

The Econometrics of Disequilibrium

ROGER J. BOWD



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THE ECONOMETRICS OF DISEQUILIBRIUM

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INTRODUCTION TO THE SERIES

This is a series of books concerned with the quantitative approach to problems in the social and administrative sciences. The studies are in particular in the overlapping areas of mathematical economics, econometrics, operational research, and management science. Also, the mathematical and statistical techniques which belong to the apparatus of modern social and administrative sciences have their place in this series. A well-balanced mixture of pure theory and practical applications is envisaged, which ought to be useful for universities and for research workers in business and government.

The Editors hope that the volumes of this series, all of which relate to such a young and vigorous field of research activity, will contribute to the exchange of scientific information at a truly international level.

THE EDITORS

PREFACE

"Equilibrium", Keynes is reported to have said, "is blither". It is also known that he thought much the same of econometrics, so that one can be less than confident in supposing that he would have approved of a project such as this. Nevertheless it is true that disequilibrium econometrics has caught on and that much of the motivation for this research effort arises out of recent discussion in the theoretical literature of the relationship between Keynesian and neoclassical forms of thought. As difficult as some of these ideas are, it is one of the constraints that econometricians have to live with, that their empirical modelling is even more difficult. So far we can claim an adequate account of the specification and testing of only the most modest of disequilibrium representations. We may single out at least two areas in which our techniques are manifestly deficient. One is the development of an adequate rule for quantity adjustment, even in an isolated market. The other is the representation of multimarket models in which perceived constraints in one market may affect behaviour in another.

In writing this book I have accordingly had two aims in mind. In the first place, to develop a set of ideas I had been thinking about since late 1975 or early 1976 when I was on leave at the Institute for Advanced Studies in Vienna. The PAMEQ methods, as they are called in the book, are the outcome. Since I wrote this material I have come across similar or related ideas in the work of others.¹ Thus I should not want to claim priority for the basic idea itself. There seems, however to be virtue in presenting a systematic account of the representation with due attention to requirements of consistency with respect to the equilibrium case, on the one hand, and to the way in which it facilitates problems of estimation and inference, on the other.

My second aim was rather different in kind. The book format offers a freedom which journal editors cannot, the opportunity to prospect a little. One need not be wholly constrained to producing a cut and polished jewel, but one can within limits wander with the hope of picking up a few stones which may be indications of more valuable finds to come. Particularly in the latter part of the book, I have laid stress on the problems of quantity adjustment and have tried to suggest one or two possibly fruitful lines of attack, without at the same time having produced what could be regarded as a definitive treatment. Such matters of specification are what I should perceive as the once and future problems of an econometrics of disequilibrium.

Writing in an area of rapid development has its risks, and one of these is to be superseded by recent results. At the time of writing the bulk of the book, as it has gone to print, remains intact (so to speak) but there is one recent result which I ought to mention. In sections 2.3 (mixed distributions) and 5.4 (the noisy-clearing short-side model) it is asserted that the method of maximum-likelihood is not available. Very recent work² has shown that provided the domain of alternative parameters excludes certain "singular" points, this assertion is not true. Thus provided these singular points are recognised in advance, there need be no problem with the application of maximum-likelihood methods to such problems.

The most pleasant task in writing this preface is to say thank you. I have been greatly helped by the various people and the anonymous referees who have commented on the various papers in which some of the material was first presented. I am grateful to the editors and publishers of the *Journal of Monetary Economics*, in which much of chapter 8 first appeared, and of the *International Economic Review*, in respect of parts of chapters 3 and 5, for permission to reproduce this material. I should also like to take this opportunity of expressing my appreciation

to the Institute for Advanced Studies in Vienna for their hospitality from September 1975 to May 1976. At the University of Western Australia, Darrell Turkington was always helpful on general questions of asymptotic theory. Ms. Dawn Lorimer drew the final versions of the diagrams. The manuscript was typed by Mrs. Marie Green in a virtuoso exhibition of speed, accuracy and beauty of presentation. Finally I should like to thank my wife, for putting up with it all.

Perth, Western Australia.

Footnotes to Preface

¹For example a study of mortgage rationing by D.M. Jaffee (1972) and a study of U.K. wages and prices by J.D. Sargan ("Wages and Prices in the United Kingdom: A Study in Econometric Methodology" in *Econometric Models for National Economic Planning* (ed) P.E. Hart, G. Mills and J.K. Whittaker, Butterworths, London 1964).

²References: N.M. Kiefer "Discrete Parameter Variation: Efficient Estimation of a Switching Regression Model", *Econometrica* Vol. 46 No. 2 (March 1978) and R.J. Bowden "The Consistent Root of the Likelihood Equations as Maximum: A Postscript to the Theory of Parametric Identification", University of Western Australia, August 1978. In terms of the discriminant function $H_1(\theta; \theta_0)$ of chapter 2, there are singular points (θ) at which $H_1(\theta; \theta_0)$ fails to exist.

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CHAPTER ONE

A GENERAL PREVIEW

Econometrics, we like to think, is the fusion of statistical practice with economic theory, with the object of identifying structural relationships or regularities. Like most scientific enquiry, the progress of positive economics has been characterised by an interaction between theorising and observations of the real world. The immediate stimulus to theorising is often a matter of personal or informal observations and the establishment of what have been called "stylised facts". J.M. Keynes' *General Theory* is perhaps of this character. Or the stimulus may arise from a systematic and detailed study of empirical series with little or no attempt at formal model building. The monetary history by M. Friedman and A. Schwartz [1963] is a good example. However what distinguishes the proudest achievements of econometrics is that they attempt to identify, test and further develop existing theoretical constructs of genuine informational content. In this respect the interpretation by J. Hicks [1937] of the elements of Keynes' *General Theory* could be regarded as a powerful intellectual stimulus for the development of econometric model building as we know it today. The paradigm involved is that of a linear simultaneous and stochastic set of equations. The specification and estimation theory for this paradigm was begun with the work of J. Tinbergen [e.g. 1939], T. Haavelmo [1943] and developed further in the work of T.C. Koopmans and others [see e.g. Koopmans [1950]]. The discovery in the fifties of computationally tractable methods of repeated least squares, associated with the names of H. Theil and R.L. Basmann, enabled development and

estimation of the formidable macroeconometric models of the late fifties and sixties.

Just as the Keynes/Hicks structural system lead to the econometric theory of linear simultaneous stochastic models, so too have recent "reinterpretations" of Keynes suggested a need for new empirical paradigms. The idea that markets may not "clear" that is, may persist in a state of disequilibrium, has recently been viewed as central to the reconciliation of Keynesian macroeconomics with individual choice theory and general equilibrium analysis. The new respectability of such ideas has lead to diffusion of interest from this specific context to others, microeconomic as well as macro-economic. This has called forth econometric interest in specifications and estimation techniques for models of markets in disequilibrium.

To be sure, there are those who do not believe that there is in fact any tendency for markets to persist out of equilibrium, provided the latter is properly specified; or that if there is, such markets are not to be counted among those of policy interest. The proper resolution of these debates is simply to recognise that "equilibrium" should be regarded as a testable hypothesis. Any specification or estimation techniques developed for models of markets in disequilibrium should therefore allow the facility of testing whether the system is in fact an equilibrium one. In this respect, such methods might be of greater generality than existing equilibrium approaches, which do not allow the possibility of testing whether the system is in fact a disequilibrium one. In summary we should make it clear that we do not regard it as an article of faith that markets at large, or any particular market, are characterised by persistent states of disequilibrium. But we do think the profession should endeavour to develop paradigms which will at least treat such statements as testable propositions.

That economic variables may adjust only slowly to new equilibrium levels is hardly a new idea in econometrics - a wide and popular variety of partial adjustment mechanisms attests to the contrary. It is interesting to note, however, that this kind of specification has never been developed to the point of modelling an entire system. A theory behind such paradigms is developed in the present study in chapter three. However, even if partial adjustment can be applied to prices, it does not in general follow that we can at the same time countenance a similar mechanism for quantities. The need to construct paradigms for quantity adjustment in disequilibrium remains one of the most pressing burdens of any econometrics of disequilibrium. Any realistic specification, it seems, may have to be highly nonlinear, as in the "short-side" models of chapter six. The burden on techniques of estimation and inference is therefore the greater. It is not too much to say that the bulk of formal development in econometrics is concerned with processes which are either stationary or semi-stationary. For instance, the recent development of methods of regression based on the frequency domain ("Hannan estimators") assumes both harmonizable processes for the error terms and exogenous variables, and a linear ARMA-type mechanism relating these to the endogenous variables. That nonlinear and nonstationary estimation theory is relatively underdeveloped is a matter not only of its inherent difficulty but of the lack of sufficiently general or representative paradigms. The establishment of such representations for quantities in disequilibrium therefore involves close interest in nonlinear estimation theory. For this reason chapter two of the present study is explicitly devoted to general matters of nonlinear estimation.

The rest of the present chapter will be devoted to amplifying some of the foregoing considerations. Some preliminary remarks are in

order. Throughout the present study we shall make intensive use of the Marshallian supply/demand apparatus, the "two blades of the scissors" closing on the resulting equilibrium price. We do not use this apparatus out of an intrinsic belief that it represents the best possible way to approach any problem of disequilibrium. Instead we view it pragmatically as the most general and robust framework available for a whole class of problems. In speaking of this very basic model, we shall speak of one axis as "price" and the other as "quantity". Obviously, with appropriate limitations specific to the problem actually being discussed, the same model is applicable to situations where the axes are labelled differently - "wage rate" for "price" and "employment" for "quantity", to take an obvious example. Moreover the emphasis, not only in this chapter but throughout the entire study, is on developing estimable specifications. In this respect, theoreticians are a privileged caste. They need only specify some monotonic transformation of excess demand as prices, or some general exchange rule governing the distribution of endowments in a non-tatonnement dynamics, in order to establish the existence of some equilibrium or construct a Liapounov function and prove stability. Econometricians have to be more specific, to specify the precise functional form of the demand or supply functions, or the price adjustment rule or the determination of quantities. To the theorist, then, the models of the kind discussed in this book must have an air of *déjà-vu*. That is the privilege of the arm-chair.

1.1 Price Adjustment

The classical textbook view of the operations of markets is one in which prices react freely and quickly to discrepancies between demand and supply. The Walrasian auctioneer is the most celebrated rationalisation of such an adjustment process. According to this formalisation, things are ordered as if there were an auctioneer balancing up offers to buy or sell at each price he calls. If there is an excess of offers to buy over offers to sell he tries another, higher price. The bidding is closed when offers are balanced, and only at this point do transactions take place. Unquestionably there are real-world markets in which something at least approximating this process occurs. One need think only of the stock exchange or commodity exchange. In any market where (a) information about available goods and their prices is freely available and (b) there are no institutional or organised barriers to price adjustment or to offers to buy or sell, the Walrasian auctioneer may properly be said to exist in shadow, if not in substance.

The question is whether there exist markets in which the above two conditions ((a) and (b)) are not met. Such markets patently do exist and are moreover of substantial economic importance. Let us consider first the violation of condition (a). Sellers may not be aware of the asking prices of other sellers. For this and other reasons, a range of such asking prices may come to exist. Buyers may therefore have to spend time and money in searching the market to discover a suitable seller. Thus if for any reason the supply curve shifts to the right (higher supply price), it may take time for buyers to realise that the shift is general. During this time an inventory of unsold goods may build up, so that we could say that the market is in a state of temporary disequilibrium.

There has in recent times been a great volume of work in what has become known as the economics of information. Much of this literature has been devoted explicitly to the way in which markets go about the "clearing" process. (For a survey see M. Rothschild [1973], and for applications to the labour market the volume edited by E. Phelps [1970]). We have noted above that imperfect information may lead to temporary disequilibrium. Just how "temporary" is a topic of some debate, one which has a bearing on the very different views of the world of neoclassical economists on the one hand and Keynesians, on the other.

As mentioned above (condition (b)) there may also be institutional barriers to effective offers to buy or sell on the part of individual agents. This categorisation may overlap with that based on imperfect information. Take for example the pricing practice, widespread in concentrated industries, known as "normal" or "target" pricing.¹ Price is set by sellers to achieve a desired rate of return expressed as a markup on either full costs or more usually costs evaluated at some "normal" level of output (say three-quarter capacity). Such pricing mechanisms may be viewed as a response to the lack of information about either the demand curve for the product in the coming period or else about the reaction of competitors. In respect of the latter it may well be that a uniform pricing code represents a tacit agreement among oligopolistic competitors. According to this, common cost increases (such as those stemming from an externally imposed wage award) may be passed on into prices with little risk to the stability of the industry concerned.

In some cases, the unfettered operations of free markets have, in their instability, been viewed as deleterious to the long-term interests of producers. Of growing importance in many countries is the control of supply by the creation of producer boards, often with power