AFRICAN ECONOMIC RESEARCH CONSORTIUM (AERC)

COLLABORATIVE PHD PROGRAMME (CPP) IN ECONOMICS FOR SUB-SAHARAN AFRICA

QUANTITATIVE METHODS
COURSE OUTLINE

(Revised: February, 2014)
TABLE OF CONTENTS

1. Introduction

1.1 Objectives

1.2 Prerequisites

1.3 Organization and mode of assessment

1.4 Main reference texts

2. Detailed Course Outline

2.1 Mathematics and Statistics for Economists

2.1.1 Matrix Algebra (8 hours)

2.1.2 Set theory (4 hours)

2.1.3 Real Analysis (8 hours)

2.1.4 Static Optimization (6 hours)

2.1.5 Dynamic Analysis (8 hours)

2.1.6 Dynamic Optimization (10 hours)

2.1.7 Distribution Theory and Statistical Inference (12 Hours)

2.1.8 Computer Intensive Methods (4 hours)

2.2 Econometrics

2.2.1 Specification, and Estimation of the Classical Linear Regression Model (8 hours)

2.2.2 Extensions (10 hours)

2.2.3 Simultaneous Equations Models (6 hours)

2.2.4 Maximum likelihood and GMM (8 hours)
2.2.5 Time Series Analysis (10 hours)

2.2.6 Microeconometrics (8 hours)

2.2.7 Panel Data Analysis (10 hours)
1. INTRODUCTION

1.1. Objectives

This course provides an advanced treatment of quantitative methods designed for Ph.D students in economics who have undertaken courses in mathematics and statistics for economists, and econometrics at the master’s degree level. The aim is to prepare the students to pursue microeconomic and macroeconomic analysis at an advanced level. To ensure that the course is pitched at a high enough level for PhD, extensive use of matrix algebra is recommended. Further, to make the course relevant to economists, it is recommended that the course be taught using economics examples.

1.2. Prerequisites: Sound knowledge and understanding of quantitative methods or equivalent course at masters level.

1.3. Organization and mode of assessment:

The course is divided into two parts each running for one semester with 60 contact hours per semester. The assessment of the course will be through course work, project and final examination.

1.4 Main Reference Texts:

1.4.1. Mathematics and Statistics for Economists

1.4.1.1. Main Texts


1.4.1.2. Supplementary Texts


**Supplementary Reading on Computer Intensive Methods**


### 1.4.2 Econometrics

#### 1.4.2.1. Main Texts


#### 1.4.2.2. Supplementary General Econometrics Texts

Creel, M (2008) *Econometrics*, Free online textbook


Hansen, B. (2014) *Econometrics*, Free online textbook
Hsiao C. (2003), *Analysis of Panel Data*, Cambridge University Press, New York,

1.4.2.2 Supplementary Reading on Topics in Time Series Analysis


1.4.2.3. Supplementary Reading on Topics in the Limited and Categorical Dependent Variables

Cameron, A. C, and P. K. Trivedi (2010), *Applied Microeconometrics Using Stata*, Stata Press
1.4.2.4. Supplementary Reading on Topics in Panel Data Analysis

Hsiao C. (2003), *Analysis of Panel Data*, Cambridge University Press, New York,

Additional econometrics resources are available at [http://econometricslinks.com](http://econometricslinks.com), and [http://www.economicsnetwork.ac.uk](http://www.economicsnetwork.ac.uk/)

1.5 Software

Since the course requires computer-assisted laboratory sessions, it is recommended that students be trained in software packages that lend themselves well, not only for econometric applications, but also for modern data analysis (using graphical methods).


Econometrics software: STATA and EViews are highly recommended statistical packages which are excellent for modern data analysis as well as for standard econometric applications (including time series analysis). Open source alternatives are GRETL ([http://gretl.sourceforge.net](http://gretl.sourceforge.net)), R ([http://www.r-project.org](http://www.r-project.org)), and OCTAVE ([https://www.gnu.org/software/octave/](https://www.gnu.org/software/octave/)). Other recommended commercial statistical packages include RATS, LIMDEP, MICROFIT, MATLAB, GAUSS and SHAZAM. Note that, at the start of the course, students need to be given an introduction to the relevant software package.
DETAILED COURSE OUTLINE

2.1 MATHEMATICS AND STATISTICS FOR ECONOMISTS

2.1.1. Matrix Algebra \(8\) hours

Brief review of Determinants, Inverses, Cramer’s Rule
Partitioned Matrices, Matrix Differentiation, Ranks and Determinants, Eigenvalues and Eigenvectors, Quadratic Form, Generalized Inverses (Moore-Penrose), Kronecker Products, diagonalisation of matrices, idempotent matrices and spectral decomposing matrices, Matrix operators and Matrix Applications

Readings:
- SHSS Chapter 1
- Simon and Blume, Chapters 7, 16, and 23
- Pemberton and Rau, Chapters 12 and 25
- Greene, Appendix A

2.1.2. Set Theory \(4\) hours

Boundary, interior, openness and closure, convexity, compactness, sequences

Readings:
- Simon and Blume, Chapter 12

2.1.3. Real Analysis \(8\) hours

Continuity of functions, Implicit Functions, Homogeneous Functions, Concave and Quasiconcave Functions, pseudo concavity, Convex and Quasiconvex Functions
Fixed point theorem

Readings:
- Simon and Blume, Chapters, 15, 20 and 21
- Pemberton and Rau, Chapters 8, 16 and 17
- SHSS, Chapters 2 and 14
2.1.4. Static Optimization 6 hours

Unconstrained and Constrained Optimization, Linear and Nonlinear Programming, and Envelope Theorem

Readings:
Simon and Blume, Chapters 17, 18 and 19.
Pemberton and Rau, Chapters 16, 17 and 18
SHSS, Chapter 3

2.1.5. Dynamic Analysis 8 hours

a) Review of Difference and Differential Equations of the 1st and 2nd order
b) Systems of Difference and Differential Equations

Readings:
Simon and Blume, Chapters 23, 24 and 25.
Pemberton and Rau, Chapters 21, 24 and 26
SHSS, Chapters 5, 6, 7 and 11
CW, Chapters 15-19

2.1.6. Dynamic Optimization 10 hours

Calculus of Variation, Optimal Control Theory and Dynamic Programming

Readings:
SHSS, Chapters, 8, 9, 10 and 12
Chiang
CW, Chapter 20

2.1.7. Distribution Theory and Statistical Inference 12 hours

a) Review of Probability Theory
b) Univariate and multivariate distributions

c) Moment generating functions and characteristics functions

d) Sampling distributions, large-sample distribution theory, point and interval estimation, maximum likelihood, methods of moments, restricted and robust estimation, and hypothesis testing

e) Bayesian theory

**Readings:**

Casella and Berger, Chapters 1, 2 and 5 - 10
Verbeek, Appendix B
Greene, Chapter 16 and Appendices B, C, and D

**2.1.8. Computer Intensive Methods:** 4 hours

Monte Carlo simulation

Re-sampling techniques including bootstrapping, jackknife and other methods

**Readings:**

Davidson and Mackinnon (1993), Chapter 21
Johnston and DiNardo, Chapter 11
Cameron and Trivedi, Chapters 11 and 12
Greene, Chapter 15
2.2. ECONOMETRICS

2.2.1. Specification and Estimation of the Classical Linear Regression Model (Matrix Approach) 8 hours
Assumptions of the classical linear regression model, least squares regression, goodness of fit and the analysis of variance, statistical properties of OLS in finite samples, multicollinearity problem, missing observations, diagnostics and outliers, testing restrictions, tests of structural change, testing non-linear restrictions, prediction. Dummy variables, non-linearity in the variables, specification analysis and model selection, biased estimators.

Readings:
Greene, Chapters 1 - 7
Johnston and DiNardo, Chapters 3 and 4
Verbeek, Chapters 2, 3 and 5

2.2.2. Extensions 10 hours
Stochastic regressors, instrumental variable estimation and measurement error, non-normal disturbances and their asymptotic properties. Consequences for least square estimation, efficient estimation, feasible generalized least squares, testing for heteroscedasticity and autocorrelation, HAC estimator. Nonlinear least squares estimators and testing hypotheses.

Readings:
Greene, Chapters 8, 9, 12 and 20
Cameron and Trivedi, Appendix A
Verbeek, Chapters 4 - 6

2.2.3. Simultaneous Equation Models: 6 hours
Problem of identification, methods of estimation: single equation and system methods,
Readings:
Greene, Chapter 10
Verbeek, Chapter 5
Johnston and DiNardo, Chapter 5.5

2.2.4. Maximum Likelihood and GMM 8 hours
Maximum likelihood estimation and hypothesis testing, and generalized method of moments (GMM)

Readings:
Greene, Chapters 13 and 14
Johnston and DiNardo, Chapters 5 and 10
Verbeek, Chapter 6

2.2.5. Time Series Analysis 10 hours
Stationarity and unit roots, ARDL models, vector autoregression analysis and its extensions, cointegration analysis, structural breaks, autoregressive conditional heteroscedasticity (ARCH), generalized autoregressive conditional heteroscedasticity (GARCH) and extensions, forecasting.

Main Readings:
Greene, Chapter 21
Verbeek, Chapters 8 and 9
Johnston and DiNardo, Chapters 7 and 9
Lutkepohl, Chapters 1, 2 and 4

2.2.8. Microeconometrics 8 hours
Limited dependent variables models, multinominal logit models, ordered discrete dependent variables, models for count data, truncation, Tobit models, duration models.
Readings:
Greene, Chapters 17 - 19
Wooldridge, Chapters 15-19, and 22
Johnston and DiNardo, Chapter 13
Verbeek, Chapter 7
Cameron and Trivedi, Chapters 14-20

2.2.9 Panel Data Analysis
10 hours
Static and dynamic panel data analysis

Readings:
Greene, Chapter 11
Wooldridge, Chapter 10
Johnston and DiNardo, Chapter 12
Verbeek, Chapter 10
Cameron and Trivedi, Chapters 21 and 22