

Report on Expansion of Preliminary Education to Incorporate Financial Economics Topics

Summary of report to be presented to the CAS and SOA

At its February, 2005 meeting, the SOA Board of Governors approved a motion to add approximately 1.5 exam hours to Exams M and/or C covering financial economics topics as outlined in the January 28, 2005 report from the Financial Economics Advisory Group. To accomplish this, the following tasks were undertaken:

- Determine the particular financial economics topics that would be appropriate for a roughly 1.5 hour expansion of the Preliminary Education syllabus.
- Review the current exam syllabus structure to recommend how financial economics topics could be incorporated.
- Review the number of exam hours relative to the amount of material to be covered and recommend appropriate changes.

Those working on this recommendation included members of the three exam sponsors, SOA, CAS and CIA. They were:

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Recommendation

The following outlines the changes proposed for exams FM/2, M and C/4. While the SOA BOG motion did not reference Exam FM/2, the introductory material on modern financial instruments fits best with the objectives of that exam and this is reflected in the recommendations. All of the changes would take effect with the May 2007 exams.

Exam FM/2:

- Add an introduction to financial derivatives, (forwards, options, futures, swaps) and their use in risk management.
- Add an introduction to the concept of no-arbitrage as a fundamental concept in financial mathematics.
- To accommodate the additional material, expand Exam FM to a 2.5-hour multiple-choice examination.

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Exam M:

- Add learning outcomes on option pricing: put-call parity, the binomial model, and Black-Scholes formula. A study note introducing actuarial applications of option pricing would be included.
- Add learning outcomes on interpretation of option Greeks and delta-hedging
- Add learning outcomes on the features of exotic options.
- Add an introduction to Brownian motion and Itô's lemma.
- To accommodate the additional material, move loss models, including risk theory, to Exam C/4.
- Given the relative increase in the amount of material, expand Exam M to a 5-hour multiple-choice examination.

Exam C/4:

- Add lognormal models for asset prices and its relationship to the Black-Scholes formula.
- Include Monte-Carlo valuation of derivative securities with the current material on simulation
- Add characteristics and calculation of risk measures such as value at risk and conditional tail expectation.
- Add the loss models and risk theory material moved from Exam M
- Remove interpolation and smoothing (splines).

The detail of the financial economics learning outcomes and syllabus materials to be added are laid out at the end

Rationale

1. Financial Economics Topics to Include

The review centered on the topics suggested in the January 28, 2005 report from the Financial Economics Advisory Group. For Preliminary Education, the emphasis should be on the basics and mathematics of financial economics. These topics fit best with the other exam material and are better suited to the multiple-choice format. Topics such as mean-variance portfolio theory, CAPM, and rational decision theory were considered more appropriate for the later exams and modules.

Other cutbacks reflect limits on the relative amount of time to be devoted to financial economics and the maturity of the candidates at this level. Topics related to financial engineering, real options and a more thorough treatment of stochastic interest rates models, although they are included in the recommended textbook are not included in the syllabus.

The group decided on using a single text for all of the fundamental topics to be covered in the interest of a consistent approach. The text selected was chosen because it is at the appropriate level of difficulty and clarity and because it pays attention to the business context. The only topics left for separate study notes are risk measures and actuarial applications.

2. Changes to the Exam FM/2 Syllabus

Exam FM/2 introduces the traditional investment vehicles. Immunization is also introduced. It is not a great leap to extend these topics into an introduction to derivatives and hedging. These concepts are basic to modern financial mathematics. Another potential advantage of adding these financial economics topics to Exam FM/2 is tied to the current consideration being given to a separate ERM credential set at or below ASA level requirements. Exam

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FM/2 would almost certainly be part of the requirement and at least an introductory knowledge of financial economics is a key element for work in ERM. In addition, by having these topics in FM rather than later exams, even a very basic credential would include this introduction.

In selecting the topics, consideration was also given to the quantity of material that could be taught at a university in a one-semester course. Also, for some universities, Exam FM/2 is the first actuarial exam that their students take. Probability is covered later in the curriculum. The topics and readings recommended for Exam FM/2 do not rely on an understanding of probability beyond some elementary concepts that all potential actuaries can handle so these schools should not be adversely affected.

3 Moving loss models

An advantage to moving the loss models learning outcomes to Exam C/4 is having the related topics of characteristics, construction and use of frequency, severity and aggregate loss models in a single exam. In addition, the relationship between loss models and the other Exam M topics was not that strong. With the removal of applied statistics from Exam C/4 in 2005 and the inclusion of smoothing and additional simulation topics, Exam C/4 is somewhat light in terms of the amount of material covered. The *Loss Models* material will not overcrowd Exam C/4.

4 Placement of financial economics topics in Exam M

The decision to put the financial economics topics in Exam M was chiefly for ease of implementation. The CAS currently covers financial economics in their Fellowship Exam 8. Exam M is the only Preliminary Education exam that is not jointly sponsored with the CAS. Therefore, these recommended changes could be implemented with very little disruption for the CAS. Furthermore, the financial economics topics combine with life contingencies for risk management for modern life insurance contracts. In the meantime, however, the CAS is in the process of reviewing their E&E program and may also be recommending changes.

Exam C/4 currently covers simulation. Monte-Carlo valuation of derivatives is being recommended for Exam C/4 as an important application of simulation. The lognormal model for asset prices, also recommended for C/4, fits with the loss models material that will be moved there. In particular, it can be presented as an application of limited expected values. Depending on changes to the CAS Exam 3, having these topics on a jointly sponsored Exam C/4 may need special syllabus material.

5 More hours of examination

The recommendation includes expanding the number of exam hours for both Exams FM/2 and M. In reaching this decision, the group considered test reliability as well as simply looking at the amount of additional material. If the exam is not long enough to adequately test the range of the syllabus, candidates are given an opportunity to choose the portion of the syllabus that they think they know best.

6 Implementation Date

Implementation before May 2007 has appeal in terms of the importance of these changes; however, candidates and university actuarial programs, in particular, need sufficient lead-time to prepare for a change of this size. These changes will likely require some schools to add a new course to their program. This can be quite an undertaking. Finally, we wish to be sensitive to candidates who are already subject to extensive changes within the E&E system.

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Transition

Because new topics are being introduced and some topics are being moved from one exam to another, the transition for this change is not clear-cut. At a minimum, there will be candidates when the changes are implemented with credit for Exams FM/2, M and C/4 who had not taken the pre-2005 Course 6. These candidates will receive their ASA without having been rigorously examined on the financial economics material being added.

The recommendation is to err on the side of simplicity. The most straightforward method of allocating conversion credits would be a one-to-one match for each exam. Exams would not be partitioned. The credit that a candidate has for a particular exam before transition will give credit for that exam after transition but not for any other exam. Some candidates may be examined on loss models twice. Alternatively, a candidate could get their ASA without having covered loss models but with financial economics. Some candidates may not be examined on the introductory financial economics material on Exam FM/2 but will need that knowledge for the later exams. Given that current candidates are not being examined on the financial economics topics, none of these scenarios seem egregious.

Learning outcomes and resources

Text: *Derivatives Markets* by Robert L. McDonald, 2003, Addison Wesley

Exam FM/2	
Learning Outcomes	Syllabus Resources
<ol style="list-style-type: none"> 1. Explain why firms might care about risk management. 2. Evaluate the risk/return characteristics of the basic building blocks of financial derivatives: forward contracts; call and put options 3. Identify associated hedging and investment strategies 4. Explain the use of derivatives as risk management tools. 	<p>Chapter 1. Introduction to Derivatives</p> <ol style="list-style-type: none"> 1.1. What is a Derivative 1.2. The Role of Financial Markets 1.3. Derivatives in Practice 1.4. Buying and Short-Selling Financial Assets <p>Chapter 2. An Introduction to Forwards and Options</p> <ol style="list-style-type: none"> 2.1. Forward Contracts 2.2. Call Options 2.3. Put Options 2.4. Summary of Forward and Option positions 2.5. Options Are Insurance 2.6. Example: Equity-Linked CDs <p>Chapter 3. Insurance, Collars, and Other Strategies</p> <ol style="list-style-type: none"> 3.1. Basic Insurance Strategies 3.2. Synthetic Forwards 3.3. Spreads and Collars 3.4. Speculating on Volatility 3.5. Example: Another Equity-Linked Note <p>Chapter 4. Introduction to Risk Management</p>

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	<p>4.1. Basic Risk Management: The Producer's Perspective</p> <p>4.2. Basic Risk Management: The Buyer's Perspective</p> <p>4.3. Why Do Firms Manage Risk?</p> <p>4.4. Golddiggers Revisited</p>
<p>5. Explain the cash-flow characteristics of forwards, futures and swaps.</p> <p>6. Use the concept of no-arbitrage to determine the theoretical value of forwards, futures and swaps</p> <p>7. Manage financial risk through use of forwards, futures and swaps</p>	<p>Chapter 5. Financial Forwards and Futures</p> <p>5.1. Alternative Ways to Buy a Stock</p> <p>5.2. Prepaid Forward Contracts on Stock</p> <p>5.3. Forward Contracts on Stock</p> <p>5.4. Futures Contracts</p> <p>Chapter 8. Swaps</p> <p>8.1. An Example of a Commodity Swap</p> <p>8.2. Interest Rate Swaps</p>

Exam M	
Learning Outcomes	Syllabus Resources
<p>1. Use put-call parity to determine the relationship between prices of European put and call options and to identify arbitrage opportunities</p>	<p>Chapter 9. Parity and Other Option Relationships</p> <p>9.1. Put-Call Parity</p> <p>9.2. Generalized Parity and Exchange Options</p> <p>9.3. Comparing Options with Respect to Style, Maturity, and Strike</p>
<p>2. Value European and American options using the binomial model.</p>	<p>Chapter 10. Binomial Option Pricing: I</p> <p>10.1. A One-Period Binomial Tree</p> <p>10.2. Two or More Binomial Periods</p> <p>10.3. Put Options</p> <p>10.4. American Options</p> <p>10.5. Options on Other Assets</p> <p>Chapter 11. Binomial Option Pricing: II</p> <p>11.1. Understanding Early Exercise</p> <p>11.2. Understanding Risk-Neutral pricing</p> <p>11.3. The Binomial Tree and Lognormality</p> <p>11.4. Estimating Volatility</p> <p>11.5. Stocks paying Discrete Dividends</p>
<p>3. Value European and American options using the Black-Scholes option-pricing model</p> <p>4. Calculate and interpret the option Greeks</p>	<p>Chapter 12. The Black-Scholes Formula</p> <p>12.1. Introduction to the Black-Scholes Formula</p> <p>12.2. Applying the Formula to Other Assets</p> <p>12.3. Option Greeks</p> <p>12.4. Profit Diagrams before Maturity</p> <p>12.5. Implied Volatility</p> <p>12.6. Perpetual American Options</p>
<p>5. Control risk by the method of delta-hedging.</p>	<p>Chapter 13. Market Making and Delta-Hedging</p> <p>13.1. What Do Market-Makers Do?</p> <p>13.2. Market-Maker Risk</p> <p>13.3. Delta-Hedging</p>

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	<p>13.4. The Mathematics of Delta-Hedging 13.5. The Black-Scholes Analysis 13.6. Market-Making as Insurance</p>
<p>6. Explain the cash-flow characteristics of the following exotic options: Asian options; barrier options, compound options, gap options, exchange options.</p>	<p>Chapter 14. Exotic Options: I 14.1. Introduction 14.2. Asian Options 14.3. Barrier Options 14.4. Compound Options 14.5. Gap Options 14.6. Exchange Options</p>
<p>7. Explain what it means to say that stock prices follow a diffusion process 8. Apply Itô's lemma in the one-dimensional case only.</p>	<p>Chapter 20. Brownian Motion and Itô's Lemma 20.1. The Black-Scholes Assumption about Stock Prices 20.2. A Description of Stock Price Behavior 20.3. Brownian Motion 20.4. Geometric Brownian Motion 20.5. The Sharpe Ratio 20.6. Itô's Lemma (only through the functions of an Itô Process)</p>
<p>9. Evaluate features of the Vasicek and Cox-Ingersoll-Ross bond price models 10. Explain why the time-zero yield curve in these models cannot be exogenously prescribed. 11. Construct a Black-Derman-Toy binomial model matching a given time-zero yield curve and a set of volatilities.</p>	<p>Chapter 23. Interest Rate Models 23.1. Bond Options, Caps, and the Black Model 23.2. Market-Making and Bond Pricing 23.3. Equilibrium Short-Rate Bond Price Models 23.4. A Binomial Interest Rate Model 23.5. The Black-Derman-Toy Model</p>
<p>12. Apply option pricing concepts to actuarial problems such as equity-linked insurance.</p>	<p>Study Note on Actuarial Applications</p>

Exam C/4	
Learning Outcomes	Syllabus Resources
<p>1. Explain the properties of a lognormal distribution. 2. Explain the Black-Scholes formula as an expected value of a lognormal distribution.</p>	<p>Chapter 18. The Lognormal Distribution* 18.1. The Normal Distribution 18.2. The Lognormal Distribution 18.3. A Lognormal Model of Stock Prices 18.4. Lognormal Probability Calculations 18.5. Estimating the Parameters of a Lognormal Distribution 18.6. How Are Asset Prices Distributed??</p>
<p>3. Simulate lognormal stock prices 4. Incorporate jumps in stock prices by mixing Poisson and lognormal random variables. 5. Use variance reduction techniques to accelerate convergence.</p>	<p>Chapter 19. Monte Carlo Valuation* 19.1. Computing the Option Price as a Discounted Expected Value 19.2. Computing Random Numbers 19.3. Simulating Lognormal Stock prices 19.4. Examples of Monte Carlo Valuation</p>

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6 Use the Cholesky decomposition method for simulating correlated random variables.	19.5. Efficient Monte Carlo Valuation 19.6 The Poisson Distribution 19.7. Simulating Jumps with the Poisson Distribution 19.8. Simulating Correlated Stock Prices
7. Calculate risk measures (VaR, CTE) 8. Explain their use and limitations.	Study Note on Risk Measure (approx. 5-10 pages)

*It is likely this material will be supported with a study note in order to integrate it with the material currently on this exam.