CENTRAL UNIVERSITY OF TAMIL NADU, TIRUVARUR

DETAILED SYLLABI AND CURRICULUM OF

M.Sc. Applied Quantitative Finance
Post Graduate Degree (a Two Year Full time)
to be offered by
MADRAS SCHOOL OF ECONOMICS

Eligibility

Any graduate of a recognized University with a minimum of 55% marks (50% for OBC-Non Creamy Layer; and 45% for SC/ST candidates) and Mathematics at plus two level. Admission will be based on common entrance test.

Other Regulations as per M.Sc. Regulations for Post-Graduate Programmes of Central University of Tamil Nadu

April 20, 2012
M.Sc. Applied Quantitative Finance

The PG Degree course is a two-year course, divided into four modules. Each module consists of four papers. In the first-year, there will be 8 core courses. In the second year, the first module comprises two core papers and two optional (elective) papers. The second module comprises of one core and two optional (elective) papers. It will be taught under the guidance of an Advisory Committee comprising eminent persons from both the analytics industry as well as academics.

Recent advances in statistical, econometric and analytical modelling have vastly improved our understanding of financial market dynamics. Our ability to adequately capture stylized facts in financial markets depends crucially on the development of good models, the estimation of the developed models and their evaluations. Consequently, there has been an exponential increase in the demand for qualified analysts. With this view, Madras School of Economics jointly with Central University of Tamil Nadu aims to introduce a two-year post-graduate degree course in Applied Quantitative Finance. The course is geared towards presenting the central concepts in clear, analytical, mathematical and computational detail with an emphasis on the underlying intuition. In addition, Business Case Study would be provided wherever it is necessary. The intended participants consists of students and professionals who have an interest in equity research, retail and investment banking, risk management, as well as derivative markets. In particular, the possible participants would include graduate students, industry professionals, and regulators. We aim to deliver a program that is valued by employers in financial markets across the globe and to ensure that the participants are ready for the marketplace. All these courses are application oriented and very relevant for today's liberalized economic environment. There is also an emphasis on independent research. Students are required to do term papers in most of the courses and each student undertakes a significant research project during the final semester. Interested students take up a summer internship programme at the end of the first year, which greatly helps them to get an orientation in applied work. With this view, Madras School of Economics jointly with Central University of Tamil Nadu aims to introduce a two-year post-graduate degree course in Applied Quantitative Finance.
M.Sc. (APPLIED QUANTITATIVE FINANCE)

**SEMESTER 1**

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<tr>
<th>Course Code</th>
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<td>QF01</td>
<td>Microeconomics I</td>
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<td>QF02</td>
<td>Macroeconomics I</td>
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<td>QF03</td>
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**SEMESTER 2**

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<tr>
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<tr>
<td>QF05</td>
<td>Microeconomics II</td>
<td>4</td>
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<tr>
<td>QF06</td>
<td>Econometric Methods</td>
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<tr>
<td>QF07</td>
<td>Financial Mathematics</td>
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<tr>
<td>QF08</td>
<td>Financial Economics I</td>
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## SEMESTER 3

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<tr>
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<tr>
<td>QF09</td>
<td>Applied Econometrics</td>
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<td>QF10</td>
<td>Risk Analysis and Management</td>
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<tr>
<td>QF11</td>
<td>Programming and Computational Languages</td>
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<td>QF12</td>
<td>Financial Economics II</td>
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<td>QF13</td>
<td>Stochastic Models</td>
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<td>QF14</td>
<td>Advanced Techniques in Finance</td>
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<tr>
<td>QF:P1</td>
<td>Project Work</td>
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Courses listed under QF11 to QF14 are optional courses. Students need to take any two out of the four offered courses.

## SEMESTER 4

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>QF:15</td>
<td>Advances in Panel Data and Time Series Econometrics</td>
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<tr>
<td>QF16</td>
<td>Financial Instruments and Markets</td>
<td>4</td>
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<tr>
<td>QF17</td>
<td>Artificial Neural Networks</td>
<td>4</td>
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<td>QF:18</td>
<td>Interest Rate Calculation and Option Pricing</td>
<td>4</td>
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<tr>
<td>QF:19</td>
<td>Topics in Behavioral Finance</td>
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<tr>
<td>QF:P2</td>
<td>Project Work</td>
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Courses listed under QF16 to QF19 are optional courses. Students need to take any two out of the three offered courses.

*C–Credit,  Total Credits: 68*
SEMESTER 1

QF:01 MICROECONOMICS-1

1. Consumer Behaviour and Demand

Consumer preferences, opportunity sets, optimum choices, indirect utility demand functions, income and substitution effects, Slutsky equation, normal versus inferior goods, types of demand functions, elasticity, welfare evaluation, consumer surplus, equivalent variation and compensating variation, revealed preference (weak and strong axioms)

2. Utility Functions and Expected Utility Theorem

Expected utility function, measures of risk aversion, state-preference approach, portfolio theory and pricing of risk, present discounted value approach to investment decisions, adjustments for risk

3. Production and Cost

Production functions, types of production functions (Cobb-Douglas, CES, etc.), marginal products, rate of technical substitution, technical progress, cost functions, average and marginal costs, short run versus long run costs, economies of scale and scope, profit maximization, cost minimization, derivation of input demand

1. Competitive Markets

Assumptions of perfect market, competitive markets – demand and supply, demand and supply curves of individual firms, short-run versus long-run, competitive market equilibrium, tax-incidence analysis, price-controls and shortages

5. Imperfect Competition

Market failure, imperfect markets – monopolistic competition and oligopoly, sources of monopoly power, monopoly market equilibrium, price discrimination – first, second and third degree, tax-incidence

Books

QF:02 MACROECONOMICS-1

1. National Income Accounting

Accounting structure, key concepts in accounting for both closed and open economies – gross national product, gross domestic product, net national product, national income, savings and investment, balance of payments, circular flow of income, computational problems – expenditure approach, income approach and value added approach for measurement, input-output tables

2. Keynesian Models

Simple Keynesian Model, assumptions, concepts of involuntary unemployment, liquidity preference, paradox of thrift, investment function, IS-LM model – two sector model, goods and money market equilibrium, multiplier, liquidity trap, complete Keynesian model – three sector model, role of government in terms of monetary and fiscal policy

3. Keynesian Models versus Classical Models

Says Law, quantity theory of money, price flexibility and full employment, Clower and Patinkin’s formulation, equilibrium concept in classical model, synthesis between classical models and Keynesian models, interpretation and policy analysis

4. Expectation and Macroeconomic Adjustments

Expectations formations – Adaptive and rational expectations hypothesis, partial adjustment model, Lucas critique, Phillips curve, rules versus discretion, time consistency, inflation targeting, interest rate rules, effects of spending and taxes in models with flexible and sticky prices, perverse effects of fiscal expansion

5. Foreign Exchange

Market for foreign exchange, devaluation and depreciation, real and nominal exchange rate, factors affecting exchange rate, Mundell-Fleming model, fixed versus floating exchange rate, price adjustment, role of fiscal and monetary policies under alternative exchange rate regimes, purchasing power parity concept

Books

QF:03 STATISTICAL METHODS

1. Probability Theory

Concept of probability, conditional probability and Bayes’ theorem, random variables – discrete and continuous, density and distribution functions, joint, marginal and conditional distribution, moment generating function, law of large numbers and Central Limit theorem

2. Theory of Distribution

Discrete versus continuous distribution, uniform, binomial, negative binomial, Poisson, geometric and hyper-geometric, normal, log-normal, exponential, gamma and beta distribution, characteristic function

3. Sampling Methods and Sampling distributions

Simple random sampling: with and without replacement, stratified random sampling, probability and non-probability sampling, statistic and sample moments, sampling distributions: Student’s-t, Chi-square and F-distribution, determinants of sample size

4. Theory of Estimation

Point and interval estimation, properties of good estimators: unbiasedness, consistency, efficiency, different methods of estimation, maximum likelihood and method of moment estimation, properties of maximum likelihood and method of moment estimators, confidence interval for unknown parameters

5. Hypothesis Testing

Statistical hypothesis, simple versus composite hypothesis, critical region, types and size of error – type-I and type-II error, power of a test, Neyman-Pearson lemma, trinity of classical tests (Wald test, Lagrange multiplier, likelihood ratio), application of hypothesis testing with known and unknown variances, Chi-square test for testing independence of two-classification criteria, test for correlation

Books

QF:04 MATHEMATICAL METHODS

1. Linear Algebra

Vectors, matrices, inverse, simultaneous linear equations, Cramer’s rule for solving system of linear equations, input-output model, Hawkin - Simon condition, open and closed models quadratic equation, characteristic (eigen) roots and vectors

2. Differential Calculus

Derivatives – partial and total, economic applications, marginal and elasticity concepts, functions of several variables, implicit function theorem, higher order derivatives and Young’s theorem, Taylor’s approximation, convex sets, convex and concave functions, properties of linear homogenous functions, Euler's theorem

3. Classical Optimization and Applications

Introduction to quadratic forms, unconstrained optimization, constrained optimization with equality constraints, Lagrangian method, Hessian and Jacobian matrices, applications – utility maximization, cost minimization, profit – output maximization

4. Linear and Non-linear Optimization

Duality theory, constrained optimization with inequality and non-negativity constraints, Kuhn-Tucker formulation, linear programming – formulation, primal and dual, solutions using graphical and Simplex methods, applications from economics and finance

5. Dynamics

Definite and indefinite integrals, applications – measuring consumer and producer surplus, continuous interest – discount calculations, difference and differential equations, phase diagrams, Cobweb model, multiplier accelerator, Harrod-Domar and Solow model, optimal control theory and Hamiltonians; present and current value Hamiltonians, applications from economics and finance

Books:

- Chiang, A. C., Fundamental Methods of Mathematical Economics, McGraw-Hill, 1984
- Knut Sydsaeter and Peter J. Hammond, Mathematics for Economic Analysis, Pearson Education Asia, 1995
Second Semester

**QF:05 MICROECONOMICS-2**

1. General Equilibrium
   
   Absolute versus relative prices, perfectly competitive price and general equilibrium models – with and without production, uniqueness and determinacy, Edgeworth box, Pareto improvement and efficiency, Walrasian equilibrium, money in general equilibrium

2. Welfare Economics
   
   Arrow-Debreu economy, welfare theorems, existence of Walrasian equilibrium, fixed-point theorem, core and core convergence, general equilibrium with time and uncertainty, Jensen’s Inequality, social welfare function, transfer efficiency; Kaldor-Hicks-Samuelson criterion, Rawl’s theory of social justice

3. Market Failure and Public Goods
   
   Reasons for market failure – market imperfections, public goods, asymmetric information, externality, macro-economic factors; types of public goods, theory of public goods – provision and pricing, government intervention, second-best solution, free riding, rent seeking and regulation, types of externalities – production and consumption externalities, Pigovian and Coasian solutions

4. Asymmetric Information
   
   Moral hazard problem, adverse selection, principal agent problem, theory of lemon, credit market, implications of asymmetric information, market signaling, hidden information modeling, efficiency wage model, information and insurance

5. Game Theory
   
   Extensive forms and normal forms, dominant strategies and elimination of dominant strategies, Nash equilibrium, cooperative and non-cooperative games, sequential and simultaneous games, Shapely value, backward induction, sub-game perfect equilibrium, applications with oligopoly markets - Cournot, Bertrand and Stackleberg, product differentiation, cartel

**Books**

1. Regression Analysis

Linear regression model, two variables and multi variables, BLUE property, general and confidence approach to hypothesis testing, partial effects and elasticity, goodness of fit, model evaluation, matrix approach to linear regression models

2. Extension of Linear Regression Models

Consequences and detection of multicollinearity, heteroskedasticity, and autocorrelation, and remedial measures

3. Dummy Variables

Regression on qualitative and quantitative variables, dummy variable trap, structural stability of regression models, Chow test, piecewise linear regression model

4. Simultaneous Equation Models

Simultaneity bias, structural versus reduced form, identification: rank versus order condition, exact and over identifications, triangular model, methods of estimation including indirect least squares, two-stage least squares and three-stage least squares, LIML and FIML

5. Distributed Lag Models

Formation of expectations, naïve expectation versus adaptive expectations models, partial adjustment models, distributed lag models; Koyck’s model, Almon lag, polynomial distributed lag models, end point restriction, rational expectations models

Books

QF:07 FINANCIAL MATHEMATICS

1. Basic Financial Calculations

Introduction: financial securities - zero coupon bond, fixed interest, index linked securities etc.; the time value of money; nominal Vs. real interest, deflationary conditions; accumulating factors, force of interest, compound interest functions.

2. Annuities and Equation of Value

Discounting and Accumulation: discrete and continuous cash flows; level annuities, deferred and increasing/decreasing annuities, equation of value and yield on transaction, probability of cash flows, higher discount, loan schedules; consumer credit: flat rate and APRs.

3. Capital Budgeting Techniques and Compound Interest Problems

Introduction to financial statement, assessing financial performance, net present value, internal rate of return, payback period; projects with different lives; money and time weighed rate of return; fixed interest securities, uncertain income securities, equities, valuing a loan with allowance for capital gains and indexation.

4. Arbitrage, Forward Contracts, and Term Structure of Interest

Rationale for no arbitrage assumption; forward contracts, calculating the forward price for a security with known dividend yield; hedging, fixed cash income; Discrete time and continuous time rates; continuous time spot rates and forward rates; instantaneous forward rates; theories of time; term structure of interest rates; yield curve; yields to maturity; convexity and immunization; interest rate risk.

5. Stochastic Interest Models and Investments

Simple stochastic interest rate models, fixed and varying interest model, log normal distribution; fixed interest government borrowings, government bonds, tax, security, marketability and return; government bills: corporate debt, debentures, unsecured loan stocks, eurobonds, certificates of deposit, convertibles, property, derivatives, future, range of futures, clearing house, margin, bond futures, short interest futures, stock index futures etc.

Books:

1. Introduction to Financial Markets
Capital markets, consumption and investments with and without capital markets, market places and
transaction costs and the breakdown of separation; Fisher separation theorem; the agency problem;
maximization of shareholder’s wealth

2. Theory of Uncertainty
Axioms of choice under uncertainty; utility functions; expected utility theorem; certainty equivalence,
measures of risk-absolute and relative risk aversions; stochastic dominance-first order, second order
and third order; measures of investment risk-variance of return, semi-variance of return, shortfall
probabilities,

3. Mean-Variance Portfolio Theory
Measuring portfolio return and risks, effect of diversification, minimum variance portfolio, perfectly
correlated assets, minimum variance opportunity set, optimal portfolio choice; mean-variance frontier
of risky and risk-free asset, portfolio weights

4. Index Models, CAPM & APT
Models of asset returns, multi index models, single index model, systematic and specific risk,
equilibrium models-capital asset pricing model, capital market line, security market line, estimation of
beta,; arbitrage pricing theory

5. Fixed Income Securities
Bond prices, spot prices, discount factors, and arbitrage, forward rates and yield-to-maturity, Price
sensitivity, Hedging

Books

  Wesley, 1992
  University Press, 1996
Third Semester

QF:09 APPLIED ECONOMETRICS

1. Stationary Time Series

Autocorrelation and partial autocorrelation, auto regressive and moving average models, conditions for stationary and invertible process, box-jenkins approach, forecasting, permanent versus temporary abruption, simple exponential smoothing and choice of parameter, seasonal models with trend, seasonal decomposition

2. Nonstationary Time Series and Volatility

Integrated process and random walk, unit root, testing for unit root, introduction to cointegration, Engle Granger method and Johansen test, error correction model, vector auto regressive model, impulse response function, variance decomposition, forecasting; volatility clustering, leverage effect, ARCH model, GARCH model and its various extension, multivariate GARCH modelling, forecasting

3. Limited Dependent Variable Models

Introduction to binary variables, limitation of LPM, logistic curve, Probit and Logit models, predicted probabilities, censored versus truncation, TOBIT model, ordinal models, multinomial models, and nested models

4. Panel data Models

Introduction to panel data, pooled model, within and between estimators, fixed effects, random effects, Hausman test, one way and two way model, random coefficients, dynamic panel data models, difference in difference methodology and dynamic panel data, generalised method of moments estimator

5. Production Function and Demand Estimation

Relationship among production, cost and profit functions, specification, estimation and applications; frontier production functions: DEA and SFA, measurement of multifactor productivity, Engel curves, complete demand models; general and particular restrictions on demand functions, estimation and applications of complete demand systems

Books

QF:10 RISK ANALYSIS AND MANAGEMENT

1. Project Risk Management

Overview, different dimensions of risk, nature of risk management, definition, benefits of risk management, concepts and processes, identification and assessment of risks: operational, strategic, hazard, economic and financial risks, possible threats to risk management

2. Phases of Risk Management and Identification

Definitions: process and stages of risk management, success criteria, stakeholder and stakeholder analysis, constraint analysis, SWOT analysis, Delphi technique, qualitative risk management: definition, probability and impact assessment, risk description and breakdown, uses of various techniques

3. Risk Analysis

Introduction: exposures of human assets, hazard risk management, crime risks, exposures of property/physical assets, strategic risk management, managing international risks, economic risk management, integrating risk types and exposures

4. Financial Risk

Statistical concepts for financial risk: probability distribution and its application, decision tress, expected value and correlation, financial risk management, difference between qualitative and quantitative risk-management, financial products and fundamentals of pricing

5. Market and Credit Risk

Definition, managing market risk, current issues in market risk, Value at Risk, advanced techniques for managing market risks, risk and diversification benefits, credit exposure and managing credit risk, financial distress and prediction of bankruptcy, impact of Basel II

Books

1. **SAS: Master Data Management**

Raw data, input statement, external data (libname statement), recoding variables, logical expressions, array processing, reshaping data: subsetting data and variables, combining datasets, grouping, sorting and merging of data sets

2. **SAS Analytics: Model Management and Deployment**

Describing data: descriptive statistics, creating summary data set using PROC MEANS, PROC UNIVARAITE and PROC TABULATE, plotting data, frequency distribution, t test and non-parametric comparisons, PROC ANOVA, model development using PROC REG and PROC LOGIT, model deployment using PROC SCORE

3. **SAS: Applications in Banking and Financial Services**

Segmentation analysis using PROC FASTCLUS, application of marketing propensity models: prospect pool targeting, proactive retention models, prepayment models, application of credit risk models: risk scorecard development, collection scorecards, and survival model using PROC PHREG

4. **MATLAB: Basics and Applications**

Basics on MATLAB, functions and script files, MATLAB Graphics, MATLAB programming: fixed-income securities, mean-variance portfolio optimization, numerical integration, unconstrained and constrained optimization

5. **Financial Modeling in EXCEL**

Excel based financial models, advanced tools, designing VBA macros in excel, excel solver in a VBA macro, looping macros, Monte Carlo simulations
QF:12 FINANCIAL ECONOMICS II

1. Future Contracts and Markets: Option Pricing Models

Forward and future contracts and markets; European and American options; pricing futures, wasp and synthetic futures; bounds for option prices, put-call parity; derivation of option pricing formula- Binomial approach; Black-Scholes option pricing models, option to expand, valuation of a real option

2. Capital Structure Choice

The value of firm with tax, Modigliani-Miller irrelevance hypothesis, choices in financing-debt and equity, the financing mix: trade-offs and theory; signalling hypothesis; effect of agency cost on capital structure, cost of capital, empirical determinants of capital structure choice

3. Dividend Policy

Irrelevance of dividend policy without tax; valuation, growth and dividend policy, dividend policy with taxes; theory of optimal dividend policy; other issues-stock dividends and share repurchase, empirical determinants of optimal dividend policy

4. Market Microstructure

Defining capital market efficiency, relationship between the value of information and efficient capital markets, rational expectations and market efficiency, market efficiency with costly information, efficient capital market theory and empirical models

5. Special Topics

a. Value at risk – Theory of VaR and estimation techniques
b. Acquisitions and takeovers – mergers activities as growth strategies, theories of mergers, implications and empirical evidence
c. Indian capital market and financial sector reforms

Books

1. Stochastic Process and Simple Markov Processes

Principles of actuarial modeling, stochastic vs. deterministic models; short run and long-run properties; stochastic process and counting process; analyzing the output of a model; sensitivity testing; types of stochastic processes: discrete state spaces with discrete and continuous time changes, continuous state space, sample paths, stationary, increments, Markov property, filtrations, white noise, general random walk, Poisson process and compound Poisson process

2. Markov Chains

Chapman-Kolmogorov equations; time homogeneous Markov chains, time-inhomogeneous Markov chains; Models- no claims discount policy model, NCD model, simple random walk on $Z=\{-2,-1,0,1,2,\ldots\}$ and on $\{0,1,2,\ldots,b\}$; accident proneness model; long-term distribution and behaviours of a Markov chain, stationary probability distribution, modelling using Markov chains; estimating transition probabilities, assessing the fit and simulation

3. Two-State Markov Model

Assumptions, probabilities, joint density function, ML estimator; alternative approach, applications, two state model of a single decrement and comparison with those of a random lifetime model

4. General Properties of Markov Process

Poisson processes, deriving and solving the Kolmogorov equations for Markov process-time and age dependent and time independent transition intensities; birth and death problems; simple survival models, sickness and marriage models in terms of Markov process and duration dependent Markov process; Kolmogorov’s backward differential equations, Markov jump process, the jump chain, simple two decrement model, calculation of total waiting time

5. Time-inhomogeneous Markov Jump Process

Chapman-Kolmogorov equations, transition rates, time inhomogeneous HSD model, Kolmogorov’s backward and forward differential equations; a two state survival model; integrated form of Kolmogorov equations, applications-marriage, sickness and death; time homogeneous Poisson process models, time homogeneous and inhomogeneous Markov models

Books

1. Kalman Filters

Introduction to Kalman filters, local level model, local linear trend model, local level model with explanatory variable and intervention variable, confidence interval, filtering and prediction, forecasting

2. Estimation, Testing and Resampling

Smoother and simulation smoother techniques, linear Gaussian state space model, choice of simulation method, Wavelet estimation, goodness of fit tests, tests for cycles, re-sampling in state space models, Bayesian parameter estimation, applications

3. Bootstrap

Introduction, estimation of standard error, parametric bootstraps, number of bootstrap replications, application of bootstrap in regression models, bootstrap pairs, bootstrap residuals, examples, confidence intervals based on bootstrap

4. Hypothesis Testing and Bootstrap Computation

Testing hypothesis with bootstrap, two sample problems, testing multimodality, cross validation, post sampling adjustment, bootstrap bias, bootstrap variance, applications of bootstrap computations

5. Bootstrap Bioequivalence

Confidence intervals, power calculations, Fieller’s interval

Books

- Efron, B., and R. Tibshirani, An Introduction to Bootstrap, Chapman Hall, 1993
Fourth Semester

QF:15 ADVANCES IN TIME-SERIES AND PANEL DATA ECONOMETRICS

1. Panel Data Models

Introduction, models with lagged dependent variable, estimation, simultaneous equation panel data models, generalised method of moment estimation, nonstationarity and panel data, panel unit root and cointegration, panel VAR models

2. Generalized Spectral Analysis

Moment generating function, characteristic function, generalized spectrum, inferences on patterns of serial dependence

3. Nonlinear Models

Threshold autoregressive model, smooth transition autoregressive model, exponential smooth transition autoregressive model, regime switching autoregressive model, amplitude-dependent exponential autoregressive model, Markov regime-switching GARCH model

4. Stochastic Volatility Models

Motivation, generalized modeling strategy, SV(1) model, long memory SV model, estimation of stochastic Volatility models, applications

5. Semiparametric and Nonparametric Methods

Univariate density estimation, bandwidth selection: rule of thumb and cross-validation, least-squares cross validation and likelihood cross validation, conditional density and quantile estimation

Books

1. World Financial Markets

Introduction, markets by geography, exchange, issuers, liquidity and instruments

2. Liquidity and Security

Difference between exchange and OTC markets, role of intermediaries, short-term debt securities, bond market: classification of bonds according to issuer, comparison of bond markets across different countries

3. Foreign Exchange and Stock Markets

Quotation conventions, types of brokers, central banks’ policies, primary and secondary stock markets, market mechanics including types of orders, market participants, margin and short trades

4. Futures Markets

Main exchange traded markets, options on futures, specifications of the most popular contracts, trade orders for futures contracts, mark-to-market procedure, and various expiration conventions

5. Commodities Markets

Specific features, delivery and settlement methods, backwardation, short squeezes and regulations, price risks

Books

QF:17 ARTIFICIAL NEURAL NETWORKS

1. Architecture

Introduction to Neural Networks and their History, Biological Neurons and Neural Networks, Artificial neurons, Networks of Artificial Neurons

2. Data Processing

Hebbian Learning, Gradient Descent Learning, Generalized Delta Rule, Practical Considerations

3. Back Propogation

Back Propogation, Learning in Multi-Layer Perceptrons, Learning with Momentum, Conjugate Gradient Learning

4. Performance Management

Bias and Variance, under-Fitting and Over-Fitting, improving generalisation

5. Applications

Practical applications of neural networks in analytics

Books

- Gurney, K., *An Introduction to Neural Networks*, Routledge, 1997
1. **Stochastic Calculus**

Review of stochastic calculus, Markov processes, martingales; interest rate models and solution of SDEs, Vasicek, Hull-White and CIR models, PDE for a zero-coupon bond price, duration, duration matching, yield curve models

2. **Option Pricing I**

Reflection principle, first passage time, maximum of Brownian motion, without and with drift, barrier options, stopping times, stopped processes, Doob's optional sampling theorem, barrier options and PDEs, lookback options and PDEs, lookback options and closed-form formulae via probability

3. **Option Pricing II**

Forward and Futures, Put-Call Parity for European Options, Put-Call Relation for American Options, Asian options and PDEs, Pricing Bounds and Convexity of Pricing Functions, The Basic Binomial Model, Interpretation of the Risk-neutral Probabilities, change of numéraire and risk-neutral measure, Numerical Applications of the Binomial Model

4. **Black-Scholes Model and its Extension**

Forward measures; stochastic interest rates and Black-Scholes-Merton formula, foreign exchange market model; domestic and foreign risk-neutral measure, Heath-Jarrow-Morton model and implementation

5. **Forward LIBOR and Jump Models**

Forward LIBOR model, caps, caplets, and Black caplet formula, forward LIBOR term structure model and calibration, swaps and swap market model, Black's formula, introduction to jump models: Poisson, compound Poisson, and jump processes, stochastic calculus for jump processes, change of measure for jump processes

**Books**

- Shreve, S. E., *Stochastic Calculus for Finance II: Continuous-Time Models*, Springer Verlag, 2004
QF:19 TOPICS IN BEHAVIORAL FINANCE

1. Information Perception and Intertemporal Choice

Cognitive information perception, peculiarities (biases) of quantitative and numerical information perception, Weber law, subjective probability, representativeness, anchoring, asymmetric perception of gains and losses, framing and other behavioral effects

2. Human Preferences and Market efficiency

Decision-making under risk and uncertainty, decision-making in historical prospective, Allais and Elsberg’s paradoxes, rationality from an economics and evolutionary prospective, different ways to define rationality: dependence on time horizon, individual or group rationality, examples from experimental economics: ultimatum and public goods games, experiments in isolated societies, bounded rationality, investor rationality and market efficiency


Fundamental information and financial markets, market predictability, the concept of limits of arbitrage, asset management and behavioral factors, active portfolio management: return statistics and sources of systematic underperformance, technical analysis and behavioral factors

4. Behavioral Factors and Corporate Finance

Behavioral factors and corporate decisions on capital structure and dividend policy, capital structure dependence on timing of good and bad corporate news announcement, mergers and acquisitions: the Winner’s curse and market timing, systematic excessive optimism and overconfidence in managers’ decisions, company name and its market value, sunk costs and mental accounting, evolutionary explanations for behavioral effects, evidence from behavioral game theory, systematic approach to using behavioral factors in corporate decision-making

5. External Factors and Investor Behavior

Weather, emotions, and financial markets: sunshine, geomagnetic activity, mechanisms of the external Factor., connection to human psychophysiology and emotional regulation, misattribution as a mechanism for externals factors influence, statistical methodology for capturing the effects of external influence onto stock market returns, emotional content of news articles and their correlation with market dynamics, social trends and market dynamics, active portfolio management: source of the systematic underperformance, fundamental information and technical analysis: case for psychological influence

Books

QF: P Project Work (2+6= 8 Credits)

Students need a project work in the third semester (2 credits) and in the fourth semester (6 credits).