Models for Financial Economics—November 2017

IMPORTANT NOTICE – This syllabus contains significant changes from the March 2017 version. Candidates should carefully read the entire document.

The Models for Financial Economics is a three-hour exam that consists of 30 multiple-choice questions. Also, a normal distribution calculator will be available during the test by clicking a link on the item screen. Details are available on the Prometric Web Site.

The purpose of the syllabus is to develop the candidate's knowledge of the theoretical basis of certain actuarial models and the application of those models to insurance and other financial risks. A thorough knowledge of calculus, probability, and interest theory is assumed.

Formulas are provided for the density and distribution functions for the standard normal and lognormal random variables. For paper and pencil examinations, tables of the standard normal distribution function are provided. Since the tables will be provided to the candidate at the examination, candidates will not be allowed to bring copies of the tables into the examination room. For CBT candidates, a normal distribution calculator is provided. See the link below for more information.

Note: It is anticipated that candidates will have done the relevant exercises in the textbooks.

Check the Updates section of the web site for any changes to the exam or syllabus.

The ranges of weights shown are intended to apply to the large majority of exams administered. On occasion, the weights of topics on an individual exam may fall outside the published range. Note that some questions may cover multiple learning outcomes.

Each multiple-choice problem includes 5 answer choices identified by A, B, C, D, and E, only 1 of which is correct. Candidates must indicate responses to each question on the computer.

As part of the computer-based testing process, a few pilot questions will be randomly placed in the exam (paper and pencil and computer-based forms). These pilot questions are included to judge their effectiveness for future exams, but they will NOT be used in the scoring of this exam. All other questions will be considered in the scoring. All unanswered questions are scored incorrect. Therefore, candidates should answer every question on the exam. There is no set requirement for the distribution of correct answers for the SOA/CIA multiple-choice preliminary examinations. It is possible that a particular answer choice could appear many times on an examination or not at all. Candidates are advised to answer each question to the best of their ability, independently from how they have answered other questions on the examination.

Since the CBT exam will be offered over a period of a few days, each candidate will receive a test form composed of questions selected from a pool of questions. Statistical scaling methods are used to ensure within reasonable and practical limits that, during the same testing period of a few days, all forms of the test are comparable in content and passing criteria. The methodology that has been adopted is used by many credentialing programs that give multiple forms of an exam. Because of the changed nature of this exam, results will no longer be instantaneous (at least for the next few sessions) since post-exam analysis will be required by the examination committee. Instead, results will be released on the SOA website about 8 weeks after each testing window ends.

LEARNING OUTCOMES – MODELS FOR FINANCIAL ECONOMICS

I. Introductory Derivatives (10%-15%)

    A. Stock as an underlying asset

        The candidate will be able to define and recognize the definitions of the following terms:

            Nondividend-paying stocks, stocks paying discrete dividends, stocks paying dividends continuously at a rate proportional to the price, short selling, long and short positions, bid and ask prices, bid-ask spread, net profit of long and short positions

    B. Forward contracts and prepaid forward contracts on stocks

        The candidate will be able to:

        1. Define and recognize the definitions of the following terms:

            Forward contract, prepaid forward contracts, outright purchase, fully leveraged purchase, payoff of long and short forward, net profit of long and short forward

        2. Determine forward and prepaid forward prices by the principle of no-arbitrage.

        3. Construct a synthetic forward from the underlying stock and a risk-free asset.

        4. Identify arbitrage opportunities when the no-arbitrage forward price is different from the market forward price.

        5. Recognize that forward price is less than the expected future stock price.

    C. Futures contracts

        The candidate will be able to:

        1. Define and recognize the definitions of the following terms:

            Marking to market, margin balance, maintenance margin, margin call

        2. Evaluate an investor's margin balance based on changes in asset values.

II. General Properties of Options (25%-30%)

    A. Option Contracts

        The candidate will be able to:

        1. Define and recognize the definitions of the following terms:

            Call and put options, expiration date, strike price / exercise price, moneyness, European option, American option, Bermudan option, payoff and net profit of long and short option positions

        2. Explain the cash flow characteristics of the following exotic options:

            Asian (both arithmetic and geometric), barrier, compound, lookback

    B. Option strategies and risk management

        The candidate will be able to:

        1. Recognize that a long put can be used as an insurance strategy for a long stock position and a long call can be used as an insurance strategy for a short stock position.

        2. Identify and explain how the following option strategies can be used as tools to manage financial risk or speculate on price or volatility:

            option spreads (bull, bear, box, ratio), collar, zero-cost collar, straddle, strangle, butterfly spread

        3. Evaluate the payoff and profit of the strategies above.

C. General Properties of Options
   The candidate will be able to
   1. Apply put-call parity to European options on the following underlying assets:
      Stock (no dividends, discrete and continuous dividends), currency, futures contract
   2. Recognize generalized parity for European exchange options, put-call duality for
      European currency options, and put-call parity for barrier and compound options.
   3. Compare options with respect to maturity and strike.
   4. Identify factors affecting the early exercising of American options and the situations
      where the values of European and American options are the same.

III. The Binomial Option Pricing Model (10%)
   The candidate will be able to:
   A. Price options under a one-period binomial model on a nondividend-paying stock by:
      1. applying the principle of no-arbitrage, and identify arbitrage opportunities if any.
      2. applying the risk-neutral pricing formula.
   B. Extend the one-period binomial model on stocks in the following directions:
      1. to other underlying assets, including stock paying dividends continuously at a rate
         proportional to its price, currency, and futures contract.
      2. to a multi-period setting for pricing European and American options.
   C. Construct a binomial model from market stock price data using historical volatility and
      the following methods:
      Forward binomial tree, Cox-Ross-Rubinstein tree, lognormal tree
   D. Understand option pricing using real probabilities and calculate the appropriate risk-
      adjusted interest rate for discounting.

IV. The Black-Scholes Option Pricing Model (25-30%)
   The candidate will be able to:
   A. Recognize the underlying assumptions behind the Black-Scholes model.
   B. Explain the properties of a lognormal distribution and calculate the following for future
      stock prices under the Black-Scholes model:
      1. probabilities and percentiles
      2. means and variances
      3. conditional expectations $E(S_t \mid S_t > K)$ and $E(S_t \mid S_t < K)$
   C. Deduce the analytic pricing formulas for the following European options using risk-
      neutral pricing formulas:
      1. cash-or-nothing calls and puts
      2. asset-or-nothing calls and puts
      3. ordinary calls and puts (the Black-Scholes formula)
      4. gap calls and puts
   D. Explain the concepts underlying the risk-neutral approach to valuing derivative
      securities.
   E. Implement the risk-neutral pricing formula using Monte-Carlo simulation:
      1. Simulate standard normal random variates by inverse transformation.
      2. Estimate prices of path-independent and path-dependent options, and compute the
         standard deviation of the estimate.
      3. Use the following variance reduction techniques to accelerate convergence:
         Antithetic variate, stratified sampling, control variate
   F. Generalize the Black-Scholes formula to price exchange options.

G. Estimate a stock's expected rate of appreciation and historical volatility from stock price data.

H. Understand the concept of implied volatility.

V. Option Greeks and Risk Management (10%-15%)
    The candidate will be able to:
    A. Interpret and compute the following under the Black-Scholes model:
        1. Option Greeks (Delta, Gamma, Theta, Vega, Rho, and Psi)
        2. Option elasticity, Sharpe ratio and instantaneous risk premium for both an option and a portfolio of options and the underlying stock.
    B. Approximate option prices using delta, gamma and theta.
    C. Recognize the relationship among delta, gamma and theta (the Black-Scholes equation)
    D. Explain and demonstrate how to control stock price risk using the methods of delta-hedging and gamma-hedging.

VI. Interest Rate Derivatives (10%)
    The candidate will be able to:
    A. Price interest rate derivatives under a binomial tree for interest rates.
    B. Recognize the features of a Black-Derman-Toy tree.
    C. Price interest rate caplets, floorlets and bond calls and puts by applying the Black formula.
    D. Apply put-call parity to European options on zero-coupon bonds.

Note: Concepts, principles and techniques needed for Exam MFE are covered in the reference listed below. Candidates and professional educators may use other references, but candidates should be very familiar with the notation and terminology used in the listed references.

Text – Models for Financial Economics*

Derivatives Markets (Third Edition), 2013, by McDonald, R.L., Pearson Education, ISBN: 978-0-32154-308-0

> Chapter 1,
> Chapter 2, Sections 2.1-2.4,
> Chapter 3,
> Chapter 5, Sections 5.1-5.2, Section 5.3 (through the middle of p.136),
>   Section 5.4 (through the top of p.143),
> Chapter 9,
> Chapter 10, Sections 10.1-10.5, Section 10.6 (through the middle of p.315),
> Chapter 11, Sections 11.1-11.3, Appendix 11.A,
> Chapter 12, Sections 12.1-12.5, Appendix 12.A, Appendix 12.B,
> Chapter 13,
> Chapter 14, Sections 14.1-14.3, Section 14.4 (through the bottom of p.419),
>   Sections 14.5-14.6,
> Chapter 18, Sections 18.1-18.5, Appendix 18.A,
> Chapter 19, Sections 19.1-19.5

Chapter 23, Section 23.1 (but with only those definitions in Tables 23.1 and 23.2 that are relevant to Section 23.1), the top half of p.714 (Re: Lookback calls and puts),
Chapter 25, Section 25.1 (through the bottom of p.754), Section 25.4 (through the middle of p.773), Section 25.5 (through the middle of p.781)
Appendices B.1, and C

Unless otherwise stated, chapter appendices are not included in the required readings from this text.

*Any textbook errata are included below.

http://derivatives.kellogg.northwestern.edu/errata/errata3e.html

Other Resources – Models for Financial Economics

Exam MFE Formulas and Tables for paper/pencil

Formulas and Tables for CBT:
- A normal distribution calculator will be available during the test by clicking buttons on the item screen.
- Formula document

Some Remarks on *Derivatives Markets*

All released exam papers, since 2000 can be found here.
Note that for Exam MFE, the only two released exams are from May 2007 and May 2009.
For a complete list of which questions from these two exams still apply to the MFE curriculum, please see Page 1 of MFE Advanced Derivatives Questions & Solutions.

MFE-01-17: MFE Introductory Derivatives Questions, from Chapters 1, 2, 3, 5 only
                    Note: only questions that still apply to the MFE curriculum remain

MFE-02-17: MFE Introductory Derivatives Solutions, from Chapters 1, 2, 3, 5 only
                    Note: only questions that still apply to the MFE curriculum remain

MFE-03-17: MFE Advanced Derivatives Questions & Solutions, from Chapters 9-14, 18-19, 23, 25 only. Note: only questions that still apply to the MFE curriculum remain