

**EDUCATION AND EXAMINATION COMMITTEE
OF THE SOCIETY OF ACTUARIES**

FALL 2011

FINANCIAL ECONOMIC THEORY AND ENGINEERING

OVERVIEW STUDY NOTE

This overview study note is intended to provide candidates with an approach for organizing the course of reading for studying the various sections of the syllabus.

The syllabus has been organized into four major areas of focus:

1. Modern Corporate Financial Theory
2. Corporate Financial Applications
3. Derivatives, Pricing, and Modeling
4. Efficient and Inefficient Markets, Complete and Incomplete Markets, Information Theory, and Market Misbehavior

The candidate should be very familiar with the Learning Outcome Statements as described in the syllabus, and repeated in this Overview Study Note. These Learning Outcome Statements were the first ingredient in developing the syllabus and also guide the examination committee when writing questions. The Learning Objectives set out the cognitive level needed to pass this exam and will also provide an indication of what the candidates are expected to get out of the readings.

The course of readings builds the candidates knowledge and each was selected to explain or illustrate one or more Learning Objectives. While studying the syllabus material candidates may want to consider both the organizational approach provided by this overview note and to refer back to the Learning Objectives to remain focused on the educational goals being tested by this exam.

In addition, the course of reading contains a Case Study, which the candidate should become familiar with. The Case Study is meant to give the candidate a “real life example” to which the Learning Objectives may be applied. There will be questions on the Exam which reference the Case Study.

Within the major areas of focus, the following represents one way that the candidate might relate syllabus material by topic.

1. Modern Corporate Financial Theory and 2. Corporate Financial Applications

Syllabus sections 1 and 2 overlap heavily; Section 1 is more theory and Section 2 applies that theory. This note suggests a way to weave them together and better master

the Learning Outcome Statements. Candidates are welcome to attack the readings in any order they prefer.

Generally, for each business initiative you present to senior management, the first response will be to understand the impact on earnings or capital. First we'll establish a baseline understanding by looking at differing definitions of capital, sources of capital and how it is deployed, and how to understand and optimize an organization's capital structure.

- FET-166-09: Megginson, W. L., *Corporate Finance Theory*, Ch. 2: Ownership, Control, and Compensation
- *Financial Theory and Corporate Policy*, Copeland, Weston, Shastri, 4th Edition, 2005
 - Ch. 2: Investment Decisions: The Certainty Case
- FET-170-09: Theory of Risk Capital in Financial Firms, by Merton & Perold
- FET-114-07: Capital Allocation in Financial Firms

Learning Objectives:

- 1a. Explain the various definitions of capital, including regulatory, rating agency and other risk-based capital requirements, the context in which they are appropriate, and how they affect decisions.

A business must earn a return to investors on capital invested. The return to investors is effectively a cost to the business, so we must calculate that cost and price for it in our products and other risk-taking.

- *Financial Theory and Corporate Policy*, Copeland, Weston, Shastri, 4th Edition, 2005
 - Ch. 15: Capital Structure and the Cost of Capital: Theory and Evidence
- Investor & Management Expectations of the Return on Equity Measure vs. Some Basic Truths of Financial Accounting, by Michelle D. Smith, *The Financial Reporter*, 9/03, <http://www.soa.org/library/newsletters/financial-reporter/2003/september/frn0309.pdf>

Learning Objectives:

- 1b. Calculate the cost of capital for a venture or a firm using the most appropriate method for given circumstances and justify the choice of method.
- 1c. Evaluate various profitability measures including IRR, NPV and ROE, etc.

However, accounting capital is dependent on the system by which it is measured, thus containing timing mismatches and levels of conservatism. For example, a hedged liability may not have its financial statement value marked to market but the derivative contracts used to hedge it are marked to market, creating potentially large earnings and capital volatility. To better understand the underlying business and its risks some firms and regulators are developing market consistent or "economic" capital and value measures.

- FET-115-08: Specialty Guide on Economic Capital, 2004 (**exclude appendices**)

- CH. 9 CSFB Handbook, Risk Measures: How Long Is a Risky Piece of String? https://www.credit-suisse.com/investment_banking/research/doc/credit_portfolio_modeling.pdf
- Application of Coherent Risk Measures to Capital Requirements in Insurance”, Artzner, NAAJ, Vol 3, No 2 http://www.soa.org/library/journals/north-american-actuarial-journal/1999/april/naaj9904_1.pdf

Learning Objectives:

- 1d. Define and compare risk metrics used to quantify economic capital and describe their limitations.
- 1e. Apply the concept of economic capital and describe methodologies for allocating capital within a financial organization.

We now explore how the types of capital used by a company interrelate, how it can be optimized, and how this creates or puts at risk shareholder value.

- *Financial Theory and Corporate Policy*, Copeland, Weston, Shastri, 4th Edition, 2005
 - Ch. 15: Capital Structure and the Cost of Capital: Theory and Evidence
 - Ch. 16: Dividend Policy: Theory and Evidence
- FET-151-08: Real and Illusory Value Creation by Insurance Companies, D. Babbel and C. Merrill, *Journal of Risk and Insurance*, 2005, Vol. 72, No.1, pp.1-21.
- FET-162-08: *Financial Markets and Corporate Strategy*, Grinblatt & Titman, 2nd Edition, Ch. 18: How Managerial Incentives Affect Financial Decisions
- FET-163-08: *Financial Markets and Corporate Strategy*, 2nd Edition, Grinblatt & Titman, Ch. 19: The Information Conveyed by Financial Decisions

Learning Objectives:

- 1f. Explain how rating agencies affect the choice of capital structure.
- 1g. Recommend a specific legal form of organization and justify the choice.
- 1h. Recommend specific firm governance measures and justify the recommendation.
- 1i. Identify sources of agency costs and explain methods to address them.
- 2g. Recommend an optimal capital structure and how to implement it for a given business or strategy and be able to justify the recommendation.
- 2h. Describe how behavioral characteristics and biases of users and providers of capital affect the capital structure.

Firms can raise financing or capital in several ways, including placing future cash flows in trust and selling securities with the right to receive those cash flows. A particular project might best be funded with a particular type of capital, and the candidate should be prepared to evaluate alternatives and make recommendations on the best approach.

In addition, the insurance industry has the tool of reinsurance which can be used in a variety of ways to accomplish specific goals. The candidate should be prepared to

evaluate different methods of reinsurance or securitizations and recommend the best alternative for a given situation.

- FET-160-08: Megginson, W. L., *Corporate Finance Theory*, FET: Ch. 9: Understanding and Accessing Financial Markets
- FET-108-07: *Integrated Risk Management*, Doherty, Ch. 13: Contingent Leverage Strategies and Hybrid Debt
- FET-161-08: Tiller & Tiller, *Life, Health and Annuity Reinsurance*, Ch. 5: Advanced Methods of Reinsurance
- FET-148-08: Securitization of Life Insurance Assets and Liabilities
- FET-165-08: *Integrated Risk Management*, Doherty, Ch. 16: A Case Study: The Securitization of Catastrophic Risk

Learning Objectives:

- 2a. Describe the steps necessary to obtain funds for a given project or firm from any specified source, and be able to recommend a specific approach to raising capital in a given situation.
- 2b. Describe the process, methods and uses of financial reinsurance (surplus relief) and recommend a structure that is appropriate for a given set of circumstances.
- 2c. Describe the process, methods and uses of insurance securitizations and recommend a structure that is appropriate for a given set of circumstances.

To increase returns to investors and to align internal incentives, firms invest resources in planning and projecting how to best use available capital. Often in projects, there are options that management has, such as abandoning a project for example. The candidate should understand the various types of real options and be able to analyze the value of these options to a given project.

- FET-114-07: Capital Allocation in Financial Firms
- *Financial Theory and Corporate Policy*, Copeland, Weston, Shastri, 4th Edition, 2005
 - Ch. 9: Multi-period Capital Budgeting under Uncertainty: Real Options Analysis

Learning Objectives:

- 2d. Evaluate alternative options for utilizing capital and recommend the most appropriate use in a given situation.
- 2e. Apply real options analysis to recommend and evaluate firm decisions on capital utilization.

Many companies seek to gain scale or enter new markets by acquiring or merging with another company or business unit, a major and potentially risky deployment of available capital. We will study this in some detail so that we are prepared should the opportunity arise to help analyze an acquisition or merger.

- *Insurance Industry Mergers & Acquisitions*, Toole and Herget, 2005
 - Ch. 1: Introduction background only
 - Ch. 2: M&A Process Overview background only

- Ch. 3: Finance
- Ch. 4: Valuation Techniques
- *Financial Theory and Corporate Policy*, Copeland, Weston, Shastri, 4th Edition, 2005
 - Ch. 18: Acquisitions, Divestitures, Restructuring, and Corporate Governance, pp. 781-806
- FET-149-08: Are You Paying Too Much for That Acquisition?

Learning Objectives:

2f. Describe the process, methods and effects of a potential acquisition or reinsurance of a business including its effect on capital structure, return on equity, price/earnings multiples, and share price.

3. Derivatives, Pricing, and Modeling

This is the technical side of financial engineering. Mastery of this material is critical for candidates aspiring to more quantitative specialties, such as hedge strategy and variable annuity work. The syllabus covers equity and fixed income financial theory, studies the core critiques of it, and introduces the rapidly evolving topic of how to accurately model capital market dynamics and instruments.

For a very accessible introduction to the concept of risk neutral valuation (though not on the syllabus), candidates should refer to:

- *Investment Guarantees: Modeling and Risk Management for Equity-Linked Life Insurance*, Hardy, 2003
 - Ch. 7: A Review of Option Pricing Theory (*background only*)

or:

- *Options Futures & Other Derivatives*, Hull, J.C., 8th Edition, 2012
 - Ch. 12: Binomial Trees (12.1 – 12.7 and 12.9 – 12.11 only, exclude Appendix) (*background only*)

For a more mathematically rigorous introduction to risk neutral and martingales see:

- FET-174-10: *Stochastic Calculus for Finance 1: The Binomial Asset Pricing Model* Shreve, Ch.1, pp. 1-15, Ch.2, pp. 25-45, Ch.3, pp. 61-71 (*background only*)

Note that in the background above the theory has not yet made normal distribution assumptions. Before we dive into Black-Scholes-Merton we'll get some cautionary advice from Section 4. This short article offers a strong challenge to the core assumptions of BSM. It is a highly distilled summary of the core arguments of Nicholas Taleb's "The Black Swan".

- FET-177-11: The Known, the Unknown and the Unknowable in Financial Risk Management, by Diebold et. al
 - Chapter 3: Mild and Wild Randomness¹

Learning Objectives:

- 4c. Describe empirical evidence and results regarding market efficiency.
- 4f. Explain the implications of incomplete markets for financial theory.

With that in mind we will proceed to develop the theory on the equity side, the core of which is the derivation of the Black-Scholes-Merton option pricing model and its results. For brevity just the Hull 8th edition references are listed here but for Fall 2011 candidates will in no way be disadvantaged by using the 7th edition (please see the full Exam Syllabus for the 7th edition chapters).

- *Options Futures & Other Derivatives, Hull, J.C., 8th Edition, 2012*
 - Ch. 13: Wiener Processes and Ito's Lemma (Appendix, exclude multivariate material)
 - Ch. 14: The Black-Scholes-Merton model
 - Ch. 18: Greek Letters
 - Ch. 19: Volatility Smiles
 - Ch. 25: Exotic Options (25.1, 25.2, 25.4, 25.6 – 25.8, 25.10 – 25.16 only)

Learning Objectives:

- e. Derive the Black Scholes Merton pricing formula.
- f. Demonstrate understanding of option pricing techniques and theory for equity and interest rate derivatives.
- g. Describe and evaluate equity and interest rate models
- h. Contrast commonly used equity and interest rate models
- p. Understand the differences and implications of P Measures and Q Measures

For further insights into the shortcomings of the Black-Scholes-Merton model:

- FET-153-08: What Does An Option Pricing Model Tell Us About Option Prices?
- FET-167-09: How to Use the Holes in Black-Scholes, by Black, F.

Learning Objectives:

- g. Identify limitations of each option pricing technique.
- h. Describe and evaluate equity and interest rate models
- i. Contrast commonly used equity and interest rate models
- k. Describe and apply alternatives to the Black-Scholes-Merton model
- l. Recommend an equity or interest rate model for a given situation

¹ See errata sheet on the SOA website.

- n. Describe how option pricing models can be modified or alternative techniques that can be used to deal with option pricing techniques' limitations.

Here are some methods to implement these theoretical models:

- *Investment Guarantees: Modeling and Risk Management for Equity-Linked Life Insurance*, Hardy, 2003
 - Ch. 2: Modeling Long-Term Stock Returns
 - Ch. 3: Maximum Likelihood Estimation of Stock Returns
- *Options Futures & Other Derivatives*, Hull, J.C., 8th Edition, 2012
 - Ch. 20: Basic Numerical Procedures
 - Ch. 22: Estimating Volatilities and Correlations (22.1 – 22.7 only)
 - Ch. 26: More on Models and Numerical Procedures (26.1 (excluding page 602 from “Models such as Merton’s...” to page 603 before “The Variance-Gamma Model”), 26.2, 26.3 only)

Learning Objectives:

- m. Describe issues and best practices in the estimation or calibration of financial models
- o. Use numerical methods to effectively model complex assets or liabilities.

For an application of the models to hedge a financial liability:

- *Investment Guarantees: Modeling and Risk Management for Equity-Linked Life Insurance*, Hardy, 2003
 - Ch. 8: Dynamic hedging for separate account guarantees

Learning Objectives:

- b. Evaluate the risk/return characteristics of complex derivatives.
- c. Identify embedded options in assets and liabilities.
- l. Recommend an equity or interest rate model for a given situation

Next we'll move to interest rates and we progress from using the deterministic forward rate curve observed at the valuation date to stochastic interest rates, models for interest rate dynamics, and using them to value derivatives and other financial assets:

- *Options Futures & Other Derivatives*, Hull, J.C., 8th Edition, 2012
 - Ch. 27: Martingales and Measures
 - Ch. 28: Interest Rate Derivatives: The Standard Market Models
 - Ch. 29: Convexity, Timing, and Quanto Adjustments
 - Ch. 30: Interest Rate Derivatives: Models of the Short Rate (exclude 30.2 properties of Vasicek and CIR, exclude 30.3 BDT and Black-Karasinski)
 - Ch. 31: Interest Rate Derivatives: HJM and LMM
 - Ch. 32: Swaps Revisited

Learning Objectives:

- a. Define the cash flow characteristics of complex derivatives including exotic options, interest rate derivatives, swaps, and other non traditional derivatives.
- b. Evaluate the risk/return characteristics of complex derivatives.
- h. Demonstrate understanding of option pricing techniques and theory for equity and interest rate derivatives.
- i. Identify limitations of each option pricing technique.
- j. Describe and evaluate equity and interest rate models
- k. Contrast commonly used equity and interest rate models
- l. Define and apply the concepts of martingale, market price of risk and measures in single and multiple state variable contexts
- p. Understand the differences and implications of P Measures and Q Measures

The following is useful *background* on modeling:

- FET-106-07: Ho & Lee, *The Oxford Guide to Financial Modeling*, Ch. 5: Interest Rate Derivatives: Interest Rate Models and Ch. 6: Implied Volatility Surface: Calibrating the Models (*background only*)

Here is more insight into some of the theoretical complexities and practical issues of these models:

- FET-158-09: Babbel & Fabozzi, *Investment Management for Insurers*, Ch. 11: "The Four Faces of an Interest Rate Model", by Fitton & McNatt
- FET-169-09: "Empirical Properties of Asset Returns: Stylized Facts and Statistical Issues" by Rama Cont, *Quantitative Finance* Volume 1 (2001) 223–236
- Variance of the CTE Estimator by Manistre and Hancock, NAAJ, April, 2005
<http://www.soa.org/news-and-publications/publications/journals/naaj/naaj-april-2005.aspx>²

Learning Objectives:

- g. Identify limitations of each option pricing technique.
- m. Describe issues and best practices in the estimation or calibration of financial models
- n. Describe how option pricing models can be modified or alternative techniques that can be used to deal with option pricing techniques' limitations.

4. Efficient and Inefficient Markets, Complete and Incomplete Markets, Information Theory & Market Misbehavior

This section is intended to acquaint candidates with problems with the current theories of capital markets. Much of modern financial theory and mathematics is based on the Markowitz mean-variance efficient frontier model from the 1950s and developments from

² See errata sheet on the SOA website.

it such as the Capital Asset Pricing Model. These models make many strict assumptions about markets and investor behavior that clearly do not hold in the real world: indifference to risk, frictionless markets, rational expectations and behavior, and on.

We looked at the Taleb reading in Section 3, but here is its natural place in the syllabus:

- FET-177-11: The Known, the Unknown and the Unknowable in Financial Risk Management, by Diebold et. al
 - Chapter 3: Mild and Wild Randomness

Learning Objectives:

- 4c. Describe empirical evidence and results regarding market efficiency.
- 4f. Explain the implications of incomplete markets for financial theory.

The Copeland chapters, seen earlier in the context of capital management, are reexamined to review this theory and compare it to the real world. First we review the theory:

- *Financial Theory and Corporate Policy*, Copeland, Weston, Shastri, 4th Edition,
 - Ch. 6: Market Equilibrium: CAPM and APT (pp. 164-188)
 - Ch. 10: Efficient Capital Markets: Theory

Learning Objectives:

- 4a. Define capital market efficiency and the value of information.

Next we examine whether the theory squares with what we see in financial markets:

- Ch. 11: Efficient Capital Markets: Evidence

Learning Objectives:

- 4b. Describe tests of efficiency and their implications for capital structure, portfolio management, and risk management.
- 4c. Describe empirical evidence and results regarding market efficiency.

and get a reality check on the intricate theoretical and analytical models we build:

- FET-175:10: Models, by Derman, E., *Financial Analysts Journal*, 2009

Learning Objectives:

- 4b. Describe tests of efficiency and their implications for capital structure, portfolio management, and risk management.

We'll explore some of the work in understanding the implications of some of these theoretical issues:

- Ch. 12: Information Asymmetry and Agency Theory
- Ch. 15: Capital Structure and the Cost of Capital: Theory and Evidence
- Ch. 16: Dividend Policy: Theory and Empirical Evidence

Learning Objectives:

- 4d. Explain information asymmetry and how it can affect financial markets, especially insurance markets.
- 4e. Define principal-agency theory and explain how it affects capital structure, portfolio management and risk management.
- 4f. Explain the implications of incomplete markets for financial theory.

Lastly, Behavioral Finance is used to study the efficiency and rationality of the investors' decision-making process, so we'll get an overview of its key concepts:

- FET-176-11: *Handbook of Economics of Finance*, Vol. 1, Part 2, Ch. 18, A Survey of Behavioral Finance - Barberis and Thaler

Learning Objectives:

- 4c. Describe empirical evidence and results regarding market efficiency.
- 4e. Define principal-agency theory and explain how it affects capital structure, portfolio management and risk management.

Conclusion

The candidate should take note to focus on both the concepts and principles addressed in the course syllabus. Candidates may be asked to apply concepts and principles in a particular context in an examination question. For example, although the candidate is not expected to remember detailed nation-specific accounting requirements, the candidate may be expected to understand how to apply accounting requirements for products or portfolios within a specific regulatory environment as specified in the examination.

Once you have completed your Fellowship, if you wish to continue your studies with the following.

- *The Volatility Surface: A Practitioners' Guide*, by Jim Gatheral

For a more mathematically rigorous treatment of mathematical finance continue in:

- *Stochastic Calculus for Finance I: The Binomial Asset Pricing Model*, Steven E. Shreve
- *Stochastic Calculus for Finance II: Continuous-Time Models*, Steven E. Shreve

For advanced interest rate modeling see:

- *Interest Rate Models – Theory and Practice*, Damiano Brigo and Fabio Mercurio

I hope this overview helps you connect the themes in the readings into a more integrated, comprehensive understanding of the whole syllabus. Writing it has been useful for me too.

I would remind you once more that mastering the Learning Objectives are of paramount importance to success on the exam. They set the cognitive level needed to pass the exam. Do review the Learning Objectives to ensure that you understand how the course of reading fits with them. The exam questions are designed to test the syllabus material, but more importantly have been written to test the Learning Objectives.

Best wishes to you for a successful exam sitting.