Quantitative Finance

Lecture 1

Outline

Overview of Quantitative Finance and Risk Management: Past, Present, and Future Frontier

Abstract

Based upon theoretical framework of finance, policy framework of finance, and research methods of quantitative finance and risk management, this paper will reviews, and discusses the overview of i) portfolio theory and investment analysis, ii) options and option pricing theory, and iii) risk management. In addition, research topics in quantitative finance and risk management will be suggested.

Introduction

The main purpose of this paper is to review theoretical framework of finance, alternative policies used in finance, and research methods in quantitative finance and risk management. Based upon theoretical framework of finance, policy framework of finance, and research methods of quantitative finance and risk management, this paper will reviews, and discusses the overview of i) portfolio theory and investment analysis, ii) options and option pricing theory, and iii) risk management. In addition, research topics in quantitative finance and risk management will be suggested.

The main purpose of section B is to discuss the important finance theories. We first discuss discounted cash-flow valuation theory (classical financial theory). Secondly we discuss Modigliani and Miller (M and M) valuation theory. Thirdly we discuss Markowitz portfolio theory. We then move on to the discussion of the capital asset pricing model (CAPM). The arbitrage pricing theory is discussed following the CAPM. Finally, the option pricing theory and futures valuation and hedging will be discussed.

Introduction

The purpose of section C is to discuss the interaction between investment, financing, and dividends policy of the firm. A brief introduction of the policy framework of finance in provided in Section C.1. Section C.2 discusses the interaction between investment and dividends policy. Section C.3 discusses the interaction between dividends and financing policy. Section C.4 discusses the interaction between investment and financing policy. Section C.5 discusses the implications of financing and investment interactions for capital budgeting. Section C.6 discusses the implications of different policies on the beta coefficients. The conclusion is presented in Section C.7.

The main purpose of section D is to discuss important quantitative methods used to do the research in quantitative finance and risk management. We first discuss statistics theory and methods. Secondly we discuss econometric methods. Thirdly we discuss mathematics. Finally we discuss other methods such as operation research, stochastic process, computer science and technology, entropy, and fuzzy set theory.

Finally, the results of this paper will be briefly summarized. In addition, future research direction in both quantitative finance and risk management will be discussed in detail.

Theoretical Framework of Finance

B1. DISCOUNTED CASH-FLOW VALUATION THEORY

BOND VALUATION

Perpetuity

Term Bonds

COMMON-STOCK VALUATION

B2. M AND M THEORY AND OPTIMAL CAPITAL STRUCTURE

M and M Theory

Optimal Capital Structure Theory

B3. Markowitz Portfolio Theory

Traditional Portfolio Theory and Method

Programming Models for Portfolio Selection

B4. CAPITAL ASSET PRICING MODEL (CAPM)

Static CAPM

Dynamic CAPM

Theoretical Framework of Finance

B6. OPTION PRICING THEORY
- Binomial OPM
- Black and Scholes OPM
- CEV OPM
- Other OPM

B7. Futures Valuation and Hedging
- FUTURES MARKETS: OVERVIEW
- THE VALUATION OF FUTURES CONTRACTS
- The Arbitrage Argument
- Interest Costs
- Carrying Costs
- Supply and Demand Effects
- The Effect of Hedging Demand
- HEDGING CONCEPTS AND STRATEGIES
- Hedging Risks and Costs
- The Johnson Minimum-Variance Hedge Strategy
- The Howard-D'Antonio Optimal Risk-Return Hedge Strategy

B8. Alternative Risk Analysis
- Theory
- Application

Investment, Dividend, Financing, and Production Policies

C1. INVESTMENT AND DIVIDEND INTERACTIONS
- Internal Financing
- External Financing

C2. INTERACTIONS BETWEEN DIVIDEND AND FINANCING POLICIES
- Cost of Equity Capital and Dividend Policy[1]
- Default Risk and Dividend Policy

C3. INTERACTIONS BETWEEN FINANCING AND INVESTMENT DECISIONS
- Risk-free Debt Case
- Risky Debt Case

C4. IMPLICATIONS OF FINANCING AND INVESTMENT INTERACTIONS FOR CAPITAL BUDGETING
- Equity-Residual Method
- After-Tax, Weighted-Average, Cost-of-Capital Method
- The Arditti-Levy method is most similar to the after-tax weighted-average cost-of-capital
- Arditti and Levy Method
- Myers Adjusted-Present-Value Method

Investment, Dividend, Financing, and Production Policies

C5. IMPACTS OF DIFFERENT POLICIES ON THE BETA COEFFICIENT

Impact of Financing Policy on Beta Coefficient Determination

Impact of Production Policy on Beta Coefficient Determination

Impact of Dividend Policy on Beta Coefficient Determination

Research Methods in Quantitative Finance and Risk Management

D1. Statistics

Binomial distribution **Multinomial distribution**

Normal distribution **Log-normal distribution**

Non-central Chi-square distribution

Factor analysis **Discriminant analysis**

Bayesian inference **Stochastic dominance**

Characteristics function **Spectrum analysis**

MLE Method **Quasi-MLE Method**

Others

Research Methods in Quantitative Finance and Risk Management

D2. Econometrics

Linear regression models

Multiple equations models

Panel data models

GARCH analyses

Spline-GARCH

Robust logistic regression

Time series modeling

Generalized methods of moments

ARM model

Defensive forecasting

Dynamic econometric loss

Others

Research Methods in Quantitative Finance and Risk Management

D3. Mathematics

- **Equilibrium analysis**
- **Optimization problems**
- **Dynamic analysis**
- **Itô calculus**
- **Ordinary differential equation (ODE)**
- **Fuzzy set theory**
- **Others**

D4. Other Research Methods

- **Operation research**
- **Monte Carlo Markov Chain (MCMC) method**

Summary and Concluding Remarks

Alternative finance theories, different decision policies, and research methodologies are three ingredients for theoretical research in quantitative finance and risk management. In this paper, we have reviewed these three ingredients in detail. In addition, accounting, finance, and market information are important in doing empirical research in quantitative finance and risk management.

Our main concluding remarks related to quantitative finance can be presented as follows:

1. **Quantitative finance is one of the most popular research subjects for both academicians and practitioners.**
2. **Derivatives are popular financial instruments until financial crisis occurred in 2008.**
3. **Risk management becomes more important after financial crisis occurred in 2008.**
4. **Information, theory, policy, and methodology are important ingredients for the research of Quantitative Finance and Risk Management.**