

STATISTICAL THEORY FOR SOCIAL SCIENTISTS

Revised title: Mathematical and Statistical Theory for Social Scientists

Lecturer: D.S.G. Pollock

This course treats a variety of mathematical topics which are of particular interest to economists. Its title, which is, in fact, a misnomer, belongs to a previous course which is now superseded.

The course fall into four parts. The first part deals with the basic concepts of probability and statistics which underlie of many of the modern methods of economic investigation. The theory of probability is developed from an axiomatic basis. The theory of statistical inference is then treated briefly, and it is illustrated by considering the estimation of the simple linear regression model. The regression model provides the basis from which many econometric techniques are derived.

The second part of the course deals with dynamic analysis. Time is treated both as a continuum, which leads to differential equations, and as a succession of discrete instants, which leads to difference equations. The two sorts of dynamic equations have many features in common; and, for a proper understanding of either, it is helpful to have established certain results in the algebra of polynomials. Several dynamic economic models are used to illustrate these methods of analysis.

The third part of the course deals with matrices and linear algebra. The topic is approached, in the first instance, via the rules for manipulating matrices, which are rectangular arrays on numbers. These rules are related to some fundamental geometric concepts which can be illustrated by examples in spaces of two and three dimensions. The concepts may be applied to spaces of arbitrary finite dimension. At the end, the notion of an abstract vector space is arrived at. The utility of the methods of matrix algebra is demonstrated by applying them to certain problems in multivariate statistical analysis. The methods are also applied to the problem of national-income accounting via Leontief's Input-Output Model.

The final section of the course is devoted to problems of optimisation. The notion of constrained optimisation, which is fundamental to the theory of consumer choice and to the theory of production, pervades all of microeconomic theory. The method of linear programming represents a practical means of solving problems of constrained optimisation which makes use of the methods of matrix algebra.

TOPICAL OUTLINE OF THE COURSE

Part I Probability and Statistics

1. Elements of Probability
2. Statistical Inference
3. Regression Analysis

Part II Dynamic Analysis

4. Algebra of Polynomial and Rational Functions
5. Difference and Differential Equations
6. Dynamic Economic Models

Part III Linear Models and Matrix Algebra

7. Matrices and Vectors
8. Vector Spaces and the Geometry of Linear Algebra
9. Statistical Applications of Linear Algebra
10. Input–Output Analysis

Part IV Optimisation Techniques

11. Optimisation via Linear Programming
12. The General Theory of Nonlinear Optimisation
13. Nonlinear Programming and Game Theory

References

There are a great number of books at all levels in statistical theory. Six books on differing levels which are appropriate to the course are

WONNACOTT, R.J. and WONNACOTT, T. H., *Introductory Statistics for Business and Economics*, John Wiley,
HEY, J.D., *Statistics in Economics*, Martin Robertson,
HOEL, P.G., *Introduction to Mathematical Statistics*, J. Wiley,
FREUND, J.E., *Modern Elementary Statistics*, Prentice Hall,
FREUND, J.E., and R.E. WALPOLE, *Mathematical Statistics*, Prentice Hall,
MENDENHALL, W., R.L. SCHEAFFER and D. D. WACKERLY, *Mathematical Statistics with Applications, second edition*, Duxbury Press.

Of these, WONNACOTT and WONNACOTT is probably the most elementary and may be read rapidly in order to get a superficial grasp of the subject. The other books will be referenced, when appropriate, at the various stages in the course. Students are advised to purchase a book which is on the same level as FREUND and WALPOLE or MENDENHALL et al. Further advice on the matter can be sought from the lecturer.

There are likewise a great number of books which expound general mathematics for economicists. The book which will be recommended for this year is

CHIANG, Alpha, C., *Fundamental Methods of Mathematical Economics*, McGraw-Hill Kogakusha.