Introduction

ON THE FOUNDATIONS OF COMPARATIVE STATICS

> We have now to examine the general relations of demand and supply; especially those which are connected with that adjustment of price, by which they are maintained in 'equilibrium'. This term is in common use and may be used for the present without special explanation. But there are many difficulties connected with it, which can only be handled gradually.
>
> Alfred Marshall [1920/64, p. 269]

> It may seem discouraging that brilliant mathematical economists are able to prove little more than they assume in this area, but there may be a methodological problem that inhibits progress. No sooner is a mathematician let loose on non-market-clearing problems than he attempts to prove the existence of a static equilibrium in which there is no incentive for an agent to change prices. Perhaps the fixation on equilibrium is a crucial handicap.
>
> Robert J. Gordon [1981, p. 514]

> One sometimes has the impression that there are only two groups of economists: those who do not understand a difference equation; and those who understand nothing else.
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> Joseph Schumpeter [1954, p. 1168]

This book is a methodological examination of neoclassical economic theory. It is primarily concerned with one fundamental analytical tool of neoclassical economics – namely, the idea of an economy being in a complete state of equilibrium. There seems to be widespread agreement that what is taught in traditional textbooks about equilibrium falls far short of providing an adequate methodological foundation for its unquestioned use as a basis for explaining the behavior of individual consumers and producers. Recent efforts to repair neoclassical equilibrium models have unfortunately been directed at identifying *ad*

hoc assumptions about disequilibrium behavior. As these efforts seem to beg more questions than are answered, we will examine them to see how a more adequate foundation for complete neoclassical explanations of the behavior of autonomous individual decision-makers might be provided.

1. Equilibrium and Explanation

The concept of equilibrium has been central in economics for over 200 years, that is, since the time of Adam Smith. For Smith and many of his followers the concept has often been used to explain away supposed evil human tendencies such as 'greed' by showing that, in a state of competitive equilibrium, greed will actually lead to the good of everyone. Picture an economy in a textbook state of general competitive equilibrium. In such a state each individual is personally optimizing, given his or her respective resources, and there is no way any self-interested individual can get ahead except by being greedy. Should we think that greed is a social evil we must not despair since such a greediness, constrained by the state of equilibrium, can be seen as a 'virtue' rather than a 'vice'. Supposedly, any state of equilibrium exists only because, given the constraints which are actually imposed by nature and the state of technical knowledge, no possible gains not already exploited by one or more self-interested individuals exist.

In the state of general competitive equilibrium all producers must be just covering their costs, including opportunity costs; in other words, everyone's excess profits must be zero. If excess profits were not zero there would be an incentive either for new firms to start up or for losing firms to go out of business. In a state of general equilibrium every firm is maximizing profit subject to given constraints, even though the maximum happens to be zero. Thus, to make more profits, the given constraints must be changed. One changeable constraint is the current state of technology. A new technique which will lower the average costs of producing any good can create an advantage in the market that will yield excess profits. While one might still think such profits are immoral – since the producer is able to sell at a price that is higher than that just necessary to produce the good in a state of equilibrium – it is easy to show that if there are no artificial (i.e. no non-natural) constraints on competition, then the existence of excess profits for one producer represents an incentive for others to imitate the new technology. And, so long as the incentive exists, more and more producers will imitate until any incentives (excess profits) disappear. The result is both an elimination of the 'evil' advantage and a general reduction of costs. The latter is a benefit to everyone. Under these circumstances – namely, the absence of restraints on competition – 'greed' will be seen to be a 'virtue' rather than a 'vice'.

In technical economics literature everything above is taken for granted. The concept of equilibrium is usually embraced for reasons other than its role in Smith's social philosophy of private goods and social evils. The reasons are to be found in Alfred Marshall's self-conscious theory of 'scientific explanation' which today is called 'comparative statics'. Marshall claims that 'this is the only method by which science has ever made any great progress in dealing with complex and changeful matter, whether in the physical or moral world' [Marshall, 1920/64, p. 315, footnote 1]. Comparative statics explains things in a very special way. In modern textbooks, we are told to distinguish between endogenous and exogenous variables. The variables that we want to explain are called endogenous variables and their explanation is always conditional, that is, endogenous variables depend on certain givens called exogenous variables – usually these are such things as tastes, technology, resource availability, government regulations, etc.

As long as the exogenous variables do not change, the equilibrium values of the endogenous variables will not change. To explain the endogenous variables we show that their values can be deduced with the hypothetically known values of the exogenous variables and the help of a behavioral theory (or model) which logically connects all the variables in question. In comparative static analysis two different sets of values for the endogenous variables, representing two different states of equilibrium, are compared. The two equilibrium states are distinguished only by the value of a single exogenous variable being different. A typical example explains how demand would change if (exogenous) tastes change in favor of one good. The argument would usually go that *ceteris paribus* the (endogenous) price of the good would increase. The term *ceteris paribus* is only shorthand for the technique of comparative statics explanation, namely that all other exogenous variables do not change while the new value of the endogenous variable (price) is being determined. What is being explained is the differences in the values of the endogenous variables (the non-givens) and thus the effect or the role of the one exogenous variable in question. In a limited sense, the differences are explained by the change in that one given variable, since within the confines of the comparison the only reason for any differences is the singular exogenous change. If this is all one wishes to explain – namely the *ceteris paribus* influence of each exogenous variable on the equilibrium values of the endogenous variables – then comparative statics is a very powerful method.

Almost all of our understanding of the economy is based on careful applications of the method of comparative statics. Even the multiplier in

macroeconomic analysis is based on this method. Critics might want to attack directly the significance of a method of explanation that only examines the role of one exogenous variable at a time. But to the contrary, the acceptability is assured by an elementary understanding of differential calculus and the idea of a partial derivative. In effect, the results of any change in one exogenous variable is analogous to the meaning of a partial derivative. Generally speaking, one can look at any point of equilibrium as being the outcome of changes in many exogenous variables such that the change in each endogenous variable (i.e. the total differential) is the sum of the changes in all exogenous variables, each of which is weighted by their partial derivatives. For example, the change in one endogenous variable X can be seen to be determined by the sum of possible changes in the exogenous variables, Y and Z, such as in

$$dX = (\partial X/\partial Y)dY + (\partial X/\partial Z)dZ.$$

In effect, the partial derivative is a measure of the contribution of one unit of an exogenous variable to the total change. In comparative static analysis either dY or dZ would be zero; and since we are only discussing changes in the equilibrium values at least one set of values for all endogenous and exogenous variables is known. In order to explain the initial equilibrium values, ideally all we would need is an explanation of the equilibrium value of each endogenous variable such as X. An explanation might be provided either by performing an integration over the range of the values of the exogenous variables or by solving an appropriate differential equation. With a little matrix algebra all of this is easily extended to deal with all endogenous and exogenous variables simultaneously in the same manner.

One well-known critic of Marshall's method, Piero Sraffa [1926], explicitly rejected any method based on *ceteris paribus* and argued for the necessity of using general equilibrium analysis. For him general equilibrium analysis was implied by the necessity of considering imperfect competition. The reason was simple. Consider the usual textbook explanation of a price-taking individual's demand curve for good X subject to two givens, the individual's income (or budget) and the price of any other good, say Y. A change in the quantity demanded of X (along the demand curve) is the result of the *ceteris paribus* change in the price of X. Except in special cases, where the demand elasticity is unitary or the number of demanders is infinite, the quantity demanded of the other good, Y, will also change. This means that if the original given price of Y was an equilibrium price (as in any comparative statics analysis) then any change in the demand for Y must cause a disequilibrium in the market for Y. Similarly, a price-taking producer considers different levels of output to supply for a given price by comparing the different levels of marginal cost to the price. The firm is a price taker only when there is virtually an infinity of sellers. If the number of sellers is finite, not only does the level of the marginal cost change with the level of output but so does the price – just as it does in the textbook explanation of the firm under imperfect competition. But, as Sraffa in effect argues, a complete explanation must explain how the price varies with the level of output and thus requires consideration of the behavior of all participants in all markets. Thus for Sraffa, either one accepts *ceteris paribus* (i.e. partial equilibrium) analysis or one's explanation of an individual's behavior requires general equilibrium analysis and imperfect competition.

2. Equilibrium Implies Disequilibrium Dynamics

Consideration of general equilibrium does not necessitate a rejection of any use of partial derivatives. The mention of matrix algebra above recognized that it is possible to deal with partial derivatives in a system of simultaneous equations. While Sraffa's critique concerns Marshall's use of partial derivatives, the emphasis on the necessary role of imperfect competition does not require the rejection of partial derivatives. This is clearly demonstrated by Joan Robinson [1934/69] who, while criticizing Marshall's method in her famous book on imperfectly competitive equilibria, made explicit use of partial derivatives. While the keystone of comparative statics is the thorough use of partial derivatives, both critics and proponents of equilibrium analysis accept the use of partial derivatives. If the idea of a partial derivative is acceptable, there would seem to be little to argue about here.

Many arguments have been advanced in the last twenty-five years that seem to suggest we spend too much time analyzing equilibrium states and that we should be worrying more about everyday disequilibrium phenomena. Doubts about calculus or partial equilibrium analysis are not the source of current interest in disequilibrium economics. The current doubts about basing all economics on the concept of equilibrium stem from the analysis of the necessary conditions for equilibrium regardless of how the equilibrium is reached or analyzed. In some sense, the current interest in disequilibrium economics was motivated by the work of John Maynard Keynes [see Richardson, 1959; Clower, 1965]. Robert Clower, for example, explicitly claimed that Keynes did not reject orthodox equilibrium theory but only argued that it could not provide an adequate account of (short-run) disequilibrium macroeconomic phenomena; the theory of market equilibrium does not allow transactions to take place at disequilibrium prices (i.e. before reaching

equilibrium prices).

The microeconomic theorist's concern is more fundamental and has two different sources. The first started with Kenneth Arrow [1959], who explicitly identified a possible contradiction between the assumptions used to explain the behavior of individuals in a state of equilibrium and those necessary to explain the adjustment of prices in a state of disequilibrium. As Arrow saw it, perfect competition was consistent with any state of equilibrium but a disequilibrium would require an explanation of the movement toward equilibrium based on imperfect competition. The second source of current interest in disequilibrium economics has been the related concern for the knowledge requirements of any participant in a state of equilibrium [Richardson, 1959; Barro and Grossman, 1971; Solow, 1979]. Let us consider, in turn, these two microeconomic perspectives on disequilibrium concepts.

2.1. Equilibrium vs. Imperfect Competition

The problem addressed by Arrow [1959] is fundamental even though it has not caused any major revolutions in economic methodology. To appreciate his problem consider a market of m buyers and n sellers. At any given price each participant decides either how much to buy to maximize utility or how much to sell to maximize profits. The total demand is the sum of all the m individuals' demands and the total supply is the sum of all the n individuals' supplies. If the given price is the equilibrium price, the total demand will just equal the total supply. In such an equilibrium state each individual need only consider the given price and his or her private circumstances (income, resources, technology, etc.). Given the equilibrium price they will all unintentionally choose quantities which are market clearing – regardless of the number of buyers and sellers. But, what happens if the market participants are not given the equilibrium price? To answer the question, consider the following table for any given price (P):

Demand	*Supply*
d_1	s_1
d_2	s_2
d_3	s_3
⋮	⋮
d_m	s_n
Totals:$(d_1+d_2+...+d_m)$	$(s_1+s_2+...+s_n)$

If the given price (P) is not the equilibrium price, 'total demand' does not equal the 'total supply'. If the demand is greater than the supply at least one of the m demanders is not able to buy the quantity which maximizes his or her utility. An excess supply means that at least one of the n suppliers cannot maximize profit. In either case, equilibrium theorists recognize that someone will have to compete by offering a different price if maximization is still the objective. The disappointed demander would have to bid the price up and the disappointed seller would have to bid the price down.

Arrow observes that our recognition that either a buyer or a seller would have to alter the 'given price' when it is not an equilibrium price means that we are not assuming that individuals are price-takers, as we would in the perfect competition theory of prices and quantities. What is required, Arrow said, is some form of an imperfect competition theory of price-quantity behavior. The question posed is, how do we explain the adjustment of price and the process of learning the demand or supply curve in a manner consistent with perfect competition? Later Donald Gordon and Allen Hynes [1970] argued, in effect, that such an explanation was generally impossible. Thus the question of how to provide a neoclassical disequilibrium adjustment and learning process was left in abeyance.

2.2. Equilibrium and Necessary Knowledge

Some critics of neoclassical economics have focused on the logical requirements of any state of equilibrium, rather than on what is required for a disequilibrium learning process. George Shackle [1972] and Herbert Simon [1979] have each repeatedly argued that there is a problem with any equilibrium concept which requires universal maximization. On the one hand, Shackle argues that we have no reason to think that any individuals going to the market could have acquired sufficient knowledge in advance to ensure they actually are all maximizing. On the other hand, Simon argues that even if such knowledge acquisition were logically possible, it would be too difficult or too costly. In either case the likelihood of ever being able to satisfy the knowledge requirement for equilibrium is questioned.

In a similar examination of the requirements for a state of equilibrium, G. B. Richardson [1959] identified two types of knowledge: *private* knowledge of one's own circumstances such as income, tastes, technical abilities, etc., and *public* knowledge such as what other people will demand or supply in the market. While assuming that everyone can know with adequate certainty about his or her private circumstances might be acceptable, there is little reason to think that everyone has adequate knowledge about the public behavior of other market participants. There is more reason to think that every individual market participant

must form expectations about the public circumstances. Unless there is some way of forming these expectations 'rationally' – that is, in a manner consistent with maximization-type decision-making – there is no reason to expect any individual to make the optimal choice in the market and hence no reason to expect an equilibrium.

Still, if we are only interested in building models, one could simply begin with the assumption that an equilibrium exists. If one does assume that an equilibrium exists, one would be implicitly assuming that everyone has somehow acquired sufficient knowledge to be maximizing without necessarily claiming that knowledge is perfect. Today this is often handled as a question of how to deal optimally with uncertainty – that is, is there an optimal method of making decisions when one's knowledge is uncertain? How one answers this question depends on one's theory of knowledge or of learning. If one believes that everyone learns only by collecting more information – that is, by *induction* – in that more information means less uncertainty, then the question concerns the economics of information. It is a question of comparing the benefits and costs of information acquisition [e.g., Stigler, 1961]. Given that information is costly, there is claimed to be an optimum degree of uncertainty such that the benefits of less uncertainty do not exceed the extra cost of reducing uncertainty. In the economics of information, the quality of one's knowledge or expectations is chosen 'rationally' when the net benefit of information collection has been maximized. Such rational expectations models simply assume that learning is inductive, and consequently that if a more perfect equilibrium were a benefit to anyone there would be an incentive for someone to collect the required additional information. In rational expectations models (*given inductive learning*) a real-time equilibrium does not require perfectly certain knowledge as some of the critics of such models seem to think. But more important, given inductive learning, any so-called disequilibrium can be explained away by one of two arguments. On the one hand, the charge of 'disequilibrium' wrongly presumes that the alternative perfect state of equilibrium is economically feasible. On the other hand, the state of disequilibrium exists only because not enough time has been allowed for the participants to acquire the necessary degree of certainty to make equilibrium decisions. If we were to deny the possibility of inductive learning, it is not clear that a state of disequilibrium can so easily be explained away.

3. The Hidden Agenda of Comparative Static Methodology

By any usual definition, the existence of an equilibrium requires that all participants be making optimal choices, so a disequilibrium implies that at least one of them is not. In order to *explain* (rather than explain away) a disequilibrium, what is needed is an explanation of why an individual might be in a non-optimal situation. What will be argued in Part I is that all orthodox models of non-optimal situations are strongly dependent on the conceptual possibility of an optimal situation. This dependence opens the door to the view that there is a certain unity of method concerning the explanation of disequilibria – a disequilibrium can be explained only as a distortion from some ideal optimum state. Since all orthodox theories of disequilibrium are indirectly based on optimizing models, there is a certain methodological vulnerability when the knowledge requirements for disequilibrium models are considered.

The major difficulty with any attempt to explain a disequilibrium state is determining what would be an acceptable explanation. Basing one's explanation on the existence, in principle, of a state of equilibrium begs too many questions. Nevertheless, there are some minimum requirements which every neoclassical theorist accepts. To be acceptable to any mainstream neoclassical economist there are two important considerations which we call the 'hidden agenda' [Boland, 1982a]. The first is the requirement that any explanation must come to grips with the 'problem *of* induction'. Either we demonstrate how individuals learn inductively, that is, acquire the necessary knowledge or expectations to make maximizing decisions or we explain how they cope with the 'problem *with* induction'. As there is no inductive logic that would allow individuals to learn *only* from experience we must show how people make judgements from limited information. Either one solves these problems or one gives reasons why they need not be solved.

The second, and more important, requirement is that in any neoclassical explanation of the economy all phenomena can be explained on the basis that only individuals make decisions. This requirement is called 'methodological individualism'. It is primarily a restriction on the type of exogenous variables that can be presumed in any complete model. While, by definition, every endogenous variable can be seen to be the direct or indirect consequence of individuals making choices, exogenous variables are not chosen by anyone. They are the ultimate givens of any model. While the exogenous variables influence the ultimate values of the endogenous variables, any change in an endogenous variable will not have an influence on the values of the exogenous variables. The only variables that cannot be influenced by someone's decisions are the

naturally given variables such as the weather, the amount of resources available on Earth and any physical limitations to one's productive skills. From the perspective of one individual there are many non-natural givens that cannot be influenced directly by his or her choices. The existing laws or other social institutions are the most obvious. Nevertheless, laws or institutions are not natural phenomena and so they cannot be used as exogenous variables in the ultimate explanation of the individual's behavior. If we accept the requirement of methodological individualism then any social institution or event, such as the market price or equilibrium, must ultimately be explained as the intentional or unintentional consequence of the actions of individuals and not the consequence of natural phenomena alone. One implication is that if individuals are thought to interact in any way, the complete explanation of one individual requires the simultaneous explanation of all individuals.

While almost all neoclassical theorists openly accept the requirements of methodological individualism, few seem fully aware of the complexity of the requirement. Moreover, they are unaware of the conflicts between their tools of analysis and their commitment to methodological individualism. Our main purpose in this book is to examine the many ways in which our standard model-building techniques (such as comparative statics and general equilibrium analysis) often create hidden obstacles for the fulfillment of the task of building microeconomic models that are consistent with methodological individualism. Most theorists seem to think that all that is required is an explanation sufficiently general that to be applicable to all individuals. Thus when one individual's behavior is explained, the behavior of every individual is explained. With this in mind, it is not always clear what is meant by 'an individual's behavior'. As Arrow pointed out, a universal theory of the individual may only work if one is explaining the behavior of the typical individual in a state of general equilibrium. If we consider a state of disequilibrium then some individuals may have to be explained differently than others. We will argue here that what is needed is a generalized methodological individualism, one that not only requires that only individuals make decisions, but does so in a manner that allows individualistic choice behavior. And thus, if everyone is behaving in the *same* way we must explain why they chose to do so. Any microeconomics that needs to presume that everyone is alike in order to explain social events is not really explaining individual behavior.

We will argue here that the problem of induction is more of an explanatory obstacle than a requirement, and has unfortunately made it difficult for disequilibrium theorists to make much headway towards solving the problem posed by Arrow. There is another related difficulty that has hindered understanding of disequilibrium phenomena. This is the view that the only way to represent an individual is in terms of psychology [Scitovsky, 1976]. That is, suppose two people face the same constraints. Will they make the same decision? The usual answer would be that they would not. If we ask why the two people would differ, the answer would have to be because they are individuals. If we ask how they are different as individuals, the answer would ultimately be that they are psychologically different. For example, their tastes are given psychologically and may be different. We call this approach to individuality 'psychologism', and when it is combined with the requirements of methodological individualism, we call it 'psychologistic individualism'. Typically, in economics, the more narrow requirements of the psychologistic version of methodological individualism are taken for granted. Individuals are identified with their psychologically given utility functions and are presumed to be endowed with certain learning skills which really reduce to a matter of how fast they learn inductively. Inductive learning is almost always taken to be a psychological fact of nature.

We will eventually argue that, while we accept the requirement of methodological individualism (only people make decisions – things do not make decisions), we cannot assume inductive learning or psychologism if we are going to build a complete neoclassical model of the economy. A complete model is one that not only explains the state of equilibrium but also explains why any given state of disequilibrium will either persist or be eventually transformed into an equilibrium state by the actions of autonomous individuals.

4. An Outline of the Book

Before we can come to grips with the problem of providing a uniform method of explaining equilibrium states as well as disequilibrium states, we must arrive at a clear understanding of how psychologistic individualism both constrains and motivates the neoclassical use of equilibrium models. We do this in Chapter 1. Our idea of an equilibrium is closely related to our understanding of an individual's optimization decision process, a relationship which we examine in Chapter 2. We will see that the question posed by any relationship between a disequilibrium of an entire economy and the optimizing decisions of singular individuals involves difficulties for maintaining a methodological individualist view of the economy. Thus, in Chapter 3 we dig a little deeper to find that the fundamental concepts of differential calculus are the primary tools used to support methodological individualism. But, the use of fundamental

calculus concepts, such as the partial derivative, may actually limit us to restrict our explanations to the behavior of individuals in a state of long-run or general equilibrium. This is only made apparent when we consider, in Chapter 4, the precarious relationship between individualism and the possibility of a logically consistent disequilibrium state. If there is a problem with the use of calculus, it is still not clear whether it is an inherent problem of calculus itself or merely the result of how we use calculus in economic explanations. In Chapter 5 we dig even deeper to see how many of the difficulties with methodological individualist models of disequilibrium may be the result of problems inherent in calculus.

The basic thrust of recent examinations of models which question the adequacy of equilibrium models is that any model which uses an equilibrium state must include an analysis of the stability of the presumed equilibrium. This turns out in most cases to be a question of the dynamics of decision processes. It is not clear that the idea of an equilibrium is compatible with the dynamics of an individual's decision-making process. So, in Chapters 6 and 7 we consider several approaches to determining what it might take to make equilibrium models capable of dealing with the dynamics of individual decision-makers. In Chapter 8, we briefly examine the usual ways of avoiding the questions posed by the consideration of the dynamics of equilibrium models.

The primary question we are addressing throughout this book concerns what it would take to provide a complete explanation of the behavior of autonomous individuals without violating the requirements of methodological individualism. In the last three chapters we consider the three obvious avenues for dealing with all the methodological problems of constructing a complete microeconomics, that is, a microeconomic theory that explains the behavior of individuals whether they be facing equilibria or disequilibria. Our primary argument throughout will be that the only way to construct such a complete microeconomics is to recognize that individuals must every day come to grips with the methodological problems of learning; at the same time it must be recognized that there is no possibility of inductive learning, and that the usual psychologism of neoclassical models is actually a denial of individualism.

Part I

The Economics of Sub-optimal Economies