgage default models in the valuation of MBS.</li><li>k) Demonstrate an understanding of measuring and marking-to-market counterparty credit risk in credit derivatives.</li><li>l) Understand and apply various approaches for managing credit risk in a portfolio setting.</li><li>m) Understand the rationale, markets and risks of structured finance.</li></ul>
<b>Resources</b>
<ul style="list-style-type: none"><li>• <i>Handbook of Fixed Income Securities</i>, Fabozzi, F.J., 8th Edition, 2012 ,<ul style="list-style-type: none"><li>○ Ch. 66 and 67</li></ul></li><li>• <i>Introduction To Credit Risk Modeling</i>, Bluhm, Christian, 2<sup>nd</sup> Edition,<ul style="list-style-type: none"><li>○ Ch. 1-3 and 6</li></ul></li><li>• <i>Quantitative Credit Portfolio Management</i>, Ben-Dor, et. al.<ul style="list-style-type: none"><li>○ Ch. 1 (background only)</li><li>○ Ch. 2-4</li></ul></li> <li>• QFIA-100-13: Modeling of Mortgage Defaults, Jan 22, 2008, pp. 5- 38 (pp. 13-25 background only)</li><li>• QFIA-101-13: <i>Managing Credit Risk: The Great Challenge for Global Financial Markets</i>, Caouette, John B., et. al., 2<sup>nd</sup> Edition, 2008, Ch. 20 &amp; 24</li><li>• QFIA-103-13: Bond-CDS Basis Handbook, pp. 3-48</li><li>• QFIA-104-13: <i>Asset/Liability Management of Financial Institutions</i>, Tilman, Leo M., 2003, Ch.9</li><li>• QFIA-122-16: Recent Advances in Credit Risk Modeling</li></ul>

<b>3. Topic: Liquidity Risk</b>
<b>Learning Objectives</b>
Candidate will understand the nature, measurement and management of liquidity risk in financial institutions.
<b>Learning Outcomes</b>
The Candidate will be able to: <ul style="list-style-type: none"><li>a) Understand the concept of liquidity risk and the threat it represents to financial intermediaries and markets.</li><li>b) Measure and monitor liquidity risk, using various liquidity measurement tools and ratios.</li><li>c) Understand the levels of liquidity available with various asset types, and the impact on a company's overall liquidity risk.</li><li>d) Understand liability termination provisions such as book-value surrender and the impact on a company's overall liquidity risk.</li><li>e) Apply liquidity risk models, including modeling cash flow of various types of assets (e.g. indeterminate maturity assets) and liabilities.</li><li>f) Apply liquidity scenario analysis with various time horizons.</li><li>g) Understand and apply techniques to manage stress liquidity risk.</li><li>h) Create liquidity risk management plans and procedures, including addressing appropriate product design, investment guidelines, and reporting given a desired liquidity risk level.</li></ul>
<b>Resources</b>
<ul style="list-style-type: none"><li>• <i>Quantitative Credit Portfolio Management</i>, Ben-Dor, et. al., 2012,<ul style="list-style-type: none"><li>○ Ch. 5-6</li></ul></li><li>• 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)</li><li>• QFIA-106-13: <i>Liquidity Risk: Measurement and Management - A Practitioner's Guide to Global Best Practices</i>, Matz, Leonard &amp; Neu, Peter, 2006, Ch. 3</li><li>• QFIA-117-13: Reflections on Northern Rock: The Bank Run that Heralded the Global Financial Crisis</li><li>• QFIA-123-16: Liquidity Risk Management</li></ul>

<b>4. Topic: Additional Quantitative Techniques</b>
<b>Learning Objectives</b>
The candidate will understand important quantitative techniques relating to financial time series, performance measurement, performance attribution and stochastic modeling
<b>Learning Outcomes</b>
The Candidate will be able to: <ul style="list-style-type: none"><li>a) Understand the concept of a factor model in the context of financial time series.</li><li>b) Apply various techniques for analyzing factor models including Principal Component Analysis (PCA) and Statistical Factor Analysis.</li><li>c) Describe and assess performance measurement methodologies for assets portfolios.</li><li>d) Describe and assess techniques that can be used to select or build a benchmark for a given asset, portfolio.</li><li>e) Recommend a benchmark for a given asset or portfolio.</li><li>f) Calculate and interpret performance attribution metrics for a given asset, portfolio.</li><li>g) Explain the limitations of attribution techniques.</li><li>h) Understand and apply various techniques of adjusting autocorrelated returns for certain asset classes</li><li>i) Demonstrate an understanding of the general uses and techniques of stochastics modeling</li><li>j) Describe and apply techniques for economic scenario generation</li></ul>
<b>Resources</b>
<ul style="list-style-type: none"><li>• <i>Handbook of Fixed Income Securities</i>, Fabozzi, F.J., 8th Edition, 2012,<ul style="list-style-type: none"><li>○ Ch. 69-70</li></ul></li><li>• QFIA-110-13: <i>CAIA Level II, Advanced Core Topics in Alternative Investment</i>, 2<sup>nd</sup> Edition, 2012, Ch. 16</li><li>• QFIA-119-14: <i>Analysis of Financial Time Series</i>, Tsay, 3<sup>rd</sup> edition, Ch. 9</li><li>• QFIA-124-16: <i>IAA, Stochastic Modeling, Theory and Reality from and Actuarial Perspective</i>, sections I-1 to I-29 and II-1 to II-24</li><li>• QFIA-125-16: <i>Market Models: A Guide for Financial Data Analysis</i>, Ch. 6, Principal Component Analysis</li></ul>

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<b>5. Topic: Behavioral Finance</b>
<b>Learning Objectives</b>
The candidate will understand the behavior characteristics of individuals and firms, and be able to identify and apply concepts of behavioral finance.
<b>Learning Outcomes</b>
The Candidate will be able to: <ul style="list-style-type: none"><li>a) Explain how behavioral characteristics of individuals or firms affect the investment or capital management process.</li><li>b) Describe how behavioral finance explains the existence of some market anomalies.</li><li>c) Identify and apply the concepts of behavioral finance with respect to individual investors, institutional investors, portfolio managers, fiduciaries and corporate managers.</li></ul>
<b>Resources</b>
<ul style="list-style-type: none"><li>• QFIA-108-13: Behavioral Finance and Investment Committee Decision Making, by A. Wood, CFA Institute Conference Proceedings, December 2006</li><li>• QFIA-109-13: A Survey of Behavioral Finance, by Barberis &amp; Thaler</li></ul>

<b>6. Topic: Alternative Assets</b>
<b>Learning Objectives</b>
<p>The candidate will understand and be able to describe the variety and assess the role of alternative assets in investment portfolios.</p> <p>The candidate will demonstrate an understanding of the distinguishing investment characteristics and potential contributions to investment portfolios of the following major alternative asset groups:</p> <ul style="list-style-type: none"><li>• Real Estate</li><li>• Private Equity</li><li>• Commodities</li><li>• Hedge Funds</li><li>• Managed Futures</li><li>• Distressed Securities</li><li>• Infrastructure</li></ul>
<b>Learning Outcomes</b>
<p>The Candidate will be able to:</p> <ol style="list-style-type: none"><li>a) Demonstrate an understanding of the types of investments available in each market, and their most important differences for an investor.</li><li>b) Demonstrate an understanding of the benchmarks available to evaluate the performance of alternative investment managers and the limitations of the benchmarks.</li><li>c) Demonstrate an understanding of the investment strategies and portfolio roles that are characteristic of each alternative investment.</li><li>d) Demonstrate an understanding of the due diligence process for alternative investments.</li><li>e) Demonstrate an understanding of infrastructure investments.</li></ol>
<b>Resources</b>
<ul style="list-style-type: none"><li>• QFIA-111-13: Maginn &amp; Tuttle, <i>Managing Investment Portfolios</i>, 3<sup>rd</sup> Ed. 2007, Ch. 8</li><li>• QFIA-112-13: <i>Commercial Real Estate Analysis &amp; Investment</i>, Chapter 12</li><li>• QFIA-113-13: Secular and Cyclic Determinants of Capitalization Rates: The Role of Property Fundamentals, Macroeconomic Factors and “Structural Changes”</li><li>• QFIA-126-16: Infrastructure as an Asset Class</li></ul>



<b>7. Topic: Liability Manufacturing/Management</b>
<b>Learning Objectives</b>
The candidate will understand various investment related considerations with regard to liability manufacturing and management.
<b>Learning Outcomes</b>
<p>The Candidate will be able to:</p> <ol style="list-style-type: none"><li>a) Identify and evaluate the impact of embedded options in liabilities, specifically variable annuities guaranteed riders (GMAB, GMDB, GMWB and GMIB)</li><li>b) Demonstrate understanding of risks associated with guarantee riders including: market, insurance, policy holder behavior, basis, credit, regulatory and accounting</li><li>c) Demonstrate understanding Risk management and dynamic hedging for existing GMXB and its embedded options – including:<ol style="list-style-type: none"><li>i. Hedgeable components include equity, interest rate, volatility and cross Greeks</li><li>ii. Partially Hedgeable or Unhedgeable components include policyholder behavior, mortality and lapse, basis risk, counterparty exposure, foreign bonds and equities, correlation and operation failures</li><li>iii. Static vs. dynamic hedging</li></ol></li><li>d) Demonstrate understanding of Target Volatility Funds and their impact on option costs.</li><li>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</li><li>f) Demonstrate understanding of projection methods of Greeks (for embedded options in variable annuities) based on:<ol style="list-style-type: none"><li>i. Fully nested stochastic simulation</li><li>ii. Fitted proxy functions based on the Least Square Monte Carlo method</li></ol></li></ol>
<b>Resources</b>
<ul style="list-style-type: none"><li>• QFIA-115-13: IAA, <i>Stochastic Modeling, Theory and Reality from and Actuarial Perspective</i> IV.A.1-8.</li><li>• QFIA-116-13: The Impact of Stochastic Volatility on Pricing, Hedging and Hedge Efficiency of Withdrawal Benefit Guarantees in Variable Annuities</li><li>• QFIA-120-15: Guarantees and Target Volatility Funds</li><li>• QFIA-127-16: Proxy functions for the projection of Variable Annuity Greeks</li><li>• <a href="#">On the Importance of Hedging Dynamic Lapses in Variable Annuities</a>, Risk and Rewards, 2015 issue 66, pp 12-16.</li></ul>