PETER G. MOFFATT

EXPERIMETRICS

ECONOMETRICS FOR EXPERIMENTAL ECONOMICS

Experimetrics

Econometrics for Experimental Economics

Peter G. Moffatt

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Praise for *Experimetrics*

'Experimental data seem deceptively easy. This book not only shows why and when estimation is involved. It also pushes the frontier, e.g. by introducing methods to capture patterned heterogeneity, random utility, or two-part decision rules.' **Christoph Engel, Max Planck Institute, Germany**

'A long-awaited, systematic treatise of the econometric modelling of experimental data brilliantly accomplished. A work of art!' **Anna Conte, University of Westminster, UK**

'*Experimetrics* provides an excellent overview of the issues concerning the econometric analysis of experimental data. Numerous STATA codes enrich the book and make the methods very accessible.' **Charles Bellemare, Université Laval, Canada**

'I believe *Experimetrics* should become an indispensable part of every experimentalist's toolkit.' **David Butler, Murdoch University, Australia**

'This text provides guidance and reference for the increasingly large number of experimental economists who want to do some serious econometric analysis of their experimental data. Not only does it explain the concepts cleanly and precisely, it also provides numerous examples of applications. It will become compulsory reading for all experimental economists.' **John Hey, University of York, UK**

'*Experimetrics* is a very well-written book, providing an outstanding in-depth analysis of the econometric methodology into economics experiments. It is structured in a balanced way covering the most topical issues in the experimental literature. Superb writing style and coverage!' **Michalis Drouvelis, University of Birmingham, UK**

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Chapter 1
Introduction and Overview

1.1 What is Experimetrics?

Experimetrics[1] comprises the body of econometric techniques that are customized to experimental applications. A wide variety of such techniques appear in the experimental economics literature. The aim of this textbook is to assemble this body of techniques, to demonstrate their use in a hands-on style, drawing on as wide a range of examples as possible, and to interpret each set of results in ways that are most useful to experimental economists. The target audience is mainly researchers in experimental economics. It is also conceivable that the book might be of interest to econometricians who are curious to know what sort of techniques are being used by experimental economists.

The experimetric techniques that already appear in the experimental economics literature range from the very basic to the highly sophisticated. At the basic end of this spectrum we see the class of techniques known as *treatment tests*, that is, tests which compare outcomes with and without a treatment, or before and after a treatment. At the sophisticated end of the spectrum, we see highly complex structural models, with a deterministic core corresponding to an underlying behavioural theory, with possibly many structural parameters, and a stochastic specification including possibly many dimensions of variation, both within and between subject. Needless to say, the type of econometric approach that is chosen is often, and justifiably, dictated by the type of experiment that has been conducted, and by the types of research questions being addressed.

In some experiments, the "home-grown" characteristics of the experimental subjects are the focus, and the objectives are usually simply to investigate how individuals make decisions, or interact with each other, in particular settings. These

[1] The word "Experimetrics" was (to the best of my knowledge) coined by Camerer (2003, p. 42). Houser's (2008) entry in the *New Palgrave Dictionary of Economics* on "Experiments and Econometrics" commences with the line "'Experimetrics' refers to formal procedures used in designed investigations of economic hypotheses." Bardsley & Moffatt (2007) are apparently the first authors to have used the word in the title of a published paper.

studies typically rely on relatively simple experimental designs (e.g. choosing between lotteries; splitting a pie), with the ultimate objective of measuring subjects' characteristics, especially preference parameters. It is normal to expect substantial variation in these measured characteristics. Indeed, it is often the precise features of this variation in which we are most interested; for example, the proportion of the population who are "selfish", or the proportion who are EU maximisers. When data are from this type of experiment, it is often seen as appropriate to model the decision-making process using structural estimation methods, for example methods that simultaneously estimate all of the parameters appearing in the individuals' objective function, as well as distributional parameters, some of which capture preference heterogeneity.

In other experiments, the focus is on the functioning of an economic institution, rather than the characteristics of the individual participants within it, and the objective may be to test a particular theory as applying to that institution. In these settings, *induced value methodology* is commonly used. This technique is based on the idea that the appropriate use of a reward medium allows the experimenter to *induce* pre-specified characteristics (e.g. preferences) in the subjects so that their innate characteristics become irrelevant. Having essentially eliminated the impact of subjects' characteristics in this way, it is clearly much easier to apply close scrutiny to the theory under test. In these settings, the experimental designs are relatively complex, since key features of the economic institutions need to be captured in convincing ways. However, the econometric techniques required are often very simple. The level of control is normally such that straightforward treatment testing is often seen to be the natural framework, and the most suitable means of obtaining answers to the research questions of interest.

The following subsections provide brief overviews of the types of econometric techniques that are best suited to each of these two broad areas. As such, this chapter provides a broad overview of the contents of the remainder of the book.

1.2 Experimental Design

The topic of experimental design is clearly much more important in experimental economics than in other areas of economics. This is because, in other areas, typically the data generation process is out of the control of the investigator. In experimental economics, the data generation process is very much within the control of the investigator. Hence, design issues such as the choice of sample size, the sampling process, and the process for assignment of subjects to treatments, all take centre stage.

A central concept is randomization. If randomization is correctly applied in the process of selecting subjects for an experiment, then identification of treatment effects, which has always been a central problem in mainstream econometrics, is not a problem. The other side of this coin is that, since the data have not been collected in a natural environment, experimental results do not necessarily carry over to the world outside the lab. We therefore see that the advantages of experimental research in terms of identification may be seen to be countered by the disadvantage of non-generalisability (see Al-Ubaydli & List, 2013).

There are several different types of design, including completely randomised designs, within-subject designs, crossover designs, and factorial designs. When groups of subjects are playing against each other, a choice also needs to be made between "partner" and "stranger" matching. Each design has both advantages and disadvantages, and the decision of which to use is often a delicate issue.

The choice of sample size is another key design decision. The question to be addressed here is how many subjects are required for the experimenter to be confident of reliable conclusions. More precisely, how many are required in each treatment? A useful framework for addressing these questions is power analysis (Cohen, 2013); that is, using probability theory to find what sample is required to provide a given "power" of the test being conducted.

A particularly interesting problem in experimental design is how to specify binary choice problems (e.g. lottery choice) in such a way as to generate a data set from which subjects' preference parameters may be estimated with maximal precision. A chapter of the text is dedicated to this problem.

1.3 The Experimetrics of Theory Testing

It is often claimed the purpose of an experiment is to test an economic theory. From the econometrician's perspective, a natural way to perceive such a test is as an assessment of whether the *predictions* from the theory provide good approximations to actual behaviour (i.e. the behaviour of subjects in the lab). From this perspective, the role of the experimenter is to find regularities in observed behaviour, and then to ask which theories are best able to account for these regularities.

Competitive equilibrium is the central concept in many theories. The objective of an experiment (a market experiment, say) may be simply to observe how close behaviour is to the competitive equilibrium, and we shall refer to this as testing the *fundamental prediction* of the theory. This type of experiment is usually performed using *induced value* methodology; that is, a system in which each subject is exogenously assigned a valuation of the object being traded, so that the complete demand and supply schedules, and therefore the equilibrium, are known by the experimenter. In this setting it is clearly a simple matter to use experimental data to assess how close actual behaviour is to the fundamental (equilibrium) prediction.

An important aspect of the fundamental prediction of the theory is that it often amounts to a "point prediction", that is, it simply tells us that a particular decision variable will, given the known fixed values of the exogenous variables, take a particular value. There are no *free parameters* in the model that generates the fundamental prediction. To see how free parameters enter a model, consider the following example. Start with a benchmark model that is built on the assumption of risk neutrality (RN). Such a model is likely to lead to a "risk-neutral equilibrium" prediction, $y = constant$, where y is the decision variable. This benchmark model has no free parameters. Now consider what happens when we adopt the assumption of expected